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Summary Volume Acronyms and Abbreviations

A/D	assembly/disassembly
AHF	Advanced Hydrotest Facility
ARS (X-1)	Advanced Radiation Source
BEEF	Big Explosive Experimental Facility
CEQ	Council on Environmental Quality
CFF	Contained Firing Facility
Complex	Nuclear Weapons Complex
CTBT	Comprehensive Test Ban Treaty
DARHT	Dual-Axis Radiographic Hydrodynamic Test
D&D	decontamination and decommissioning
DOD	Department of Defense
DOE	Department of Energy
DP	DOE Office of the Assistant Secretary for Defense Programs
EIS	environmental impact statement

FXR	Flash X-Ray
HE	high explosives
HEPPF	High Explosive Pulsed Power Facility
HEU	highly enriched uranium
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
NEPA	*National Environmental Policy Act*
NIF	National Ignition Facility
NLVF	North Las Vegas Facility
NPR	Nuclear Posture Review
NPT	Nuclear Nonproliferation Treaty
NTS	Nevada Test Site
NWSM	Nuclear Weapon Stockpile Memorandum
NWSP	Nuclear Weapon Stockpile Plan
ORR	Oak Ridge Reservation
Pantex	Pantex Plant
PDD	Presidential Decision Directive
PEIS	programmatic environmental impact statement
R&D	research and development
ROD	Record of Decision
SNL	Sandia National Laboratories/New Mexico
SRS	Savannah River Site
START	Strategic Arms Reduction Talks
Y-12	Y-12 Plant, Oak Ridge Reservation

SUMMARY

S.1 INTRODUCTION

The Department of Energy (DOE) is the Federal agency responsible for providing the Nation with nuclear weapons and ensuring that those weapons remain safe and reliable. This programmatic environmental impact statement (PEIS) analyzes the potential consequences to the environment if certain changes to the Nuclear Weapons Complex (Complex) are implemented to support DOE's Stockpile Stewardship and Management Program.

Stockpile stewardship and stockpile management describe DOE's management of the nuclear weapons program. While these terms are not new, DOE has recently redefined them in light of its current roles and responsibilities. Stockpile stewardship comprises the activities associated with research, design, development, and testing of nuclear weapons, and the assesument and certification of their safety and reliability. These activities have been performed at the three DOE weapons laboratories and the Nevada Test Site (NTS). Stockpile management comprises operations associated with producing, maintaining, refurbishing, surveilling, and dismantling the nuclear weapons stockpile. These activities have been performed at the DOE nuclear weapons industrial facilities (see figure S.1-1).

Since the inception of nucWar and changes in the world's political regimes, the emphasis of the U.S. nuclear weapons program has shifted dramatically over the past few years from developing and producing new weapons to dismantlement and maintenance of a smaller, enduring stockpile. Accordingly, the nuclear weapons stockpile is being significantly reduced, the United States is no longer manufacturing new-design nuclear weapons, and DOE has closed or consolidated some of its former weapons industrial facilities. Additionally, in 1992 the United States declared a moratorium on underground nuclear testing, and in 1995 President Clinton extended the moratorium and decided to pursue a lear weapons in the 1940s, DOE and its predecessor agencies have been responsible for stewardship and management of the Nation's stockpile. In response to the end of the Cold "zero-yield" Comprehensive Test Ban Treaty (CTBT). Even with these significant changes, DOE's responsibilities for the nuclear weapons stockpile continue, and the President and Congress have directed DOE to continue to maintain the safety and reliability of the enduring nuclear weapons stockpile.

In response to direction from the President and Congress, DOE has developed its Stockpile Stewardship and Management Program to provide a single, highly integrated technical program for maintaining the continued safety and reliability of the nuclear weapons stockpile. It has evolved from predecessor programs that served this mission over previous decades. With no underground nuclear testing, and no new-design nuclear weapons production, DOE expects existing weapons to remain in the stockpile well into the next century. This means that the weapons will age beyond original expectations and an alternative to underground nuclear testing must be developed to verify the safety and reliability of weapons. To meet these new challenges, DOE's science-based Stockpile

Stewardship and Management Program has been developed to increase understanding of the basic phenomena associated with nuclear weapons, to provide better predictive understanding of the safety and reliability of weapons, and to ensure a strong scientific and technical basis for future U.S. nuclear weapons policy objectives.

The size and composition of the U.S. nuclear weapons stockpile is determined annually by the President. The Department of Defense (DOD) prepares the Nuclear Weapon Stockpile Plan (NWSP) based on military requirements and coordinates the development of the plan with DOE concerning its ability to support the plan. The NWSP, which is classified, covers the current year and a 5-year planning period. It specifies the types and quantities of weapons required and sets limits on the size and nature of stockpile changes that can be made without additional approval by the President. The Secretaries of Defense and Energy jointly sign the Nuclear Weapon Stockpile Memorandum (NWSM), which includes the NWSP and a long-range planning assesument. As such, the NWSM is the basis for all DOE stockpile support planning.

The Stockpile Stewardship and Management PEIS discusses the relevant factors, such as treaties, that shape the NWSM. Also explained is the fact that potential variances in stockpile size, such as a Strategic Arms Reduction Talks (START) I Treaty-sized stockpile versus a START II protocol-sized stockpile, affect only the issue of manufacturing capacity required for the foreseeable future. National security policies in the post-Cold War era require that all the historical capabilities of the weapons laboratories, industrial plants, and NTS be maintained. Capability is the practical ability to perform a basic function or activity. Stockpile stewardship and management capabilities are independent of foreseeable future stockpile sizes. Stockpile management manufacturing capacities are examined in this PEIS, including those required to support a hypothetical low case stockpile size below START II. This was done to examine the sensitivity of potential decisions to transfer manufacturing activities to the weapons laboratories and NTS versus downsizing the industrial plants in place.

S.1.1 Background

A general understanding of nuclear weapons, including the components that make up a weapon and the physical processes involved, helps one understand the scope of the Stockpile Stewardship and Management PEIS and what is to be accomplished by the Stockpile Stewardship and Management Program. Figure S.1.1-1 presents a simplified diagram of a modern nuclear weapon. An actual nuclear weapon produced in the United States is much more complicated, consisting of many thousands of parts.

The nuclear weapon primary is composed of a central core called a pit, which is usually made of plutonium-239 and/or highly enriched uranium (HEU). This is surrounded by a layer of high explosives (HE), which when detonated, compresses the pit, initiating a nuclear reaction. This reaction is generally thought of as the nuclear fission "trigger," which activates the secondary assembly component to produce a thermonuclear fusion reaction. The remaining nonnuclear components consist of everything from arming and firing systems to batteries and parachutes. The production and assembly of many of these components is accomplished at dedicated industrial facilities. Assembly and disassembly (A/D) of nuclear weapons is done only at Pantex.

S.1.2 Alternatives Analyzed in this *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*

DOE must maintain a Complex with sufficient capability and capacity to meet current and future weapons requirements. For those activities associated with the ongoing stockpile stewardship program, DOE proposes to add enhanced capabilities to existing stockpile stewardship facilities to fulfill requirements. For those activities associated with the ongoing stockpile management program, DOE does not propose to construct any major new weapons industrial facilities. Rather, DOE proposes to "rightsize" existing facilities or consolidate them to fulfill expected requirements for manufacture of repair or replacement components for an aging U.S. stockpile.

This PEIS addresses potential changes to the future missions of the three weapons laboratories, the four weapons industrial plants, and NTS. A No Action alternative is also described and analyzed. Figure S.1-1 shows the locations of the eight DOE sites comprising the current Complex. Tables S.3.2-1 and S.3.4-1 show the alternatives analyzed.

To estimate the potential environmental impacts from modifying/constructing and operating the facilities proposed for stockpile management, DOE assumes that facilities would be sized and operated to support a base case stockpile size consistent with the START II protocol. This PEIS also discusses impacts that would be expected for supporting a larger stockpile based on START I Treaty levels, and a hypothetical stockpile smaller than the START II protocol.

With regard to stockpile management facilities, potential environmental impacts from the base case are analyzed quantitatively in the greatest detail, while impacts from the high and low cases are discussed qualitatively. The facilities proposed for stockpile stewardship are independent of projected stockpile size.

The stockpile stewardship portion of this PEIS evaluates the potential environmental impacts of the proposed actions and the reasonable alternatives for carrying out the stockpile stewardship functions. As described in section S.2.4, the three independently justified proposed facilities include the National Ignition Facility (NIF), the Contained Firing Facility (CFF), and the Atlas Facility. Four sites (figure S.1-1) are potentially affected by the stockpile stewardship alternatives: Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratories (SNL), and NTS (includes NLVF). This PEIS also assesses the No Action alternative of relying on existing experimental facilities and continuing the missions at these four sites to fulfill the stockpile stewardship mission.

The science-based stockpile stewardship program is expected to continuously evolve as better information becomes available and technological advances occur. Additional experimental facilities, such as the Advanced Hydrotest Facility (AHF), the High Explosives Pulsed Power Facility (HEPPF), the Advanced Radiation Source (ARS [X-1]), and the Jupiter Facility are considered to be next generation facilities that may be required in the future to support stockpile stewardship objectives. However, these facilities are not proposed actions in this PEIS because they have not reached the stage of development and definition that is necessary for evaluation and decisionmaking.

The stockpile management portion of this PEIS evaluates the potential environmental impacts of the reasonable alternatives for carrying out the stockpile management functions. Alternatives are assessed for nuclear weapons A/D and for fabricating pit, secondary and case, HE, and nonnuclear components. Eight sites (figure S.1-1) are potentially affected: Oak Ridge Reservation (ORR), Savannah River Site (SRS), Kansas City Plant (KCP), Pantex Plant (Pantex), LANL, LLNL, SNL, and NTS. This PEIS also assesses the No Action alternative of relying on existing facilities and continuing the missions at the current sites to fulfill the stockpile management mission.

S.1.3 *National Environmental Policy Act* Strategy for Stockpile Stewardship and Management

This PEIS has been prepared in accordance with section 102(2)(c) of the *National Environmental Policy Act* (NEPA) of 1969, as amended (42 U.S.C. 4321 et seq.), and implemented by regulations promulgated by the Council on Environmental Quality (CEQ) (40 CFR 1500-1508) and DOE regulations (10 CFR 1021). Under NEPA, Federal agencies, such as DOE, that propose major actions that could significantly affect the quality of the human environment are required to prepare an environmental impact statement (EIS) to ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. For broad actions, such as the Stockpile Stewardship and Management Program, a PEIS is prepared.

DOE's NEPA compliance strategy for the Stockpile Stewardship and Management Program consists of two phases. The first phase includes the Stockpile Stewardship and Management PEIS and subsequent Records of Decision (ROD). Decisions will be based on relevant factors including economic and technical considerations, DOE statutory mission requirements, policy considerations, and environmental impacts. In addition to the analyses in this PEIS, engineering studies, cost, schedule, and technical feasibility analyses will be considered in the ROD. The ROD is expected to identify the effects of U.S. national security policy changes on Stockpile Stewardship and Management Program missions and determine the configuration (facility locations) necessary to accomplish the Program missions.

During the second phase of the NEPA strategy, which would follow the PEIS ROD, DOE would prepare any necessary project-specific NEPA documents to implement any programmatic decision. However, as explained below, this PEIS also includes project-specific environmental analyses for the experimental facilities proposed for stockpile stewardship.

For the three facilities in the proposed action for stockpile stewardship--NIF, CFF, and the Atlas Facility--the Stockpile Stewardship and Management PEIS is intended to include sufficient project-specific analyses to complete NEPA requirements for siting, construction, and operation, and thus, satisfy both phases of the NEPA compliance strategy. This PEIS supports the programmatic decisions on whether to proceed with the facility and, if so, where to site the facility. The project-specific analysis describes the detailed construction and operational impacts for each facility at the alternative sites. Each proposed facility's project-specific analysis can be found in Volume III of this PEIS.

S.1.4 Related Recently Completed *National Environmental Policy Act* Actions

Two other actions that DOE has already evaluated in separate EISs, in accordance with CEQ regulations for interim actions (40 CFR 1506.1), are within the scope of the Stockpile Stewardship and Management PEIS. These are the *Programmatic Environmental Impact Statement for Tritium Supply and Recycling* and the *Dual-Axis Radiographic Hydrodynamic Test* (DARHT) *Facility Environmental Impact Statement.*

The Tritium Supply and Recycling PEIS evaluated the potential environmental impacts associated with alternatives for siting, constructing, and operating tritium supply and recycling facilities. The purpose of the Tritium Supply and Recycling Program is to provide long-term, assured tritium supply and recycling to support the Nation's nuclear weapons stockpile. The Tritium Supply and Recycling Draft PEIS (DOE/EIS-0161) was issued in March 1995 and was followed by public hearings in April 1995. A Final PEIS was issued in October 1995, followed by the ROD published in the *Federal Register* (60 FR 63878) on December 12, 1995.

The DARHT *Facility EIS* analyzed the environmental consequences of alternative ways to accomplish enhanced high-resolution radiography for the purposes of performing hydrodynamic tests and dynamic experiments. These tests are used to obtain diagnostic information on the behavior of nuclear weapons primaries and to evaluate the effects of aging on nuclear weapons. The DARHT Facility's construction was about 34 percent complete when construction was halted under a U.S. District Court preliminary injunction issued on January 27, 1995, pending completion of the DARHT Facility EIS and issuance of the ROD. The DARHT Facility EIS evaluated the potential environmental impacts of six alternatives; the preferred approach entailed completing and operating the proposed DARHT Facility at LANL and implementing a phased enhanced containment strategy for testing at the DARHT Facility, so that most tests would be conducted inside steel vessels. The DARHT Facility Draft EIS (DOE/EIS-0228) was issued in May 1995 and was followed by public hearings in May and June 1995. A Final PEIS was issued in August 1995, followed by the ROD published in the *Federal Register* (60 FR 53588) on October 16, 1995.

In the ROD, DOE announced that it will complete and operate the DARHT Facility at LANL while implementing a program to conduct most tests inside steel vessels, with containment to be phased in over 10 years. Following the ROD, DOE filed a motion for dissolution of the injunction. On April 16, 1996, the U.S. District Court concluded that the purpose of the injunction had been satisfied, and therefore lifted the injunction and dismissed the case.

DOE will rely on hydrodynamic testing in the absence of underground nuclear testing to ensure the stockpile's safety and reliability. Under any course of action analyzed in this PEIS, DOE will still need to continue hydrodynamic testing and acquire near-term enhanced radiographic capability such as that provided by the DARHT Facility. DOE determined that implementing the DARHT Facility

ROD will not prejudice any decisions in the Stockpile Stewardship and Management Program. The impacts of the DARHT Facility for each resource area are addressed in the No Action impact discussions for LANL in Volume I, section 4.6.3.

S.1.5 Other Department of Energy Ongoing *National Environmental Policy Act* Reviews

In addition to the two completed actions identified above, DOE is currently preparing other programmatic, project-specific, and site-wide NEPA documents. The following major documents have been determined to have potential cumulative effects for the sites being analyzed by this Stockpile Stewardship and Management PEIS, and are described in this PEIS and included in the analysis. This PEIS describes and includes in its analysis the ongoing alternatives being developed by the *Waste Management Programmatic Draft Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* ; the *Storage and Disposition of Weapons-Usable Fissile Materials Draft Programmatic Environmental Impact Statement* ; the *Site-Wide Draft Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* ; the Site-Wide EIS for the Los Alamos National Laboratory; and the Site-Wide EIS for the Nevada Test Site.

In May 1994, when DOE announced its intention to prepare the Pantex Site-Wide EIS, DOE believed that the Pantex Site-Wide EIS ROD would precede decisionmaking on the long-term storage of pits by at least several years. Accordingly, the Draft Pantex Site-Wide EIS was scoped to address alternative locations for interim pit storage (i.e., until the long-term decisions were made and implemented).

Since May 1994, DOE has initiated two additional NEPA documents that address the storage of pits. This Stockpile Stewardship and Management PEIS will support decisions on the long-term storage of pits that will be needed for national security requirements (strategic reserve pits). The Storage and Disposition PEIS will support decisions on the long-term storage of all pits (strategic reserve and surplus) and the approach for dispositioning pits that are surplus to national security requirements.

Both of these PEISs have progressed to the point where they are scheduled to have their RODs issued by the Fall of 1996, at or about the same time as the ROD for the Pantex Site-Wide EIS, which is scheduled for November 1996. Therefore, DOE is proposing that so long as the RODs of both the PEISs and the Pantex Site-Wide EIS occur within a short period of time of one another, decisions on the long-term storage of pits would be made in the RODs of the PEISs. A decision relating to the interim storage of pits at Pantex would be made in the ROD of the Pantex Site-Wide EIS pending implementation of the selected long-term storage option.

However, if there is a significant delay in the RODs for either of the PEISs, or if DOE does not make a decision on the long-term storage of pits in those RODs, then there would be a need to make a decision on the location of interim storage of pits uninformed by a decision on long-term storage. In any event, the Pantex Site-Wide EIS will be completed with the analysis of interim storage alternatives, including addressing the issues and comments received from the public on that EIS, to support a decision relating to the storage of pits until a long-term storage decision has been made and implemented.

S.1.6 Public Participation

Public participation for this PEIS consisted of two primary activities: the scoping process and the public comment process. CEQ regulations require "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7)." This is usually called the public scoping process. Section 4.1 of the *Implementation Plan Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (DOE/E1S-0236IP, December 1995) describes the scoping process. The following sections describe the public comment process on the Draft EIS.

S.1.6.1 *Public Comment Process on the Draft Programmatic Environmental Impact Statement*

In February 1996, DOE published the Stockpile Stewardship and Management Draft PEIS that evaluated the siting, construction, and operation of the proposed stockpile stewardship facilities and the modification/construction and operation of facilities proposed for stockpile management at eight alternative sites within the Complex. The 60-day public comment period for the Draft PEIS began on March 8, 1996, and ended on May 7, 1996. However, late comments were accepted to the extent practicable.

During the comment period, public hearings were held in Los Alamos, NM; Albuquerque, NM; Las Vegas, NV; Oak Ridge, TN; Kansas City, MO; Livermore, CA; Washington, DC; Amarillo, TX; Santa Fe, NM; and North Augusta, SC. Five of the public hearings were joint meetings to obtain comments on both the Stockpile Stewardship and Management PEIS and the Storage and Disposition PEIS. Two of the joint meetings (Pantex and SRS) also included the Pantex Site-Wide EIS. In addition, the public was encouraged to provide comments via mail, fax, electronic bulletin board (Internet), and telephone (toll-free 800 number). Figure S.1.6.1-1 shows the dates and locations of the hearings.

The public hearings held for the Draft PEIS were conducted using an interactive workshop-type format. The format chosen allowed for a two-way interaction between DOE and the public and encouraged informed public input and comments on the document. Neutral facilitators were present at the hearings to direct and clarify discussions and comments. Court reporters were also present to provide a verbatim transcript of the proceedings and record any formal comments.

All public hearing comment summaries were combined with comments received by mail, fax, Internet, or telephone during the public comment period. Volume IV of this PEIS, the *Comment Response Document* , describes the public comment process in detail, presents comment summaries and responses, and provides copies of all comments received.

S.1.6.2 *Major Comments Received on the Draft Programmatic Environmental Impact Statement*

A large number of the comments received on the Draft PEIS related to concerns that the analysis of particular alternatives and/or alternative sites did not adequately consider such factors as cost and technical feasibility. Although these concerns made up the majority of the comments, many other comments related to the resources analyzed, NEPA and regulatory issues, and DOE and Federal policies as they related to the PEIS. The major issues identified by commentors include the following:

- The potential conflict between the Stockpile Stewardship and Management Program and the Nuclear Nonproliferation Treaty (NPT) goals, and the pursuit of a CTBT
- Using the funds allocated for the Stockpile Stewardship and Management Program for social programs and on research of alternative sources of energy
- The generation, storage, and disposal of radioactive and hazardous wastes and the associated risks
- The impacts of the alternatives on human health (both from radiation and hazardous chemicals) and how these risks were determined and evaluated
- The relationship of this PEIS to other DOE documents and programs, particularly the Pantex and NTS Site-Wide EISs, the Waste Management and the Storage and Disposition PEISs, and the need to make decisions based on all associated programs and activities concurrently
- The need for decisions to be based on many different factors, including environmental, cost, and safety concerns
- The need for DOE to consider a zero-level stockpile, remanufacturing, and denuclearization as alternatives
- Maintaining deterrence with surveillance, curatorship, and remanufacturing without the need for the proposed facilities
- The need for DOE to adequately consider the ongoing stewardship programs
- The need for DOE to perform detailed analysis of future stockpile stewardship facilities.

All of the issues identified above are summarized and responded to in detail in chapter 3 of Volume IV. Substantial revisions to this PEIS resulting from public comments are discussed below.

Revisions in the Final PEIS include additional discussion and analysis in the following areas: alternatives considered but eliminated (section 3.1.2); the No Action alternative (appendix A "Stockpile Stewardship and Management Facilities," sections A.1.5, A.1.6, A.1.7, and A.1.8); socioeconomics at ORR, Pantex, and KCP; accident impacts at Pantex; normal operation impacts for radiological and chemical sections; cumulative impacts (section 4.13); and minor changes to LANL water resources section (4.6.2.4). A new section was also added to appendix F (section F.4, Secondary Impacts of Accidents). Each of these areas is discussed in more detail in the following section.

S.1.6.3 *Changes from the Draft Programmatic Environmental Impact Statement*

As a result of comments received on the Draft PEIS, several changes were incorporated into this PEIS. A brief discussion of the more significant changes is provided in the following paragraphs.

Alternatives Considered but Eliminated from Detailed Study and Related Issues. In response to public comments expressing a concern that DOE had not analyzed a reasonable range of alternatives, section 3.1.2 was expanded. The changes were in response to specific questions concerning compliance with treaties, stockpile size, maintenance and remanufacturing options, and the stockpile stewardship alternatives including No Action. The discussions in section 3.1.2 provide greater detail and more clarification on why alternatives were eliminated from detailed study in this PEIS. Together, chapter 2 and section 3.1.2 explain the framework and the constraints of national security policy that have shaped the proposed actions and reasonable alternatives for this PEIS.

No Action Alternative. Several commentors did not think that the No Action alternative was clearly explained in the Draft PEIS. More specifically, they were not sure which existing facilities at LANL, LLNL, SNL, and NTS were part of the ongoing stockpile stewardship program. As a result, the description of No Action was modified in appendix A to include a listing of major DOE Office of Defense Programs (DP) facilities at LANL, LLNL, SNL, and NTS. Additionally, the discussion of impacts of No Action at LANL (section 4.6.3) was revised as appropriate to include the effects of the DARHT Facility.

Socioeconomics at Oak Ridge Reservation, Kansas City Plant, and Pantex Plant. Based on public comments and revised workforce size estimates, the socioeconomic impact sections for the downsizing alternatives at ORR (section 4.2.3.8), KCP (section 4.4.3.8), and Pantex (section 4.5.3.8) have been revised. The analyses were also expanded to cover the base case single-shift options in greater detail. At these three sites, downsizing of existing facilities is the preferred alternative. For such downsizing, the base case single-shift scenario represents the bounding analysis for the workforce. The change in worker estimates did not cause any of the major indicators in the socioeconomic analysis to change in any significant manner.

Accident Impacts at Pantex Plant. The analyses of impacts due to an aircraft impact and the resulting release of plutonium by a fire or an explosion were modified to include more updated data on probability and source terms developed for the Pantex Site-Wide EIS. Section 4.5.3.9 and appendix sections F.2.1.1 and F.2.1.2 were revised to incorporate the new analytical results. Based on the updated data, the potential impacts and risks to the public from the composite accident presented in this PEIS would be less than previously reported in the Draft PEIS. This change was not significant.

Normal Operation Radiological/Chemical Impacts. The discussion of the normal operation radiological affected environment for LANL, section 4.6.2.9, has been updated to include the latest data from *Environmental Surveillance at Los Alamos* During 1993 (LA-12973-ENV, October 1995). The normal operation radiological impact sections 4.2.3.9, 4.3.3.9, and 4.6.3.9 have also been revised to include the contribution of recent facilities at ORR, SRS, and the new environmental surveillance data for LANL. The chemical health effects, section 4.6.3.9 for LANL and section 4.7.3.9 for LLNL, were revised based on new analyses using updated dispersion rates. Tables in appendix section E.3.4 supporting these sections were also updated. The majority of these changes affected the No Action alternative analyses. None of the changes to these sections significantly changed the analysis of impacts for the "action" alternatives.

Cumulative Impacts. The cumulative impact section 4.13 has been modified to incorporate a discussion of normal operation radiological impacts and other changes based on more recent data from NEPA documents and RODs. The changes to this section did not have a meaningful effect on the analysis/comparative evaluation of alternatives.

Los Alamos National Laboratory Water Resources. Changes were incorporated in section 4.6.2.4 (Water Resources) for LANL based on more recent water use and water quality data. The Draft PEIS had erroneously stated that the LANL water allotment would be fully used by about the year 2000. The Final PEIS correctly reports that this allotment would be fully used by about the year 2052. This change did not have a meaningful effect on the analysis/comparative evaluation of alternatives. Minor revisions reflecting the baseline changes, were also made to the LANL water resources impact section 4.6.3.4.

Health Effects Studies. Appendix section E.4, which outlines epidemiological studies at the alternative sites, was rewritten to provide more detail and incorporate more recent and other applicable studies. Although these epidemiology sections do not affect the environmental analysis of future stockpile stewardship and management missions, they do provide relevant information regarding potential health effects from past actions. These changes did not have a meaningful effect on the analysis/comparative evaluation of alternatives.

New Section. A new section has also been added to the Final PEIS (appendix section F.4, Secondary Impacts of Accidents). This section evaluates the secondary impacts of accidents that affect elements of the environment other than humans (e.g., farmland). The section was added because of public comments. The results of this analysis show that secondary impacts from accidents would generally not extend beyond site boundaries, except at Pantex and LLNL, where it is possible that some surface contamination could occur. This new analysis did not have a meaningful effect on the analysis/ comparative evaluation of alternatives.

S.2 PURPOSE OF AND NEED FOR THE STOCKPILE STEWARDSHIP AND MANAGEMENT ACTION

The Stockpile Stewardship and Management Program is broad in scope and technically complex. The Program currently involves the integrated activities of three national laboratories, four industrial plants, and a nuclear test site. Further, the Program must be consistent with, and supportive of, U.S. national security policies, which have changed considerably since the end of the Cold War. Therefore, to better understand the Stockpile Stewardship and Management PEIS purpose, need, proposed action, and alternatives, it is useful to view the Program from two different perspectives. One perspective (see section S.2.1) is from the top level of national security policies for nuclear deterrence, arms control, and nonproliferation. These policies include ongoing responsibilities, strategies, and directives. The other perspective (see section S.2.2) focuses on the relevant technical efforts to maintain a safe and reliable U.S. nuclear weapons stockpile. Flow diagrams representing the logic of each perspective are included in figures S.2-1 and S.2-2.

S.2.1 National Security Policy Considerations

There are four principal national security policy overlays and four related treaties that define Program conditions for the reasonably foreseeable future. They are:

- Presidential Decision Directives (PDD)
- National Defense Authorization Act of 1994 (Pub. L. 103-160)
- DOD Nuclear Posture Review (NPR)
- NWSM
- Proposed CTBT
- NPT
- START I Treaty
- START II protocol

Of the above, the START II protocol is the most useful in helping define a specific time period to bound the reasonably foreseeable future.

Nuclear Posture Review

Beginning in 1991, several Presidential policy decisions, some unilateral and some made in conjunction with international treaties, resulted in DOD conducting the comprehensive NPR, which was approved by the President in 1994. The NPR defines and integrates past and present U.S. policies for nuclear deterrence, arms control, and nonproliferation objectives. The unclassified NPR strategies that pertain to the Stockpile Stewardship and Management Program were presented at the eight public scoping meetings conducted in the summer of 1995. There was general public interest in understanding this complex issue, especially as it relates to treaties, policies, and stockpile size. A summary of how the post-Cold War treaties relate to the NPR strategies and the stockpile follows.

Strategic Arms Reduction Talks. The NPR assumes that the START I Treaty and START II protocol will be fully implemented. However, since the START I Treaty is not yet fully implemented and the START II protocol is not scheduled to be fully implemented until 2003, the NPR strategy protects the U.S. option to reconstitute the stockpile to START I levels should unfavorable events occur in the former Soviet Union. The treaties only control the number of strategic nuclear weapons that can be loaded on treaty-specified and -verified strategic missiles and bombers. These nuclear weapons are limited to 6,000 by the START I Treaty and 3,500 by the START II protocol. The treaties do not control the total stockpile size or the composition of strategic and nonstrategic nuclear weapons of either side. The U.S. stockpile will be larger than 6,000 under START I and 3,500 under START II since the stockpile also includes retaining weapons for nonstrategic nuclear forces, DOD operational spares, and spares to replace weapons attrited by DOE surveillance testing. In the START II case, the stockpile may also include retaining weapons to reconstitute to the START I level. However, the terms "START I-sized stockpile" and "START II-sized stockpile" are relevant to the Stockpile Stewardship and Management PEIS as explained in the discussion of the NWSM.

Comprehensive Test Ban Treaty. It is the declared policy of the United States to seek ratification of a "zero-yield" CTBT as soon as possible. The United States has been observing a moratorium on nuclear testing since 1992. The NPR strategy reflects this policy and the strategy has a significant effect on shaping the Stockpile Stewardship and Management Program. As explained in section S.2.2, it is anticipated that repairs or replacements to an aging U.S. stockpile will be needed. Assesument and certification of the safety and reliability of stockpile repairs or replacements without nuclear testing is a significant challenge to the Stockpile Stewardship and Management Program. In declaring the policy to seek a CTBT, the President also declared that the continued safety and reliability of the U.S. nuclear stockpile is a "supreme national interest" of the United States.

Nuclear Nonproliferation Treaty. Article VI of the NPT obligates the parties "to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." However, the NPT does not provide any time period for achieving this goal. Even relatively simple bilateral treaties, such as START I and START II, require more than 10 years to implement, not counting the years of negotiations. In the words of Ambassador Thomas Graham, "Regrettably, none of us is clairvoyant, and so it is unwise to predict with any degree of precision the future international reality and consequently, the complete arms control agenda." [1] For the Stockpile Stewardship and Management PEIS, speculation on the terms and conditions of a "zero level" U.S. stockpile with international verification, as some have suggested during the scoping meetings, goes beyond the bounds of a reasonably foreseeable future. For the same reason, DOE has not chosen to speculate on a return of the nuclear arms race requiring a stockpile larger than START I size. However, in keeping with the NPT goals, the NPR strategy does express the U.S. intent to pursue further reductions in nuclear forces beyond START II. Therefore, the implications of further reductions below the START II-sized stockpile are discussed in this PEIS where they are relevant.

Nuclear Weapon Stockpile Memorandum

Although the NWSM is a classified document, its effect in shaping the Stockpile Stewardship and Management PEIS can be explained in an unclassified context. Without access to the classified NWSM, one might assume that the exact details of the projected stockpile size and composition under START I and START II could have a significant effect on the Stockpile Stewardship and Management PEIS. This is not the case for the following reasons:

- The stockpile composition (i.e., the number of different weapon types), does not vary significantly in either a START I- or START II-sized stockpile. All weapon types are tritium-boosted, thermonuclear weapons that could be affected by the same types of safety and reliability problems requiring repair, replacement, and certification in the absence of nuclear testing. The basic weapons laboratory and industrial capabilities required for the foreseeable future do not vary significantly from planned differences in size or composition of either a START I- or START II-sized stockpile.
- Industrial capacity is only indirectly affected by projected variances in stockpile size and composition. Stockpile size must be linked with historical stockpile data to arrive at estimates of average annual industrial capacity needed to produce components for repair or replacement. Even without the limitations on the use of historical stockpile data described in section S.2.2, this cannot be done with mathematical precision and therefore reasonable technical judgment must be applied. The result is to forecast a need for a smaller industrial base with capacities on a scale of hundreds of weapons per year versus the thousands of weapons per year that existed prior to the end of the Cold War. A range of annual requirements is considered for impact analysis in the Stockpile Stewardship and Management PEIS that bounds potential variances in the NWSM under the START II protocol. In addition, a qualitative sensitivity analysis is performed on the hypothetical low case that is well below the START II-sized stockpile projection and the high case associated with a START I-sized stockpile.

Presidential Decision Directives and Public Law

Over the past few years, there have been several publicly announced PDDs that have shaped the Stockpile Stewardship and Management Program. In the National Defense Authorization Act *of 1994* (Pub. L. 103-160), Congress acted to reinforce many of the same points. A summary of their effect in shaping the Stockpile Stewardship and Management PEIS follows:

- The continued maintenance of a safe and reliable nuclear weapons stockpile will remain a cornerstone of the U.S. nuclear deterrent for the foreseeable future.
- The core intellectual and technical competencies of the United States in nuclear weapons will be maintained. This includes competencies in research, design, development, and testing (including nuclear testing); reliability assesument; certification; manufacturing; and surveillance capabilities.
- The United States will develop new ways to maintain a high level of confidence in the safety, reliability, and performance of its nuclear weapons stockpile in the absence of nuclear testing. The strategy for this action will be structured around the use of past nuclear test data in combination with enhanced computational modeling, experimental facilities, and simulators to further comprehensive understanding of the behavior of nuclear weapons and the effects of

radiation on military systems. 2

- The continued vitality of all three DOE nuclear weapons laboratories will be essential in addressing the challenges of maintaining a safe and reliable nuclear weapons stockpile without nuclear testing and without the production of new-design weapons.

S.2.2 Safety and Reliability of the United States Stockpile

This section focuses on the technical effects of national security policy decisions on shaping the purpose, need, proposed actions, and alternatives of the Stockpile Stewardship and Management Program. The stockpile is currently judged to be safe and reliable by DOE. National security policy changes will significantly change the characteristics of the future nuclear weapons stockpile and the manner in which it will need to be certified as safe and reliable.

Stockpile History

Since the beginning of the Cold War, the United States has maintained a nuclear deterrent force as safe and reliable as the evolution of military requirements and technology development would permit. A safe and reliable U.S. nuclear weapons stockpile has been a cornerstone of maintaining a credible nuclear deterrent. The size of the U.S. nuclear weapons stockpile peaked in the 1960s. In the 1970s, it was significantly reduced due to the easing of Cold War tensions with the former Soviet Union. In the late 1970s and through most of the 1980s, Cold War tensions with the former Soviet Union significantly increased and the U.S. nuclear deterrent force was modernized in response. However, the size of the U.S. nuclear weapons stockpile remained stable during the 1980s with the production of new-design weapons replacing dismantled weapons nearly one for one.

The beginning of the 1990s brought the collapse of the Warsaw Pact and the former Soviet Union and a significant effort to end the Cold War. During the first half of the 1990s, many changes occurred in U.S. policy and planning for its nuclear deterrent force. Much has already been accomplished, including the dismantlement, without replacement, of more than 8,000 U.S. nuclear weapons since the end of the Cold War; however, much more will need to be accomplished with the former Soviet Union over the next 10 years to stay the course. Large uncertainties remain concerning the nuclear weapons stockpile of the former Soviet Union, and it is the policy of the United States to protect its national security options for its nuclear deterrent, including the reconstitution of its nuclear forces. The following excerpt is from the President's national security strategy statement in July 1994:

Even with the Cold War over, our Nation must maintain military forces that are sufficient to deter diverse threats ... We will retain strategic nuclear forces sufficient to deter any future hostile foreign leadership with access to strategic nuclear forces from acting against our vital interests and to convince it that seeking a nuclear advantage would be futile. Therefore we will continue to maintain nuclear forces of sufficient size and capability to hold at risk a broad range of assets valued by such political and military leaders.

Smaller, Aging Stockpile

Until recently there has been no reason to expect that weapons would remain in the stockpile longer than they have in the past. Continuous modernization to improve safety and reliability kept the stockpile young as new-design weapon types replaced old ones. Now, with no new-design weapons being produced, the United States will have a steadily aging stockpile. The average age of the stockpile has never approached the typical lifetime specified in the weapon requirements (approximately 20 years for the most modern U.S. nuclear weapons). The average age of the stockpile is currently about 13 years. The NWSM forecasts the average age will now climb roughly 1 year per year and will reach the 20 year mark by 2005, at which time the oldest weapons will be about 35 years old.

Historical Stockpile Data

The following paragraphs describe the effects of historical stockpile data in shaping the Stockpile Stewardship and Management Program. This information was extracted from an unclassified report, Stockpile Surveillance: Past and Future (tri-laboratory report requested by DOE and issued as Sandia Laboratory Report, SAND 95-2751, September 1995), which was co-authored by the three weapons laboratories and is available to the public. The past role of nuclear testing is emphasized because such testing can no longer be relied on to provide unambiguous high confidence in the future safety and reliability of an aging stockpile.

Stockpile Evaluation Program. [3]Continuous evaluation of the safety and reliability of the stockpile has always been a major part of the U.S. nuclear weapons program. Since the introduction of sealed-pit weapons more than 35 years ago, a formal surveillance program of nonnuclear laboratory and flight testing has been in existence. More than 13,800 weapons have been evaluated in this program. The Stockpile Evaluation Program, with its reliance on functional testing, has provided information that can be used in the statistical analysis of nonnuclear component and subsystem reliability. This program has detected about 75 percent of all problems ultimately detected, and it has been the principal mechanism for discovering defects and initiating subsequent repairs and replacements. However, not all aspects of a nuclear weapon can be statistically assessed this way. Weapons research and development (R&D) at the three weapons laboratories and nuclear testing have played an important part in assessing the stockpile and in making corrective changes when needed.

Past Role of Nuclear Testing. Nuclear tests have been a critical part of the nuclear weapons program. They have contributed to a broad range of activities from development of new weapons to stockpile confidence tests to tests that either identified a concern or showed that remedial actions were not needed. However, the United States has not conducted a sufficient number of nuclear tests for any one weapon type to provide a statistical basis of reliability assesusment for the nuclear explosive package. This is why the word "performance" instead of "reliability" is used when discussing a nuclear explosive package.

Although nuclear tests were never a part of the formal Stockpile Evaluation Program, they played an important role in maintaining the safety and performance of the weapons in the stockpile. Every advantage was taken of developmental nuclear tests to eliminate potential nuclear explosive problems. In some cases, nuclear testing during development of one weapon type uncovered a problem that was pertinent to a previous design already in the stockpile, which then had to be corrected. Nuclear tests identified certain classes of stockpile problems not observable in the surveillance program. Nuclear tests have been used to resolve issues raised by the Stockpile Evaluation Program, such as whether a particular corrosion problem affected the nuclear yield of a weapon. Nuclear tests have also been used to verify the efficacy of design changes. For example, the adequacy of certain mechanical safing techniques was determined through nuclear testing. In the case of a catastrophic defect, tests have been used to certify totally new designs to replace an existing design. Finally, in some cases, nuclear testing proved that a potential problem did not exist.

Beginning in the late 1970s, DOD and DOE agreed to a formal series of underground nuclear tests of weapons withdrawn from the stockpile. These tests were referred to as Stockpile Confidence Tests. They differed from developmental nuclear tests because the weapons were from actual production, had experienced stockpile conditions, and had minimal changes made to either nuclear or nonnuclear components prior to the test. There have been 17 such confidence tests since 1972, including 4 tests in the early 1970s that were not officially designated as Stockpile Confidence Tests. Confidence tests have been conducted for each of the weapon types expected to remain in the stockpile well into the next century.

In addition to the 17 confidence tests, at least 51 additional underground nuclear tests have been conducted since 1972 involving nuclear components from the stockpile, components from the actual weapon production line, or components built according to stockpile design specifications and tested after system deployment. The objectives of these tests included weapon effects, weapons R&D, confirmation of a fix, or investigation of safety or performance concerns. Three of these tests (in addition to one confidence test) revealed or confirmed a problem that required corrective action. Four tests (in addition to three confidence tests) confirmed a fix to an identified problem. Additionally, five tests were performed to investigate safety concerns affecting three different weapon types. These five tests verified that a problem did not exist.

The confidence in the performance of the nuclear explosive package has been based on underground nuclear test data, aboveground experiments, computer simulations, surveillance data, and technical judgment. The directors of the three weapons laboratories must certify the nuclear performance of the weapons designed by their laboratory.

In a future without additional nuclear testing, the core capabilities of the weapons laboratories that were developed to eliminate potential problems in new weapon designs must now be employed to assess stockpile problems. However, in the absence of nuclear testing, the ability to assess nuclear components is more difficult; new methods of assesument, discussed later, will have to be developed to help compensate for this loss.

Stockpile Data Summary. The historical stockpile database includes more than 2,400 findings from more than 45 weapon types. Findings are any abnormal conditions pertaining to stockpile weapons, such as out-of-specification data. Findings are then investigated and assessed as to whether or not they are a problem. Excluding multiple occurrences of the same anomalous condition, table S.2.2-1 provides a summary of the distinct findings and actionable findings since 1958. Actionable findings are those that require some form of corrective action. All major components and subsystems have had problems that required corrective actions. The number of findings for nonnuclear components is much larger than that for nuclear components largely because there are so many more nonnuclear components in a nuclear weapon that require testing more frequently. However, the ratio of actionable findings to distinct findings is much greater for the nuclear components. Thus, when a finding has occurred for a nuclear component, it has generally been a serious one requiring corrective action. Often these corrective actions to nuclear components have required changes to all of the weapons comprising the weapon type affected.

For the nuclear explosive package, there were approximately 110 findings on 39 weapon types requiring some remediation either to the entire build of that design or to all weapons produced after the particular finding. In addition to rebuilds and changes in production procedures, other actions included imposing restrictions on the weapon, accepting a performance decrement, and in several cases, conducting a nuclear test to determine that the finding did not require any physical change. There have been other instances not counted as actionable where a material was chemically changing and the weapon was closely monitored to see if further action was necessary or it was an isolated case that did not require remediation.

Table S.2.2-1. *Summary of Distinct and Actionable Findings Since 1958*

Type of Components	Distinct Findings	Actionable Findings	
		Findings	Weapon Types
Nuclear	145	110	39
Nonnuclear	703	306	38

Source: SNL 1996a.

Certified Repairs or Replacements will be Needed

Based on the age of the planned stockpile over the next 10 years, historical data would project an average of one to two actionable findings per year in the planned stockpile and an average of one to two change proposals approved per year, with one of these resulting in a major change. Even with a START II-sized stockpile, one change can affect thousands of weapons. These projections are most likely minimum numbers. The stockpile they were derived from was, on average, younger than the planned stockpile will be in future years, and the number of components in the weapon types was less than the number of components in weapon types of the planned stockpile. Furthermore, the aging characteristics of some of the materials used in the weapon types remaining in the stockpile are not well understood.

The previous paragraphs describe how problems were identified in stockpile weapons during the period when nuclear testing and active weapons development were being conducted along with the Stockpile Evaluation Program. At the present time, with no anticipated new weapons and no nuclear testing, new approaches are needed to assess weapons for potential problems and anticipate aging concerns, especially in the nuclear explosive package. This is important because the smaller, less diverse U.S. stockpile will be more vulnerable to single-component and common-cause failures (i.e., failures or defects compromising the safety or reliability of, respectively, a single weapon system or several systems sharing a common design feature).

DOE will continue to rely on well-established methods while the weapons laboratories develop new methods of measurement and evaluation to address aging, safety, reliability, and performance issues. As the new methods mature for either nuclear or nonnuclear components, they will be incorporated into the Stockpile Evaluation Program. In the future, for example, DOE will rely on improved experimental capabilities, coupled with an improved computational capability, to address issues associated with the nuclear explosive package. These experimental capabilities, along with enhanced surveillance methods, are now crucial to help assess and predict the state of the stockpile and to provide long lead time information about incipient problems.

S.2.3 Purpose and Need

Broadly stated, changes to U.S. national security policies for nuclear deterrence now place two significant constraints on the way in which DOE has traditionally accomplished its statutory nuclear weapons mission:

- The United States has declared a moratorium on nuclear testing and will seek ratification of a "zero-yield" CTBT.
- The United States has stopped the development and production of new-design nuclear weapons.

With these constraints, U.S. national security policy directs DOE to:

- Maintain the core intellectual and technical competencies of the United States in nuclear weapons including:
- Research, design, development, testing, reliability assesusment, certification, manufacturing, and surveillance
- All three nuclear weapons laboratories and the capability to resume nuclear testing if needed
- Maintain a safe and reliable U.S. nuclear weapons stockpile

The NPR, PDDs, and Pub. L. 103-160 all address the need to maintain the core competencies of the United States in nuclear weapons without nuclear testing. The NPR strategy adds the expectation of no new-design weapon production; therefore, the NWSM does not currently direct or forecast such a requirement.

The Stockpile Stewardship and Management Program must accomplish these fundamental purposes in a safe, efficient, and environmentally responsible manner. National security policies do not eliminate any of the current or historical core competencies and capabilities of the DOE weapons laboratories, industrial plants, or NTS. They are basic needs that must be maintained for the foreseeable future. These needs are summarized in a focused discussion of their relationship to the development of the PEIS proposed actions and alternatives. A classified appendix has also been prepared to support the PEIS.

Stockpile Stewardship--The Weapons Laboratories and Nevada Test Site

The three weapons laboratories possess most of the core intellectual and technical competencies of the United States in nuclear weapons. These competencies embody more than 50 years of weapons knowledge and experience that cannot be found anywhere else in the United States. Since the end of the Cold War, laboratory staffing in the weapons program has declined significantly due to the effects of policy changes on program and budget. Further significant reductions or consolidations of the weapons laboratories would counter efforts to maintain core competencies and to develop the new technologies necessary to ensure continued high confidence in a safe and reliable stockpile. Current stockpile activities in this regard, such as ongoing retrofits of enduring stockpile weapons and safe dismantlement of weapons no longer required, would also be hampered. For the foreseeable future it would be unreasonable to pursue an alternative course for the weapons laboratories. In addition, because there can be no absolute guarantee of complete success in the development of enhanced experimental and computational capabilities, the United States will maintain the capability to conduct nuclear tests under a "supreme national interest" provision in the anticipated CTBT. DOE will need to maintain the capability for nuclear testing and experimentation at NTS and the necessary technical capabilities at the weapons laboratories to design and conduct such tests.

The science and engineering technology base at the three weapons laboratories controls all DOE technical requirements for a U.S. nuclear weapon. The laboratories perform the basic research, design, system engineering, development testing, reliability assesument, and certification of nuclear performance. In addition, they provide or control all technical specifications that are used by the industrial base for manufacturing and surveillance operations and for maintenance operations conducted by DOD. Data from these operations are provided to the weapons laboratories for assesument and technical resolution of problems.

When stockpile problems develop, all of the core laboratory capabilities may come into play. The cause of the problem is identified and an assesument made of its impact on safety, reliability, or performance. If the problem is to be fixed, alternative solutions are developed. These can range from simple repair of a defective feature to complete redesign of the weapon component or subsystem.

The focus is always on the acquisition of relevant test data to make these judgments. Once a fix is determined, it must be designed, prototyped, and development tested by the laboratories before the design is released for manufacture. This generally includes weapon system-level laboratory and flight tests for nonnuclear features and, in the past, nuclear tests if the changes could affect the weapon's nuclear performance. If the fix is to be manufactured, the laboratories provide the quality assurance test specifications. For nonnuclear components, a significant amount of functional test data is acquired during manufacture and is used to begin building a statistical estimate of component reliability. Subsequent laboratory and flight testing in the surveillance program accumulates additional data that include the effects of aging and exposure to stockpile environments. Thus, over time, high confidence in the safety and statistical reliability of nonnuclear components and subsystems can be established.

The situation is not the same for nuclear components and the assesument of nuclear performance. Nuclear components cannot be functionally tested during manufacture or surveillance. The data acquired during manufacture only show that the component was manufactured as designed. Surveillance data indicate whether the component is changing as a result of aging or exposure to stockpile environments. Manufacturing and surveillance data can identify concerns, but these data do not provide all of the necessary information to assess nuclear performance. Assesument and certification of nuclear performance is a nonstatistical, technical judgment by the weapons laboratories based on scientific theory, experimental data, and computational modeling. The scientific practice of "peer review" has been fundamental to these judgments. Experts from the two nuclear design laboratories review each other's data and conclusions on important issues, thereby providing an independent check and balance.

In the past, nuclear testing filled the gaps in basic understanding of the complex physics phenomena; it provided high confidence in the certification of nuclear safety and performance. Without nuclear testing, science-based stockpile stewardship will focus on obtaining the more accurate scientific and experimental data that will be needed for more accurate computer simulations of nuclear performance. The new experimental data must also be validated against past nuclear test data. Assesument of stockpile problems and certification of repairs or replacements of nuclear components will have to rely on improvements to these tools. The existing tools were used in conjunction with nuclear testing and are inadequate if used alone.

From a broader national security perspective, the core intellectual and technical competencies of the weapons laboratories provide the technical basis for the pursuit of U.S. arms control and nuclear nonproliferation objectives. Their extensive core competencies have provided most of the nuclear weapons arms control technologies developed and employed by the United States. The weapons laboratories will have to continue to provide this essential service in the future. For the same reasons, the weapons laboratories also provide significant technical support for U.S. efforts on nuclear weapons nonproliferation and counter-proliferation programs.

Stockpile Management--The Industrial Base

None of the manufacturing and surveillance capabilities of the current industrial base can be eliminated on the basis of the post-Cold War changes in national security policies. The industrial base also possesses core competencies, such as manufacturing product, process, and quality control know-how. However, with a smaller stockpile and no new-design weapons production, industrial capacity can be reduced to meet anticipated manufacturing requirements for stockpile repair and replacement activities. A summary discussion of each of the major functions needed is provided in this section.

Broadly stated, there are six major manufacturing and surveillance functional areas in the weapons industrial base:

- Weapon A/D
- Pit components
- Secondary and case components
- HE components
- Nonnuclear components
- Tritium supply and recycling

As explained in section S.1.4, tritium supply and recycling was evaluated in a separate PEIS.

Weapon Assembly/Disassembly. Pantex is the only DOE site currently authorized to assemble or disassemble stockpile weapons. Special facilities built to explosives safety criteria are required; in addition, some facilities are designed to limit nuclear material dispersal in case of an HE accident. These facilities exist in large numbers at Pantex, and because they are relatively discrete structures, downsizing-in-place is a viable alternative. NTS has a much smaller set of these special structures that were constructed for use in assembling nuclear test devices. However, NTS has few of the support facilities required for volume assembly or disassembly of stockpile weapons. A major programmatic consideration is the cost of re-creating facilities that already exist at Pantex. Due to ongoing weapon dismantlement requirements, the alternative to transfer this function to NTS would be slow but achievable within a 10-year period.

Pit Components. These components are designed by LANL and LLNL and were formerly produced at the Rocky Flats Plant, which is no longer available for this function. The LLNL facility is not large enough to accommodate both stewardship and management activities; therefore, only LANL is considered to be a reasonable alternative if this function is reestablished at a weapons laboratory. Also, LANL has the more extensive and complete plutonium facility infrastructure. SRS is also considered a viable alternative for reestablishing this function because it has a plutonium processing infrastructure, although it does not have a precision component manufacturing capability. Other than the synergism with maintaining core competencies at the weapons laboratories, a major program consideration would be the scale of manufacturing capacity required for the foreseeable future.

The preceding discussion applies to new pit fabrication as well as both intrusive and nonintrusive modification pit reuse manufacturing capability and capacity. Intrusive modification pit reuse requires handling and processing of the plutonium internal to the pit. Nonintrusive modification pit reuse involves the external features of the pit and does not require an extensive plutonium infrastructure; the risk of contamination and the generation of radioactive waste is very low for nonintrusive modification activities. Therefore, the weapons A/D Facility is also an alternative for nonintrusive modification pit reuse.

Secondary and Case Components. The Y-12 Plant (Y-12) at ORR produces the secondary and case components. These components are designed by LANL and LLNL; therefore, each of those facilities would be reasonable alternative sites if this function is transferred to the weapons laboratories. Both of these laboratories have a uranium technology base and facility infrastructure, although they have only a very limited R&D manufacturing capability. Other than the synergism with maintaining core competencies at the weapons laboratories, a major program consideration would be the cost of transferring product technologies and the re-creation of capital facilities that already exist at Y-12. Due to the complicated nature of nuclear facilities and plans for retrofit of an enduring stockpile weapon involving these components, a transition to either LANL or LLNL would be slow but achievable within a 10-year period. Downsizing Y-12 is considered to be a reasonable alternative.

High Explosive Components. Pantex currently manufactures HE components in special facilities built to explosives safety criteria. Downsizing the facilities at Pantex is a reasonable alternative. Comparable facilities also exist at both LANL and LLNL, and either laboratory has sufficient capacity to meet estimated future manufacturing requirements. Costs for this function are relatively low in any case. If a decision is made to transfer this function to the weapons laboratories, it could be done more quickly than the transfer of other functions. However, Pantex would have to retain disposition and disposal capability for the HE inventories currently onsite and those expected from near-term weapon dismantlement. A major program consideration would be the synergism of this function in maintaining the core competencies of the weapons laboratories.

Nonnuclear Components. KCP currently manufactures the majority of the nonnuclear components. The KCP facilities are not unique in structural design and are amenable to downsizing in place. The manufacturing technologies are complex and varied due to the large number of component types and high reliability requirements. SNL designs most of the components that KCP manufactures; therefore, SNL would become the major nonnuclear component supplier if a decision is made to transfer this function to the weapons laboratories. Other than potential synergism with maintaining core competencies at the weapons laboratories, a major program consideration would be the cost of transferring product technologies and re-creating facilities that already exist at KCP. Requirements for ongoing support of the enduring stockpile would make this a slow transition, but it would be achievable within a 10-year period.

S.2.4 Proposed Action and Alternatives

All of the existing basic capabilities of the laboratory and industrial base continue to be needed even though there have been changes in national security policy since the end of the Cold War. These changes do not affect the standards for stockpile safety and reliability. Therefore, the proposed action concentrates on three major issues that result from the national security policies and constraints placed on the program. The three program elements of the proposed action are:

- Providing enhanced experimental capability
- Rightsizing the industrial base
- Reestablishing manufacturing capability and capacity for pit components

Reasonable alternatives for the proposed action are briefly discussed below. Section S.3 describes these alternatives in more detail.

Enhanced Experimental Capability

Understanding nuclear weapon performance requires knowledge of the performance of the individual elements: the primary (pit and HE), the secondary, and the functional interaction between the primary and the secondary inside the case. Computer model-based validation and certification will be the key to DOE's ability to determine, with confidence, many of the future safety and performance characteristics of the stockpile in the absence of nuclear testing. This requires two principal elements: advanced computational models and facilities to provide experimental data that can be used to adjust (normalize) the computational models in conjunction with past nuclear test data. DOE is proposing three facilities to complement the existing capabilities to provide these data. Two are new facilities and one is the upgrade of an existing facility.

NIF and the Atlas Facility are proposed new facilities. The Atlas Facility would be collocated in TA-35 with the existing Pegasus II Facility at LANL, and the two facilities would use common infrastructures and support facilities. CFF is a proposed environmental and diagnostic upgrade to the existing Flash X-Ray (FXR) Facility at LLNL. As described in section S.3.2, these three new facilities would perform separate functions and provide different types of experimental data. Thus, they are complementary in nature and are not alternatives to one another. In each case, the alternative to constructing and operating the facility is No Action (i.e., relying on existing facilities to provide data). In addition, site alternatives are evaluated for NIF, since it is not associated with an existing facility. Volume III of this PEIS contains project-specific analyses for each of these facilities.

The stockpile stewardship program is expected to continuously evolve as better information becomes available and technological advancements occur. DOE is in the early planning stages for a number of what can be described as "next generation" stewardship facilities. These facilities are discussed in section S.3.2. They will build on the knowledge gained from existing and proposed new facilities. Since these facilities are in the conceptual planning stages, they are not sufficiently defined to be analyzed in this PEIS. When these technologies reach the appropriate level so as to be ripe for decisionmaking, DOE would complete NEPA documentation for them.

Rightsizing the Industrial Base

One of the primary goals of stockpile management is to rightsize functions to provide an effective and efficient manufacturing capability for a smaller stockpile. Such rightsizing must be accomplished in a manner that preserves core competencies in manufacturing and surveillance. This PEIS analyzes two alternative approaches to rightsizing the stockpile management functions described in section S.2.3: (1) transfer manufacturing and surveillance activities from the industrial sites to the weapons laboratories and NTS and (2) downsize the industrial plants in place. Relocation alternatives were selected on the basis of existing technical and facility infrastructure at the laboratories and NTS. Section S.3.4 discusses these alternatives in more detail.

Reestablishing Manufacturing Capability and Capacity for Pit Components

Plutonium pit manufacturing is a special case among those stockpile management functions discussed in section S.2.3. In 1992, DOE ceased plutonium pit manufacturing operations at the Rocky Flats Plant due to concerns about the safety of the plant and national security policy decisions to cease the production of new-design nuclear weapons. Reestablishing pit manufacturing capability and capacity was to be part of the Reconfiguration PEIS. This function is now part of the proposed action in this Stockpile Stewardship and Management PEIS.

Pit manufacturing capability and capacity, like that of all other major weapons components and subsystems, is essential for protecting national security options with regard to the nuclear deterrent. In addition, repair or replacement of pits for existing stockpile weapons may be required in the future. Reasonable alternative sites for reestablishing this function were selected from sites that already possess some measure of the appropriate technical or facility infrastructure.

S.2.5 Nonproliferation

On August 11, 1995, the President announced his commitment to seek a "zero-yield" CTBT. He also established several safeguards that condition the U.S. entry into a CTBT. One of these safeguards is the conduct of science-based stewardship, including the conduct of experimental programs. This safeguard will enable the United States to enter into such a treaty while maintaining a safe and reliable nuclear weapons stockpile consistent with U.S. national security policies.

One benefit of science-based stockpile stewardship is to demonstrate the U.S. commitment to NPT goals; however, the U.S. nuclear posture is not the only factor that might affect whether or not other nations might develop nuclear weapons of their own. Some nations that are not declared nuclear states have the ability to develop nuclear weapons. Many of these nations rely on the U.S. nuclear deterrent for security assurance. The loss of confidence in the safety or reliability of the weapons in the U.S. stockpile could result in a corresponding loss of credibility of the U.S. nuclear deterrent and could provide an incentive to other nations to develop their own nuclear weapons programs.

The United States has halted the development and production of new-design nuclear weapons. The experimental testing program will be used to assess the safety and reliability of the nuclear weapons in the remaining stockpile. Much of this testing is classified and could not lead to proliferation without a breach of security. Use of classified data from past U.S. nuclear tests is also a vital part of the overall process for validation of new experimental data. Most of the component technology used for the proposed enhanced experimental capability is unclassified and is available in open literature, and many other nations have developed a considerable capability.

Proliferation drivers for other states, such as international competition or the desire to deter conventional armed forces, would remain unchanged regardless of whether DOE implemented the proposed action analyzed in this PEIS. In the NPT, the parties agree not to transfer nuclear weapons or other devices, or control over them, and not to assist, encourage, or induce nonnuclear states to acquire nuclear weapons. However, the treaty does not mandate stockpile reductions by nuclear states, and it does not address actions of nuclear states in maintaining their stockpiles.

S.3 ALTERNATIVES

S.3.1 Development of Stockpile Stewardship and Management Program Alternatives

This PEIS evaluates the direct, indirect, and cumulative impacts associated with the Stockpile Stewardship and Management Program alternatives which are summarized in figure S.3.1-1. For the various alternatives, this includes evaluating the applicable impacts of new facility construction or existing facility modification. Also assessed are the operational impacts of long-term stewardship and management activities in support of the base case nuclear weapons stockpile, including transportation of materials and components between sites. This PEIS also provides a sensitivity analysis of differences, when applicable, from the base case alternatives for the high and low case stockpile. However, since it is expected that the annual workload may vary above and below the base case capacity assumptions, the base case is analyzed in the greatest detail.

Planning Assumptions and Basis for Analysis

In the Stockpile Stewardship and Management Program and in this PEIS, DOE will:

- Emphasize compliance with applicable laws and regulations and accepted industrial and weapons safety practices that safeguard the health of workers and the general public, protect the environment, and ensure the security of nuclear material and weapons
- Analyze alternatives that are consistent with, and supportive of, national security policies
- Maximize efficiency and minimize cost and waste consistent with programmatic needs
- Minimize the use of hazardous materials and the number and volume of waste streams consistent with programmatic needs through active pollution prevention programs and measures

DOE is currently preparing site-wide EISs covering continued operations for some of the alternative sites evaluated in the Stockpile Stewardship and Management PEIS. Some of the existing activities covered by these site-specific, site-wide EISs are similar to those of the No Action alternative of the Stockpile Stewardship and Management PEIS. Although the near-term analytical periods for these site-wide EIS analyses are different from that of the Stockpile Stewardship and Management PEIS, which is focused on long-term activities, the preparation of these documents has been closely reviewed and coordinated. As work on these site-wide EISs proceeds, their analyses will continue to be reviewed to ensure consistency. To the extent that the site-wide EIS analyses provide better information, such information has been incorporated. In the preparation of the Stockpile Stewardship and Management Final PEIS, any updated information relating to the sites' affected environment was reviewed and appropriate changes were made if new information could potentially change results of the impact analyses.

DOE has developed several planning assumptions as the basis of analyses presented in this PEIS.

These considerations are summarized below.

No Action Alternative Assumptions

- The No Action alternative for this PEIS is defined in a way that takes into account the fact that DOE for decades has had in place a program for the stewardship and management of the nuclear weapons stockpile. Consistent with CEQ guidance, the No Action alternative consists of those facilities necessary to maintain the status quo in terms of DOE's current program direction. These consist primarily of existing facilities where DOE currently conducts weapons activities, including modifications to those facilities necessary to maintain their current mission capabilities. However, the No Action alternative also includes a small number of minor new facilities that will also be needed simply to maintain current mission capabilities at individual sites. Finally, the No Action alternative includes two major new facilities which are proceeding independent of this PEIS, and for which DOE has prepared separate EISs under the interim action provisions of the CEQ regulations. These EISs are the PEIS for Tritium Supply and Recycling (DOE/EIS-0161) and the EIS for the DARHT Facility (DOE/EIS-0228).

Stockpile Management Assumptions

- Base case stockpile size for the PEIS analysis is consistent with the START II protocol but larger than 3,500 weapons. This PEIS also analyzes a high and a low case stockpile size. The high case consists of maintaining the stockpile at a level consistent with the START I Treaty but larger than 6,000 weapons. The hypothetical low case is a stockpile of approximately 1,000 weapons.
- Impacts from construction, including modifying existing structures, and operation are evaluated. The period of construction or downsizing for each alternative varies; however, for analytical purposes, this PEIS assumes that operations would begin in 2005. A 25-year lifetime was evaluated for operations.
- For plutonium, strategic reserve storage is evaluated at Pantex and NTS. For HEU, strategic reserve storage is evaluated at ORR, Pantex, and NTS. (For purposes of this PEIS, DOE does not intend to move the strategic reserves of HEU to Pantex or NTS if ORR is chosen as the secondary and case fabrication site).
- This PEIS contains an analysis of low-consequence/high-probability accidents (evaluation basis) and high-consequence/low-probability accidents (beyond evaluation basis). A spectrum of both types of accidents is analyzed. For radiological accidents, impacts are evaluated for both the general population residing within an 80-kilometer (km) (50-mile [mi]) radius (including the maximally exposed individual) and for noninvolved workers in collocated facilities. The accident analyses in this PEIS are based upon facility conditions that are expected to exist in 2005. In some cases, facility conditions in 2005 may differ from current facility conditions due to design upgrades.
- Plutonium or uranium would not be introduced into a site that does not currently have a plutonium or uranium infrastructure because of the high cost of new facilities and the complexity of introducing plutonium or uranium operations to sites without current

capabilities.

Stockpile Stewardship Assumptions

- The range of stockpile sizes used for analysis of manufacturing capacity-related issues for stockpile management functions is not applicable to stockpile stewardship functions. Capabilities are independent of stockpile size. Stockpile stewardship functions are basic capabilities.
- National security policy requires a safe and reliable stockpile without further nuclear testing and with an aggressive pursuit of enhanced experimental capabilities. Three stockpile stewardship facilities are proposed in this PEIS: NIF, CFF, and the Atlas Facility. These facilities are analyzed as supplements to the facilities and capabilities that currently exist for carrying out the stockpile stewardship mission. Each proposed facility is an independent component of the overall stockpile stewardship program, each has unique value, and, therefore, these proposed facilities are not competing alternatives.
- Assumptions regarding accident analysis are the same as described under stockpile management.

S.3.1.1 *Alternative Sites*

Eight locations (ORR, SRS, KCP, Pantex, LANL, LLNL, SNL, and NTS) are being considered as alternative sites for stockpile stewardship and management missions. All of these sites are currently performing DP activities.

Site Selection

One important strategy of the Stockpile Stewardship and Management Program is to maximize the use of existing infrastructure and facilities as the Complex transitions to be smaller and more efficient in the 21st century. Consequently, only those sites with existing infrastructure or facilities capable of supporting a given stockpile stewardship or stockpile management mission are considered reasonable site alternatives for detailed study in this PEIS. Sites without a technical infrastructure or facilities for a given mission would require significant new construction that would be costly and impractical compared to sites with existing infrastructure and facilities.

For stockpile stewardship, the three existing weapons laboratories (LANL, LLNL, and SNL) and NTS are being considered for new or upgraded stockpile stewardship facilities. This is because the weapons testing mission and stockpile stewardship have always been primary responsibilities of the weapons laboratories and NTS, and existing facilities and capabilities can be built upon to meet the stewardship mission.

Oak Ridge Reservation

ORR, located in Oak Ridge, TN, contains the Oak Ridge National Laboratory, Y-12, and the K-25

Site. DP assignments at ORR are performed at Y-12 and include maintaining the capability to produce secondaries and cases for nuclear weapons, storing and processing uranium and lithium materials and parts, dismantling nuclear weapon secondaries returned from the stockpile, and providing special production support to the DOE weapons laboratories and to other DOE programs.

Savannah River Site

SRS, located near Aiken, SC, contains fuel and target fabrication facilities, nuclear material production reactors, chemical separation plants used for recovery of plutonium and uranium isotopes, a uranium fuel processing area, and the Savannah River Technology Center. SRS is now conducting tritium-recycling operations in support of stockpile requirements using dismantled weapons as the tritium supply source.

Kansas City Plant

KCP, situated on the Bannister Federal Complex in Kansas City, MO, produces and procures nonnuclear electrical, electronic, electromechanical, mechanical, plastic, and nonfissionable metal components for the nuclear weapons program. KCP is currently the principal nonnuclear fabrication facility within the Complex.

Pantex Plant

Pantex, located northeast of Amarillo, TX, fabricates chemical HE for nuclear weapons, assembles and performs maintenance and surveillance of nuclear weapons in the stockpile, disassembles nuclear weapons being retired from the stockpile, and provides interim storage of plutonium components from dismantled weapons.

Los Alamos National Laboratory

LANL, located at Los Alamos, NM, is a multidisciplinary research facility engaged in a variety of programs for DOE and other Government agencies. Its primary mission is the nuclear weapons Stockpile Stewardship and Management Program and related emergency response, arms control, and nonproliferation and environmental activities. It conducts R&D activities including the basic sciences, mathematics and computing with applications to these mission areas and to a broad range of programs including: nonnuclear defense; nuclear and nonnuclear energy; atmospheric, space, and geosciences; bioscience and biotechnology; and the environment.

In regard to nuclear weapons, LANL is responsible for the design of the nuclear explosive package in certain U.S. weapons. In addition, since the end of the Cold War, LANL now conducts the pit surveillance program and some manufacturing of nonnuclear components due to termination of the nuclear weapons missions at the Mound, Pinellas, and Rocky Flats Plants.

Lawrence Livermore National Laboratory

LLNL, located at Livermore, CA, is a multidisciplinary research facility engaged in a variety of programs for DOE and other Government agencies. Its primary mission is the nuclear weapons stewardship program and related emergency response, arms control, and nonproliferation activities. It conducts R&D activities in the basic sciences, mathematics, and computing with applications to these mission areas and to a broad range of programs including: nonnuclear defense; nuclear and nonnuclear energy; atmospheric, space, and geosciences; bioscience and biotechnology; and the environment. In regard to nuclear weapons, LLNL is responsible for the design of the nuclear explosive package in certain U.S. weapons.

Sandia National Laboratories

SNL maintains facilities in three locations in the United States: Albuquerque, NM; Livermore, CA; and Tonopah, NV. The facilities discussed in this document refer only to the Albuquerque location which is located adjacent to the city of Albuquerque, NM. SNL is a multidisciplinary research and engineering facility engaged in a variety of programs for DOE and other Government agencies. Its primary mission is the nuclear weapons Stockpile Stewardship and Management Program and related emergency response, arms control, and nonproliferation activities. In addition, it conducts R&D activities in advanced manufacturing, electronics, information, pulsed power, energy, environment, transportation, and biomedical technologies.

In regard to nuclear weapons, SNL is responsible for the design of nonnuclear components and related system engineering. In addition, since the end of the Cold War, SNL now performs some nonnuclear manufacturing functions due to termination of the nuclear weapons mission at the Mound and Pinellas Plants.

Nevada Test Site

NTS occupies approximately 351,000 hectares (ha) (867,000 acres) in the southeastern part of Nye County in southern Nevada. NTS, located about 104 km (65 mi) northwest of Las Vegas, is a remote, secure facility that maintains the capability for conducting underground testing of nuclear weapons and evaluating the effects of nuclear weapons on military communications systems, electronics, satellites, sensors, and other materials.

North Las Vegas Facility . The North Las Vegas Facility (NLVF), located in the city of North Las Vegas, NV, supports DOE Nevada Operations Office and LANL, LLNL, and SNL weapons test programs, and is considered an adjunct to NTS.

S.3.2 Stockpile Stewardship

Historically, nuclear testing has provided unambiguous high confidence in the safety and reliability of weapons in the stockpile. Without additional underground nuclear testing, DOE must rely on experimental and computational capabilities, especially in weapons physics, to predict the consequences of the complex problems that are likely to occur in an aging stockpile. Without these enhanced capabilities, DOE will lack the ability to evaluate some safety and reliability issues, which could significantly affect the stockpile. It is also possible that, without these enhanced capabilities, DOE could not certify the acceptability of weapons components repaired or modified to address future safety or reliability issues. The nuclear weapons phenomena involved in enhanced experimental capability can be broadly grouped into three categories: physics of nuclear weapons primaries, physics of nuclear weapons secondaries, and weapons effects. Each of these categories are described below, as well as alternatives that are assessed in this PEIS. Table S.3.2-1 depicts the proposed alternatives and facilities under consideration for stockpile stewardship.

Table S.3.2-1. ***Stockpile Stewardship Enhanced Experimental Capability Alternatives***

Capability	LANL	LLNL	SNL	NTS
Physics of Nuclear Weapons Primaries				
No Action	X	X		X
Contained Firing Facility [4]		X		
Physics of Nuclear Weapons Secondaries [5]				
No Action	X	X		
National Ignition Facility[4]	X	X	X	X
Atlas Facility [4]	X			
Weapons Effects				
No Action[6]			X	

Physics of Nuclear Weapons Primaries

With respect to the physics phenomena from the implosion of the primary, the experimental facilities provide physics validation, material behavior information, improved understanding of the implosion and the ability to assess age related defects. Proposed new facilities and site alternatives under consideration, along with the existing facilities which are part of the No Action alternative, are discussed below.

No Action. The principal diagnostic tools DOE currently uses to study nuclear weapons primaries are hydrodynamic tests and dynamic experiments. Under the No Action alternative, DOE would continue to use the hydrodynamic testing facilities currently available at LANL, LLNL, and NTS, and a new facility planned for LANL. The FXR Facility at LLNL Site 300 uses linear induction accelerator technology for high-speed radiography. The Pulsed High-Energy Radiation Machine Emitting X-Rays Facility has been in continuous operation at LANL since 1963, and uses a radio-frequency accelerator designed for high-speed radiography.

The DARHT Facility at LANL will consist of a new accelerator building with two accelerator halls to provide two perpendicular lines-of-sight which will enable two radiographic images to be captured simultaneously or sequentially and will provide a capability to perform three dimensional diagnostics of a simulated nuclear weapon primary. For the purposes of this PEIS, DOE includes the DARHT Facility in No Action as an existing facility at LANL because DOE has reached an independent decision to construct and operate the facility.

Besides LANL and LLNL, NTS has some hydrodynamic testing facilities in place (e.g., Big Explosive Experimental Facility [BEEF]). BEEF is used to study hydrodynamic motion associated with HE detonations.

Proposed Contained Firing Facility. Both LANL and LLNL are considered necessary for the continued development of a science-based stockpile stewardship program. In this regard, both laboratories will continue to utilize and improve radiographic hydrodynamic testing capability. The proposed CFF would augment and be collocated with the existing FXR Facility at LLNL Site 300. The containment enclosure would provide for containment of hydrodynamic tests and reduce the environmental, safety, and health impacts of current outdoor testing. The enclosure will also improve the quality of diagnostics data derived from testing by better controlling experimental conditions.

Physics of Nuclear Weapons Secondaries

The energy released by the fission of the nuclear weapons primary activates the secondary assembly, creating a thermonuclear (fusion) explosion. With respect to the phenomena of the physics from the thermonuclear explosion of the secondary, the experimental facilities provide improved understanding of thermonuclear ignition, secondary physics validation, and material behavior information. The proposed physics facilities and site alternatives under consideration are discussed below. Some of the facilities may also be useful for investigating physics phenomena related to nuclear weapons primaries and weapon effects. The capabilities that would be provided by the proposed NIF and the Atlas Facility are independent components needed to improve the understanding of the physics of nuclear weapons secondaries. Each proposed facility responds to a different diagnostic need related to nuclear weapons secondaries and they are not competing alternatives.

No Action. Few methods are currently available to study the physics of nuclear weapons secondaries. The principal facilities currently available are the Nova Facility at LLNL and the Pegasus II Facility at LANL. Without improvements to these capabilities, as proposed by the NIF and the Atlas Facility, DOE would lack the ability to evaluate some significant nuclear performance issues, which could adversely affect confidence in the Nation's nuclear deterrent.

Proposed National Ignition Facility. The proposed NIF would make it possible to study radiation physics in the laboratory close to the conditions which would approach that of a thermonuclear detonation. NIF would achieve higher temperatures and pressures, albeit in a very small volume, than any other existing or proposed stockpile stewardship facility. This facility could be located at either LANL, LLNL, SNL, or NTS.

Proposed Atlas Facility. The proposed Atlas Facility at LANL would be used for experiments that would contribute to the development of predictive capabilities related to the aging and performance of secondaries. This facility would build on existing special equipment at LANL.

Weapons Effects

One of the reasons for past underground nuclear testing has been to determine the effects of nuclear weapon radiation outputs of x rays, gamma rays, and neutrons on nuclear weapon subsystems and components. Existing facilities at SNL, such as the Saturn Facility or the Particle Beam Fusion Accelerator Facility, provide a limited capability to investigate these effects, and would continue to operate under No Action. No alternatives for new facilities designed principally for weapons effects testing are being proposed in this PEIS.

Next Generation Stockpile Stewardship Facilities

The science-based stockpile stewardship program will build upon existing information and capabilities. Thus, the program is expected to continuously evolve as better information becomes available and technological advancements occur. In fact, evolution is expected to be an integral part of the science-based stockpile stewardship program. While the proposed NIF, CFF, and Atlas Facility would provide improvements over existing capabilities, and are expected to be important components of science-based stewardship, they do not represent the entire science-based stewardship program that is envisioned for all time.

The next generation of stockpile stewardship facilities have not been defined to the degree necessary for decisionmaking. These anticipated facilities are AHF, HEPPF, ARS (X-1), and the Jupiter Facility. AHF would be a next generation radiographic hydrodynamic test facility featuring multiple pulse and multiple view diagnostic capability. HEPPF would provide experimental capabilities for studying secondary physics at shock pressures and velocities approaching those of actual weapons conditions. ARS (X-1) and Jupiter Facilities would be advanced pulsed-power x-ray sources that would provide enhanced experimental capabilities in the areas of weapons physics and weapons effects.

S.3.2.1 *Stockpile Stewardship Comparison of Alternatives*

To aid the reader in understanding the differences in environmental impacts among the various PEIS stewardship alternatives, this section presents comparisons of the alternatives, concentrating on the major resources assessed in this PEIS.

Proposed National Ignition Facility

The following comparisons have been summarized from the more-detailed comparisons for the NIF alternatives found in Volume III, appendix section I.3.5. The NIF project-specific analysis addresses the impacts of constructing and operating NIF at four alternative sites: LLNL (preferred), LANL, SNL, and NTS (includes NLVF). A No Action alternative is also assessed.

Under No Action, DOE would rely on existing aboveground experimental facilities, predominantly the Nova Facility at LLNL, to study the physics of nuclear weapons secondaries. No construction impacts are associated with the No Action alternative and the operational impacts of the Nova Facility have been accounted for in the overall environmental baseline presented for LLNL.

For the action alternative, the analysis indicates that there would be few significant differences in environmental impacts at the candidate sites. The maximum 24-hour concentration of particulate matter 10 microns or smaller (PM *10*) in the air during site clearing would exceed applicable standards at LLNL and NLVF. However, the ambient air quality impacts would be localized and of short duration. Uncommitted land requirements would be greatest at NTS ha acres]), although this acreage is less than 1 percent of the uncommitted land at NTS. Conversely, the least amount of uncommitted land that would be required for NIF would be 3.2 ha (7.9 acres) at NLVF. However, this acreage represents the largest percentage of uncommitted land at a candidate site (56 percent). Of greater significance would be the quality of the habitat of the uncommitted land that would be affected by NIF construction. The highest-quality habitats that would be affected would be forest (4.0 ha [9.9 acres]) at LANL or desert ha acres]) at NTS. At the other candidate sites, habitat disturbance would occur to grassland (LLNL and SNL) or to an area of sparse vegetation (NLVF). No significant biotic or cultural impacts are expected at any of the NIF alternative sites.

At each NIF alternative site, beneficial socioeconomic impacts associated with construction and operation would occur. During construction, 270 to 470 direct new jobs would be created in the peak year of activity. These direct jobs would create indirect jobs such that the total jobs during the peak year would be: 2,870 at LLNL; 1,130 at LANL; 1,640 at NTS; and 1,770 at SNL. Once operations begin, NIF would employ 330 direct workers. The total number of jobs (direct plus indirect) during operation would be 890 at LLNL, 600 at LANL, 620 at NTS, and 670 at SNL.

Over the 30-year operational life of NIF, the public would be exposed to a very small dose of radiation. No cancer fatalities would be expected to occur from exposures associated with routine NIF operations under either the Conceptual Design or Enhanced options. A radiological accident at NIF would not cause any cancer fatalities to the public except possibly at NLVF and SNL. Under postulated accident conditions, radiological impacts to the public and workers would be minor. The highest calculated radiation dose is 4,900 person-rem. At most, two cancer fatalities could occur if an accidental release occurred. Because of the extremely low accidental release frequency (2x10 *-8* /yr), the risk of radiation-caused cancer fatalities from the postulated accident at any site is essentially zero. The cancer fatality risk associated with radiological exposure from an accident involving the transport of NIF tritium targets would range from 1x10 *-8* to 8x10 *-10* fatalities per year, whereas the nonradiological fatality risks associated with vehicular emissions and accidents would be in the range of 10-3 to 10-4 fatalities per year.

Although each candidate site would implement waste minimization practices, the generation of additional wastes would be unavoidable. All candidate sites have current or planned capacity to handle wastes associated with construction and operation of NIF; however, this would entail offsite shipment of some of the wastes for all sites except LANL.

NIF would comply with all applicable Federal, state, and local environmental regulatory requirements, including the *California Environmental Quality Act* if NIF is sited in the state of California. Such compliance functions as a general form of mitigation. The candidate sites have also established several mitigative measures for construction actions that would also be applicable to NIF construction. While each of these mitigative measures may be minor, in combination they could significantly reduce impacts to the environmental resources of the selected site.

With regard to unavoidable impacts, land clearing and construction activities for NIF would eliminate habitat and destroy or displace wildlife. Construction of new facilities could result in short-term disturbances of previously undisturbed biological habitats. These disturbances could cause long-term reductions in the biological productivity of an area. Construction of NIF would replace natural habitat with areas of pavement and buildings. Depending upon the candidate site selected, this conversion could extend the influence of urbanized/industrial habitats into natural areas, increase fragmentation of natural habitat, and cause minor loss of habitat used by rare species. However, no critical habitat for Federal threatened or endangered species would be affected.

Radiological doses to the general public from NIF operation would be no more than percent of the dose from all other candidate site operations and no more than one-millionth of the dose to the population from normal background radiation. NIF would be considered a low-hazard, radiological facility. Such a facility uses radionuclides (for nonreactor purposes) and has other hazards (such as chemicals needed at the facility). Low hazard implies that there are minor onsite and negligible offsite consequences.

Cumulative impacts would result from the addition of the incremental effects of the construction and operation of NIF to the effects of other past, present, and reasonably foreseeable future actions at the selected site. Fugitive dust emissions from construction of NIF would be an incremental addition to the already existing environmental impact of dust emissions to the atmosphere. Minor changes in stormwater runoff are expected due to removal of grass cover during NIF construction and increased runoff from pavement during facility operation.

Proposed Contained Firing Facility

The following comparisons have been summarized from the more-detailed information for CFF found in Volume III, appendix J.

Under No Action, DOE would rely on existing aboveground experimental facilities, predominantly the existing hydrotest facilities at LLNL, LANL, and NTS to study the physics of nuclear weapons primaries. No construction impacts are associated with those existing facilities, and the operational impacts of those facilities have been accounted for in the overall environmental baseline presented for LLNL, LANL, and NTS.

Because the proposal for CFF involves modification to the existing FXR Facility, construction impacts are expected to be small. Very little land would be disturbed and the construction activities would largely involve internal modifications to the existing facility. Wastes and socioeconomic impacts from construction would be negligible.

Impacts associated with operation would also be negligible. CFF would not utilize any significant quantities of resources, would not cause any significant socioeconomic changes at LLNL, and would not generate large quantities of hazardous or low-level wastes. LLNL has adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by CFF. Impacts to human health from CFF operation are expected to be extremely small and within regulatory limits.

Proposed Atlas Facility

The following comparisons have been summarized from the more-detailed information for the Atlas Facility found in Volume III, appendix K.

Under No Action, DOE would rely on existing aboveground experimental facilities, predominantly the Pegasus Facility at TA-35 at LANL, to study the physics of nuclear weapon secondaries. No construction impacts are associated with that facility, and the operational impacts from Pegasus have been accounted for in the overall environmental baseline presented for LANL.

Because the proposal for the Atlas Facility involves modification to the existing facilities within TA-35, construction impacts are expected to be small. Very little land would be disturbed and the construction activities would largely involve internal modifications to the existing facility. Wastes and socioeconomic impacts from modification activities would be negligible.

Impacts associated with operations would also be negligible. The Atlas Facility would not utilize any significant quantities of resources, would not cause any significant socioeconomic changes at LANL, and would not generate large quantities of hazardous or low-level wastes. LANL has adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by the Atlas Facility. Impacts to human health from Atlas Facility operations are expected to be small and within regulatory limits.

S.3.3 Underground Nuclear Testing

One of the primary purposes of the Stockpile Stewardship and Management PEIS is to evaluate ways of maintaining a continued safe and reliable nuclear deterrent in the absence of nuclear testing. Thus, the proposal described in this PEIS does not include nuclear testing. However, because it is possible--although not probable--that the United States might one day exercise its "supreme national interests" rights and conduct underground nuclear testing to certify the safety and reliability of its nuclear weapons, this PEIS and the NTS Site-Wide EIS include an analysis of the environmental impacts of underground nuclear testing at NTS.

S.3.4 Stockpile Management

Stockpile management comprises operations associated with producing, maintaining, refurbishing, surveilling, and dismantling the nuclear weapons stockpile. The individual stockpile management functions can be grouped into five major categories: weapons A/D, nonnuclear components fabrication, pit fabrication, secondary and case fabrication, and HE fabrication. Specific alternatives that would enable DOE to maintain its stockpile management responsibilities are shown in table S.3.4-1 and are discussed below.

Table S.3.4-1. ***Stockpile Management Alternatives***

Capability[7]	**Y-12**	**SRS**	**KCP**	**Pantex**	**LANL**	**LLNL**	**SNL**	**NTS**
Weapons Assembly/Disassembly[8]								
No Action				X				
Downsize existing capability				X				
Relocate capability								X
Nonnuclear Fabrication								
No Action			X		X		X	
Downsize existing capability			X					
Relocate capability					X [9]	X [9]	X [9]	
Pit Fabrication and Intrusive Modification Pit Reuse [10]								
No Action [11]					X	X		
Reestablish capability		X			X			
Secondary and Case Fabrication[10]								
No Action	X [12]							
Downsize existing capability	X[12]							
Relocate capability					X	X		
High Explosives Fabrication								
No Action				X				
Downsize existing capability				X				

Relocate capability					X	X		

Weapons Assembly/Disassembly Alternatives

Weapons A/D provides the capability to dismantle retired weapons, assemble nuclear and nonnuclear components into nuclear weapons, and perform weapons surveillance. In addition, the capability to conduct nonintrusive modification pit reuse would be a mission of the weapons A/D Facility. This alternative also includes an option to store strategic reserves of nuclear components (pits and secondaries).

The alternatives for A/D are: 1) to continue in current facilities at Pantex with only those changes that are currently scheduled and budgeted (No Action), 2) to downsize and consolidate facilities and operations at Pantex, or 3) to relocate operations to NTS.

No Action. The No Action alternative for these activities, except nonintrusive modification pit reuse, is presently located at Pantex. Current plutonium R&D facilities at LANL and LLNL have limited capability and capacity to perform nonintrusive modification pit reuse.

Downsize at Pantex Plant. This alternative would downsize and consolidate facilities and operations including strategic reserve storage at Pantex. Downsizing of the A/D operation at Pantex could consist of an in-place decrease in facility footprint and relocation into modern, existing facilities, mostly within Zone 12. No new construction would be required at Pantex; however, relocation and reinstallation of equipment would be required.

Relocate to Nevada Test Site. This alternative is based on the use of the current Device Assembly Facility and balance of plant infrastructure available and required to maintain the capability for underground nuclear testing. Additional new construction would be required and would be designed and sized to meet the specific needs of the reduced program.

Nonnuclear Fabrication

Nonnuclear fabrication consists of the following general functions:

- Fabrication of electrical, electronic, electro-mechanical, and mechanical components (plastics, metals, and composites) and assembly of arming, fuzing, and firing systems
- Surveillance inspection and testing of nonnuclear components

The alternatives considered for nonnuclear fabrication include the No Action alternative of continuing in current facilities, downsizing and consolidating existing facilities at KCP, or closing KCP and sharing nonnuclear fabrication functions among LANL, SNL, and/or LLNL.

No Action. The No Action alternative for these activities is presently located at KCP, SNL, and

LANL. KCP manufactures nonnuclear weapon components and conducts surveillance testing on and makes repairs to nonnuclear weapons components. SNL conducts system engineering of nuclear weapons, designs and develops nonnuclear components, conducts field and laboratory nonnuclear testing, manufactures some nonnuclear weapons components, and provides safety and reliability assesuments of the stockpile. LANL also manufactures a few nonnuclear weapons components and conducts surveillance on certain nonnuclear weapons components.

Downsize at Kansas City Plant. The downsized nonnuclear fabrication alternative consists of three major factory segments designed around electronics, mechanical, and engineered materials product lines, procuring some components from outside sources, and reducing the KCP footprint for DP activities about 45 percent. This alternative consists of downsizing and consolidating existing facilities and would require facility modification but no new construction.

Relocate to Los Alamos National Laboratory. The basis for this alternative would be to use the existing infrastructure at LANL to provide for production requirements of the Complex. Nonnuclear fabrication missions considered for transfer to LANL include plastics, which might also be transferred to LLNL; detonator inert components and pilot plant; and reservoirs and valves, which might also be transferred to SNL.

Relocate to Lawrence Livermore National Laboratory. This alternative calls for LLNL to provide support for nuclear system plastic components that might also go to LANL. This alternative would build on LLNL's established plastics fabrication mission with no new facility construction required.

Relocate to Sandia National Laboratories. This alternative would transfer the majority of current KCP missions to the Albuquerque, NM facility of SNL, except for nuclear system plastic components which would go to either LANL or LLNL and high energy detonator inert components, which would go to LANL. In addition, there is the option of moving the reservoir mission to either LANL or SNL. This alternative would require construction of a new stand-alone production site at SNL, directly east of Technical Area I consisting of six new buildings and renovations or minor modifications to some existing buildings.

Pit Fabrication and Intrusive Modification Pit Reuse Alternatives

This capability, hereafter referred to as pit fabrication, includes all activities necessary to fabricate new pits, to modify the internal features of existing pits (intrusive modification), and to recertify or requalify pits. There are two alternative sites for pit fabrication: SRS and LANL. Nonintrusive modification pit reuse, which is an inherent capability of the Pit Fabrication Facility, includes the processes and systems necessary to make modifications to the external features of a pit, if necessary, and to recertify the pit for reuse in a weapon.

No Action. Under the No Action alternative, DOE would continue to use existing R&D capabilities at LANL and LLNL. LANL maintains a limited capability to fabricate plutonium components using its plutonium R&D facility and performs surveillance operations on plutonium components returned from the stockpile. In addition, less extensive capabilities would continue at LLNL to support material and process technology development.

Reestablish at Los Alamos National Laboratory. This alternative would reconfigure the Plutonium Facility at LANL to fulfill the pit fabrication mission and the intrusive modification pit reuse mission. This alternative would locate pit manufacturing in existing facilities within five technical areas. Existing equipment would be retained as much as possible, but some equipment would be upgraded.

Reestablish at Savannah River Site. This alternative would establish a pit fabrication and reuse facility at SRS within existing hardened facilities, but with new equipment and systems. Facilities are available at the SRS separation areas, F- and H-Area, which could house all the process functions required for the manufacture of plutonium pits. Pit fabrication would be located in Building 232-H and plutonium processing would be located in the F-Canyon facilities. New equipment and systems would be required for the Pit Fabrication Facility.

Secondary and Case Fabrication

The secondary and case fabrication mission includes all activities to support fabrication, surveillance, inspection, and testing of secondaries and components. Functional capabilities for these services include operations to physically and chemically process, machine, inspect, assemble, and disassemble secondary and case materials. Materials include depleted uranium, enriched uranium, uranium alloys, isotopically enriched lithium hydride and lithium deuteride, and other materials. Alternative sites considered for stockpile management secondary activities are ORR, LANL, and LLNL.

No Action. Under No Action, ORR would continue secondary and case fabrication. Y-12 maintains the capability to produce and assemble secondaries, cases, and related nonnuclear weapon components.

Downsize at Oak Ridge Reservation. This alternative would be based on downsizing the existing secondary and case fabrication facilities at Y-12 on ORR. The downsized facilities would only require approximately 14 percent of the existing Y-12 floor space and there would be no new facility construction at Y-12 to support the secondary and case fabrication mission. Modifications to the existing buildings would be required for implementation of the alternative secondary and case fabrication mission and to upgrade the buildings to meet natural phenomena requirements.

Relocate to Los Alamos National Laboratory. This alternative would establish a secondary and case fabrication capability using the processes proven at Y-12 and would use facilities in 11 existing buildings. Modifications to the LANL facilities would be required to perform the stockpile management secondary and case fabrication mission.

Relocate to Lawrence Livermore National Laboratory. This alternative would establish a secondary and case fabrication capability using the processes proven at Y-12, and would use facilities in existing buildings. The secondary and case fabrication facilities at LLNL would principally involve minor modifications to six buildings at the Livermore Site.

High Explosives Fabrication

The HE fabrication mission is described in two functional areas: HE main charge fabrication and small HE component fabrication. The HE fabrication mission includes activities needed to provide HE, binders, main charge formulations, initiation HE, and mock HE formulations.

The HE fabrication mission supports the production aspect of stockpile management and also supports HE surveillance and some stockpile stewardship activities.

No Action. Under No Action, Pantex would continue fabrication and surveillance of HE components for nuclear weapons. LANL and LLNL would continue to perform weapons HE R&D, surveillance, and HE safety studies.

Downsize at Pantex Plant. The Pantex HE fabrication alternative would downsize and consolidate current HE operations and facilities. Only minor modifications to existing facilities within Zones 11 and 12 would be required. This alternative would be considered only in conjunction with maintaining the weapons A/D mission at Pantex.

Relocate to Los Alamos National Laboratory. This alternative would transfer HE operations from Pantex to LANL. This alternative would use existing LANL R&D facilities, which have sufficient capacity for stockpile management requirements. There would be no new building construction and no significant modifications required.

Relocate to Lawrence Livermore National Laboratory. The LLNL HE fabrication alternative would transition HE fabrication activities from Pantex. The LLNL HE fabrication alternative would require construction of 1 new facility for storage of HE and would use 23 existing buildings, 66 existing magazines, and various utilities and services at Site 300.

Relocate to both Los Alamos National Laboratory and Lawrence Livermore National Laboratory. This option would involve splitting the mission between the two laboratories. Since its impact is bounded by the previous two options, this option is not analyzed further.

S.3.4.1 *Stockpile Management Comparison of Alternatives*

To aid the reader in understanding the differences in environmental impacts among the various PEIS management alternatives, this section presents comparisons of the alternatives, concentrating on the major resources assessed in this PEIS.

Assembly/Disassembly

In addition to the No Action alternative, two alternatives are being considered that would meet the needs of the Program: (1) downsizing the existing A/D facilities at Pantex and (2) transferring the A/D mission to NTS by expanding the Device Assembly Facility. Under No Action, the A/D mission would remain at Pantex. No downsizing or modification of facilities would occur, and there would be no construction impacts. Downsizing existing facilities at Pantex would involve internal modifications to the existing facility. Transferring the A/D mission to NTS would entail upgrading and expanding the Device Assembly Facility.

Socioeconomic Impacts. Because of the reduced workload associated with completing the weapon dismantlement backlog, significant employment reductions will occur at Pantex for all alternatives. There would be a decrease from the current total of 3,437 workers to about 1,644 workers. Of the current workforce, 3,002 are associated with A/D operations. Under No Action only 915 A/D workers would be required. The downsized Pantex facility would be optimally configured for the reduced future workload, and would operate more efficiently than the No Action Pantex facility. The downsized Pantex facility would require 800 workers for single-shift operation. To perform operations in the downsized Pantex facility in a three-shift mode, 1,266 workers would be required.

If the A/D mission were transferred to NTS, 1,093 direct jobs (based on three-shift operation) would be created at that site, along with 1,160 indirect jobs. The 2,253 total new jobs would cause the regional economic area unemployment rate to decrease by approximately 0.1 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. If the A/D mission were transferred to NTS, there would be socioeconomic impacts associated with phasing out the A/D mission at Pantex. The phaseout would result in 1,644 direct jobs lost at the Pantex site, and another 1,905 indirect jobs would be lost in the regional economic area. The loss of 3,549 total jobs would cause the regional economic area unemployment rate to increase from 4.8 to 6.2 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent.

Socioeconomic impacts at NTS associated with a peak construction workforce of 662 would produce small positive economic benefits. The 662 direct workers would also generate 622 indirect jobs. The 1,284 total new jobs during peak construction would cause no change in the regional economic area unemployment rate. Housing rental vacancies and public finance expenditures/revenues would change by less than 1 percent.

Resource Impacts. Due to the reduced workload expected in the future at Pantex, impacts from operations are expected to be less than current impacts. Air quality would remain within regulatory limits, and water requirements would be met without increased aquifer drawdowns. In addition, downsizing existing facilities at Pantex would involve internal modifications to the existing facility. No land would be disturbed.

Transferring the A/D mission to NTS would entail upgrading and expanding the Device Assembly Facility, with associated increases in land disturbance. An estimated 7.5 ha (18.5 acres) of additional land would be disturbed, which is less than 1 percent of the land available at NTS for development. This land disturbance would increase the potential to impact cultural and biotic resources; however, the impact to cultural resources is not expected to be significant because the proposed A/D site has been previously disturbed during construction activities associated with the Device Assembly Facility. Impacts to biotic resources are expected to be minor; however, the presence of the desert tortoise at NTS would require a site survey to determine any impacts. With mitigation measures already in place at NTS to minimize impacts to the Federal-listed desert tortoise, significant impacts due to the proposed project are not expected.

Because both alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, both alternatives would produce similar operational environmental impacts for most resource areas. Impacts to air quality were modeled, and results indicate minimal impacts for both alternatives. Water use for the NTS alternative is projected to be less than for the Pantex alternative because continued operations at Pantex would rely on existing, older, site-wide infrastructure. At both sites, water requirements could be adequately met without substantial aquifer drawdown. At Pantex, downsizing would reduce groundwater withdrawals by 21 percent compared to No Action. At NTS, water requirements to support the A/D mission would be approximately 4 percent more than projected usage. Groundwater withdrawals at NTS would be less than the recharge rates for the aquifer.

Radiation and Waste Management Impacts. The average radiological dose to workers at Pantex would not be expected to change, although the total worker dose would change due to the reduced number of workers associated with a reduction in workload. Worker exposure to radiation is expected to be about equal (approximately 10 mrem/year) for both alternatives and well within regulatory limits. Because of the small difference in the workforce for this mission at the two sites, this would result in a total worker dose of 3.0 person-rem/year at Pantex and 2.6 person-rem/year at NTS. The added risk to the workforce due to these levels of radiation exposure is extremely small.

Radiation exposure to the public from normal operation would be well within regulatory limits at both sites. At Pantex, the incremental dose to the population within 80 km (50 mi) would be 4.0x10-4 person-rem/year. At NTS, the incremental dose to the public within 80 km (50 mi) resulting from operation of the A/D Facility would be 3.1x10-6 person-rem/year. The added risk to the public due to these levels of radiation exposure is extremely small.

Both sites have adequate waste management facilities to treat, store, and/or dispose of wastes from the A/D mission, although LLW at Pantex would continue to be shipped offsite to NTS. The impacts of transporting LLW are similar to the impacts of transporting nonradiological materials, which are small. Transferring the A/D mission to NTS would eliminate the need to ship LLW from Pantex to NTS. Transferring the A/D mission to NTS by expanding the Device Assembly Facility would also increase the overall amount of eventual decontamination and decommissioning (D&D) activities and wastes.

Accident Impacts. Potential impacts from accidents would not be expected to change significantly due to reduced workload. Accident impacts were determined using computer modeling. For the composite accident, less than one fatal cancer would be expected for the surrounding 80-km (50-mi) population at either Pantex or NTS. Based on a weighted averaging of the postulated accidents, at Pantex there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 43,000 years from accidents. At NTS, there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 500,000 years from accidents.

Other. The A/D mission also includes an option to store strategic reserves of plutonium and/or uranium. At Pantex, which presently stores both strategic reserves and surplus quantities of plutonium, no additional facilities would be needed, and no significant new environmental impacts or risks would result. Storing the strategic reserve would not produce any additional air emissions, require any additional water withdrawals, generate any wastes, or require additional workers. At NTS, however, the Device Assembly Facility would be further expanded to accomplish the strategic reserve storage. The additional construction would have smaller impacts (less than 10 percent) than the construction associated with the Device Assembly Facility upgrade for the A/D mission. Radiation exposure to the public in the event of an accident would be significantly less than for the A/D mission for either alternative.

Pit Fabrication

For pit fabrication, a capability that no longer exists due to the closure of the Rocky Flats Plant, two alternatives are being considered that would reestablish this mission and meet the needs of the Program: (1) upgrading the existing plutonium R&D fabrication capability at LANL and (2) upgrading existing H-Area and F-Canyon facilities at SRS. Both alternatives involve relatively minor (though costly) upgrades to existing facilities. Under the No Action alternative, DOE would not reestablish this mission, but would rely on the existing R&D capabilities at LANL and LLNL.

Socioeconomic Impacts. During operation, both alternatives would have small positive socioeconomic impacts. Based on the socioeconomic modeling, impacts would be higher at SRS because of the indirect jobs that would be created due to this mission. Modeling results indicate no indirect jobs for this mission at LANL. At SRS, up to 813 direct jobs would be created for surge operations, along with 1,594 indirect jobs. These 2,407 total new jobs would cause the regional economic area unemployment rate to decrease from 6.7 to 6.0 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. At LANL, up to 260 new direct jobs would be created for surge operations, but no indirect jobs would be created. The 260 total new jobs would cause the regional economic area unemployment rate to decrease from 6.2 to 6.0 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. Because the SRS alternative has less of an infrastructure in place for plutonium fabrication, the SRS alternative would require more direct workers (288 versus 138) during construction. At both sites, however, the socioeconomic impacts during construction would not cause any socioeconomic indicator to change by more than 1 percent.

Resource Impacts. Construction activities would involve internal modifications to existing facilities, no land would be disturbed, and thus, no impacts to cultural and biotic resources would result. Because both alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, both alternatives would result in similar operational environmental impacts for most resource areas. Impacts to air quality were modeled, and results indicate minimal impacts to air quality for both alternatives. Water requirements at SRS would be provided from surface water, which is plentiful, and no adverse impacts would be expected. At LANL, groundwater would be used. Water requirements for this mission, which would be less than 1 percent of projected No Action uses, could be adequately met without exceeding the groundwater allotment at LANL.

Radiation and Waste Management Impacts. Worker exposure to radiation is expected to be about equal for both alternatives and well within regulatory limits. At either SRS or LANL, the average workforce dose from this mission would be approximately 380 mrem/year. Because of a difference in workforce for this mission at the two sites, this would result in a total worker dose of 156 person-rem/ year at SRS and 55 person-rem/year at LANL. Statistically, this would equate to one fatal cancer every 16 years at SRS, and every 45 years at LANL, from operation of the Pit Fabrication Facility. Radiation exposure to the public from normal operation would be well within regulatory limits at both sites. At SRS and LANL, the incremental dose to the public within 80 km (50 mi) would be 5.9x10-4 person-rem/year and 8.6x10-5 person-rem/year, respectively. The added risk to the public due to these levels of radiation exposure is extremely small. Both site alternatives have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by this mission.

Accident Impacts. Potential impacts from accidents were determined using computer modeling. For the composite accident, less than one fatal cancer would be expected for the surrounding 80-km (50-mi) population at both SRS and LANL. Based on a weighted averaging of the postulated accidents, at SRS there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 360,000 years from accidents. At LANL, there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 160,000 years from accidents.

Secondary and Case Fabrication

In addition to the No Action alternative, three alternatives being considered would meet the needs of the Program: (1) downsizing facilities that presently perform this mission at ORR, (2) transferring the secondary and case fabrication mission to LANL by upgrading the existing R&D secondary and case fabrication capabilities of LANL, and (3) transferring the secondary and case fabrication mission to LLNL by upgrading the existing R&D secondary and case fabrication capabilities of LLNL. Under No Action, the secondary and case fabrication mission would remain at Y-12 at ORR, and no downsizing or modification of facilities would occur.

Socioeconomic Impacts. Under No Action, there would be a decrease in the number of workers at Y-12 from the current total of 5,152 workers to 4,721 workers. Of the 5,152 workers, 3,126 workers are currently associated with the core stockpile management mission. Under No Action, only 2,741 core stockpile management workers would be required. The downsized Y-12 would be optimally configured for the reduced future workload, operate more efficiently, and require 784 workers for single-shift operation, a reduction of 1,957 workers. To perform operations in the downsized Y-12 in a three-shift mode, 1,376 core stockpile management workers would be required, a reduction of 1,365 workers. A reduction of 1,365 direct jobs represents approximately 9 percent of the projected No Action workforce at the entire ORR site, and less than 1 percent of the regional economic area. Another 3,490 indirect jobs would also be lost.

Mitigating the workforce reductions would be the fact that downsizing would require 1,152 new jobs associated with landlord activities in preparation for D&D activities. Another 1,600 indirect jobs would be created by these D&D jobs. The net effect for the three-shift mode of operation would be a loss of a total of 213 direct jobs at Y-12, which would represent less than 1 percent of the projected No Action workforce at ORR.

Transferring the secondary and case fabrication mission to either LANL or LLNL would have small positive socioeconomic impacts at those sites, and negative socioeconomic impacts at ORR due to the phaseout of this mission. At LANL, 321 direct jobs (based on three-shift operation) would be created, but no indirect jobs would be created for this industry. The 321 new jobs would cause the regional economic area unemployment rate to decrease from 6.2 to 6.0 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. At LLNL, 290 new direct jobs (based on three-shift operation) would be created, along with 722 indirect jobs. The 1,012 new jobs would cause the regional economic area unemployment rate to decrease by less than 1 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent.

Transferring the secondary and case fabrication mission from ORR to either LANL or LLNL would result in the loss of 3,336 jobs projected for this mission under No Action at Y-12, and the closure and D&D of the Y-12 facilities previously involved in this mission. Another 10,134 indirect jobs could also be lost. It is expected that 1,385 new jobs would be created by a direct transfer of responsibilities from DP to the DOE Office of Environmental Management. Additionally, because the D&D of facilities at ORR would be a relatively long-term process, any initial negative socioeconomic impacts resulting from the transfer of the secondary and case fabrication mission to LANL or LLNL would be minimized by the additional workforce associated with D&D activities at ORR. These 1,385 new D&D jobs would also create 1,937 new indirect jobs. The net effect would be a loss of a total of 13,470 total jobs (direct plus indirect) in the ORR regional economic area. This would cause the regional economic area unemployment rate to increase from 4.9 to 7.4 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent.

During construction activities, socioeconomic impacts would result, but would be small. The number of peak workers would be 14 at ORR, 55 at LANL, and 130 at LLNL, which has the least extensive existing infrastructure for secondary and case fabrication. At all three sites, the socioeconomic impacts during construction would not cause any socioeconomic indicator to change by more than 1 percent.

Resource Impacts. Impacts from continued operation at Y-12 are expected to be similar to current impacts. Air quality would remain within regulatory limits and water requirements would be adequately met by surface water withdrawals. For the three "action" alternatives, no previously undisturbed land would be disturbed, and thus, no impacts to biotic resources would result. Minimal impacts to cultural resources may result from building modifications to facilities eligible for the National Register of Historic Places. Because each of the alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, each of the alternatives would produce similar operational environmental impacts for most resource areas. Impacts to air quality were modeled for each alternative and results indicate minimal impacts to air quality for each of the alternatives. Water requirements at ORR would be met from surface water, which is plentiful, and no adverse impacts would be expected. At LANL, groundwater would be used. Groundwater withdrawals would increase by less than 1 percent over projected No Action water requirements, and LANL's groundwater allotment would not be exceeded. At LLNL, public water supply would be used, and usage would be approximately 20-percent higher than projected No Action water requirements. No adverse impacts to water resources are expected.

Radiation and Waste Management Impacts. Radiation worker exposure to radiation is expected to be about equal for all three alternatives and well within regulatory limits. At each of the three sites, the average workforce dose from this mission would be approximately 2.2 mrem/year. Because of differences in projected workforces, this would result in a total worker dose of 0.38 person-rem/year at ORR, 0.33 person-rem/year at LANL, and 0.55 person-rem/year at LLNL. The added risk to the workforce due to these levels of radiation exposure is extremely small. Radiation exposure to the public from normal operation would be well within regulatory limits at these sites. At ORR, the incremental dose to the population within 80 km (50 mi) would be 0.6 person rem/year. The probability of a member of the public dying from cancer would be 3x10-4/year. At LANL, the incremental dose to the population within 80 km (50 mi) would be 0.5 person-rem/year. The probability of a member of the public dying from cancer would be 2.5x10-4/year. At LLNL, the incremental dose to the population within 80 km (50 mi) would be 0.84 person-rem/year. The probability of a member of the public dying from cancer would be 4.2x10-4/year. The added risk to the public due to these levels of radiation exposure is extremely small. All three site alternatives have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by this mission.

Accident Impacts. Potential impacts from accidents were determined using computer modeling. For all postulated accidents, less than one fatal cancer would be expected for the surrounding 80-km (50-mi) population at each of the sites. Based on a weighted averaging of the postulated accidents, at ORR and LANL there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 830,000 years from accidents. At LLNL, there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 260,000 years from accidents.

Other. If the secondary and case fabrication mission were transferred from ORR, storage of the strategic reserves of HEU would be transferred to the A/D Facility (or a consolidated storage facility being assessed in the Storage and Disposition PEIS). The potential impacts associated with the one-time transfer of the strategic reserves of HEU to the A/D Facility are expected to be minor, even in the event of an accident, due to the robust shipping containers.

High Explosives Fabrication

In addition to the No Action alternative, three alternatives are being considered that would meet the needs of the Program: (1) downsizing facilities that presently perform this mission at Pantex, (2) transferring the HE fabrication mission to LANL by upgrading the existing R&D HE fabrication capabilities of LANL, and/or (3) transferring the HE fabrication mission to LLNL by upgrading the existing R&D HE fabrication capabilities of LLNL. Transferring the HE fabrication from Pantex to LANL and/or LLNL would result in the closure and D&D of Pantex facilities previously involved in this activity. Under No Action, the HE fabrication mission would remain at Pantex. No downsizing or modification of facilities would occur.

Socioeconomic Impacts. Downsizing the HE fabrication mission at Pantex would reduce the number of direct workers associated with this mission to 37, compared to 105 for No Action. Transferring the HE fabrication mission to either LANL or LLNL would create small positive socioeconomic impacts at either of those sites, and small negative socioeconomic impacts at Pantex, due to the phaseout of this mission. For surge operations at LANL, 67 new direct jobs would be created, but no indirect jobs would be created by this industry. The 67 new jobs would cause the regional economic area unemployment rate to decrease from 6.2 to 6.1 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. For surge operations at LLNL, 100 new direct jobs would be created, along with 155 indirect jobs. The 255 total new jobs would cause the regional economic area unemployment rate to decrease by less than 1 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. Phasing out the HE fabrication mission at Pantex would cause the loss of 105 direct jobs, which would be approximately 3 percent of the projected No Action workforce at Pantex. The direct plus indirect jobs lost would cause no observable change to the Pantex regional economic area unemployment rate, housing/rental vacancies, and public finance expenditures/revenues.

During construction activities, socioeconomic impacts would result, but they would be small. The number of peak workers would be 29 at Pantex, 46 at LANL, and 19 at LLNL. At all three sites, the socioeconomic impacts during construction would not cause any socioeconomic indicator to change by more than 1 percent.

Resource Impacts. For the three "action" alternatives, construction impacts are expected to be minor and would involve internal modifications to existing facilities. No land would be disturbed at Pantex or LANL, and thus, no impacts to cultural or biotic resources would result. At LLNL, a small area of land (less than 1 ha) would be disturbed to construct an HE and parts storage building, but impacts to biotic and cultural resources are not expected.

Because each of the alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, each of the alternatives would result in similar operational environmental impacts for most resource areas. Impacts to air quality were modeled for each alternative, and results indicate minimal impacts to air quality for each of the alternatives. At all sites, water requirements would be met from groundwater. At Pantex, this alternative applies only in conjunction with the downsize A/D alternative at Pantex discussed earlier. Downsizing both missions would reduce groundwater withdrawals by 16 percent compared to No Action. At LANL, groundwater withdrawals would increase by less than 1 percent over projected No Action water requirements, and LANL's groundwater allotment would not be exceeded. At LLNL, groundwater and/or the public water supply could be used to support the HE fabrication mission. If public water were used, it would require approximately 21 percent of the design capacity of the public water tap line. If groundwater were used, withdrawals would increase by approximately 65 percent from No Action, but they would not have any adverse impacts to aquifer levels.

Radiation and Waste Management Impacts. There are no radiological risks to workers or the public associated with the HE fabrication mission and no adverse impacts associated with normal operation. All three site alternatives have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by this mission.

Accident Impacts. Potential impacts from chemical accidents or explosions were determined using modeling. Impacts from these types of accidents could include death or bodily damage. Due to proximity, workers would be most susceptible to any potential impacts. For all postulated accidents, impacts to the public were much less than to workers. In the event of an accident involving HE fabrication, due to the higher population surrounding LLNL, public impacts could be higher at LLNL compared to LANL and Pantex. Transferring the HE fabrication mission from Pantex to LANL and/or LLNL would require HE components to be shipped from the fabrication site to the A/D Facility. HE is a nonradioactive, hazardous material. There are no impacts associated with the incident-free transportation of HE. In the event of an accident, HE transportation impacts would be no greater than those encountered by the public from industry's transportation of similar explosives. Potential accidents could include both explosive and nonexplosive roadway accidents, with potential impacts of death, lesser bodily injury, and property damage.

Nonnuclear Fabrication

In addition to the No Action alternative, two alternatives are being considered that would meet the needs of the Program: (1) downsizing the facilities that presently perform this mission at KCP and (2) transferring the KCP nonnuclear fabrication mission to LANL, LLNL, and SNL by upgrading existing nonnuclear fabrication capabilities at LANL and LLNL, and constructing new nonnuclear fabrication facilities at SNL. Under No Action, the nonnuclear fabrication mission would remain at current locations; primarily at KCP, with small workloads at LANL and SNL.

Socioeconomic Impacts. At KCP, workforce downsizing consistent with a reduced workload has already taken place; therefore, the projected No Action workforce (3,179 workers) is equal to the current workforce. Of these 3,179 workers, 2,508 workers perform core stockpile management missions. The downsized KCP facility would be optimally configured for the reduced future workload, would operate more efficiently, and would require 1,669 core stockpile management workers for single-shift operation. To perform operations in the downsized KCP facility in a three-shift mode, 2,257 workers would be required. This is 251 workers less than the No Action single-shift number of workers. Another 443 indirect jobs would also be lost. The loss of a total of 694 jobs (direct plus indirect jobs) would not cause the regional economic area unemployment rate to change.

Transferring the nonnuclear fabrication mission to the laboratories would create small positive socioeconomic impacts at both LANL and LLNL, with increases of 240 and 131 total (direct plus indirect) jobs, respectively. At each of these sites, socioeconomic indicators would change by less than 1 percent. At SNL, 1,160 direct jobs would be created, along with 1,350 indirect jobs. The 2,510 new jobs would cause the regional economic area unemployment rate to decrease from 5.7 to 5.2 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. Phasing out the nonnuclear fabrication mission from KCP would cause the loss of 3,179 direct jobs and the loss of 5,609 indirect jobs in the regional economic area. The loss of 8,788 total jobs from KCP would cause the regional economic area unemployment rate to increase from 4.9 to 5.6 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. Some socioeconomic impacts could be mitigated by employing personnel for D&D of the KCP facility, although that is not expected to last more than 5 years.

During construction activities, socioeconomic impacts would result, but would be small. At KCP, 187 direct jobs would be created during downsizing activities, plus another 262 indirect jobs. The 449 total jobs created during construction at KCP would represent less than a 1 percent increase in the regional economic area, and would cause no observable change to the regional economic area unemployment rate, housing/rental vacancies, and public finance expenditures/revenues. If the nonnuclear fabrication mission is transferred to the three laboratories, no observable socioeconomic impacts would occur at LANL or LLNL. At SNL, 379 direct jobs would be created during construction activities, plus another 421 indirect jobs. The 800 total jobs created during construction at SNL would represent less than a 1 percent increase in employment in the regional economic area, and would not cause any socioeconomic indicator to change by more than 1 percent.

Resource Impacts. Due to the reduced workload expected in the future, impacts from operations are expected to be less than current impacts. Air quality would remain within regulatory limits at each of the sites, and water requirements would be adequately met.

For the alternative that would downsize KCP, the construction activities would involve internal modifications to the existing facility. No land would be disturbed. For the alternative that would transfer the KCP mission to the laboratories, construction impacts would involve internal facility modifications at LANL and LLNL. At SNL, approximately 9 ha (22 acres) of land would be disturbed to construct a new facility. This represents approximately 6 percent of the undisturbed land at SNL. Potential impacts to cultural and biotic resources would exist, but they would be mitigated to the extent practicable during follow-on, site-specific studies.

Because each of the alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, each of the alternatives would result in similar operational environmental impacts for most resource areas. Impacts to air quality were modeled for each alternative. Modeling results indicate minimal impacts to air quality for each of the alternatives. Water requirements for nonnuclear fabrication are relatively minor at each of the sites. At KCP, water requirements, which are publicly provided, would be reduced by approximately 31 percent compared to No Action. At LANL, groundwater withdrawals would increase by less than 1 percent over projected No Action water requirements, and LANL's groundwater allotment would not be exceeded. At LLNL, there would also be a less than 1 percent increase in water requirements to support nonnuclear fabrication. At SNL, groundwater would be used. Groundwater withdrawals would increase by approximately 64 percent over projected No Action withdrawals, but would still represent only 29 percent of the Kirtland Air Force Base groundwater rights. Thus, no adverse impacts are expected.

Radiation, Waste Management, and Accident Impacts. There are no radiological risks to workers or the public associated with the nonnuclear fabrication mission, and there are no adverse impacts associated with normal operation. Accident profiles at the sites would not change as a result of downsizing KCP or transferring the nonnuclear fabrication mission to the laboratories. Phaseout of the nonnuclear mission from KCP would eliminate any potential accidents at that site. All three site alternatives have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by this mission.

Stockpile Management Top-Level Comparison

Based upon the reasonable alternatives for the five major missions that make up the stockpile management program, one could construct a matrix with a large number of discrete alternatives for the entire Complex. Analyzing such a large number of alternatives is neither practical nor useful. What is useful, however, is to look at the two extreme configurations for the entire Complex in order to compare environmental impacts for a bounding case analysis. Based on the alternatives that are reasonable for the individual missions, the bounding configurations and environmental impacts for the Complex are a relatively unconsolidated Complex that is downsized/rightsized in place or a relatively consolidated Complex that is rightsized by upsizing the laboratories and NTS.

For the first configuration (referred to as Downsize/Rightsize-in-Place), the Complex would consist of A/D at Pantex, HE fabrication at Pantex, pit fabrication at LANL (or SRS), secondary and case fabrication at ORR, and nonnuclear fabrication at KCP. This is essentially the preferred alternative for stockpile management. For the second configuration (referred to as Maximum Consolidation), the Complex would consist of A/D at NTS, HE fabrication at LANL (or LLNL), pit fabrication at LANL, secondary and case fabrication at LANL (or LLNL), and nonnuclear fabrication at SNL, LANL, and LLNL. Major differences in environmental impacts between these two configurations are presented below.

Socioeconomic Impacts. It is worthy to note that some of the reductions in workforce at the various stockpile management facilities are associated with reduced workloads expected in the future, while additional reductions in workforce could occur due to the physical downsizing of facilities. For the A/D and HE missions at Pantex, under No Action, the core stockpile management workforce would be reduced from the current level of 3,107 workers (3,002 for A/D and 105 for HE) to 1,020 workers (9l5 for A/D and 105 for HE) for single-shift operation. The physical downsizing of the facility would also improve efficiency such that the workforce could be reduced even further, to 831 workers for single-shift operation (800 for A/D and 31 for HE). Three-shift operation of the downsized Pantex facility would require 1,303 core stockpile management workers (1266 for A/D and 37 for HE).

For the secondary and case fabrication mission at ORR, under No Action, the workforce would be reduced from the current level of 3,126 core stockpile management workers to 2,741 workers for single-shift operation. The physical downsizing of Y-12 (essentially an 86-percent reduction in facility size) would also improve efficiency such that the core stockpile management workforce could be reduced even further, to 784 workers for single-shift operation. Three-shift operation of the downsized Y-12 facility would require 1,376 core stockpile management workers. The adverse socioeconomic impacts associated with the Y-12 downsizing would be mitigated by the creation of 1,152 new jobs associated with landlord activities in preparation for the D&D of the facilities no longer needed.

At KCP, workforce reductions consistent with a reduced workload have already taken place; therefore, the projected No Action workforce (2,508 core stockpile management workers) is equal to the current workforce. Downsizing the KCP facility would improve efficiency such that the workforce could be reduced to 1,669 workers for single-shift operation. Three-shift operation of the downsized KCP facility would require 2,257 workers.

Overall, socioeconomic impacts from construction for the Maximum Consolidation configuration would be minimal, except at NTS and SNL. Socioeconomic impacts from construction for the Downsize/Rightsize-in-Place configuration would also be minimal.

Resource Impacts. Construction impacts associated with the Downsize/Rightsize-in-Place configuration would be minimal. All construction activities would be modifications to existing facilities, with no new construction. Consequently, no significant land disturbance at any sites would result, and no potential impacts to biota or cultural resources would occur.

Construction impacts associated with the Maximum Consolidation configuration would be small overall; only the Device Assembly Facility upgrade at NTS and the Nonnuclear Facility at SNL involve any land disturbance greater than 1 ha (2.47 acres). Most construction activities would be modifications to existing facilities, with no significant land disturbance, and no potential impacts to biota or cultural resources.

During operation, because each of the two configurations would utilize similar facilities, procedures, resources, and numbers of workers, each would result in similar operational environmental impacts for most resource areas. For the Maximum Consolidation configuration, the greatest potential for any significant environmental impacts would occur at LANL, which would be the site for pit fabrication, secondary and case fabrication, HE fabrication, and a portion of nonnuclear fabrication. For each of the resources evaluated in this PEIS, no significant impacts are expected from such consolidation. Modeling results for air quality indicate minimal impacts to air quality. Water requirements would increase at LANL by 2.5 percent, but would still be less than the LANL allotment.

Radiation, Waste Management, and Accident Impacts. Cumulative doses to the population from normal operation would be less than regulatory limits. Impacts from accidents are independent of other missions (e.g., accident risks are additive, not multiplicative). Thus, the potential accident would be the sum of the risks from each mission. For maximum consolidation at LANL, there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 135,000 years from accidents. LANL would have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by these missions.

A difference in the operation of the Downsize/Rightsize-in-Place configuration and the Maximum Consolidation configuration would involve the transportation of nuclear and hazardous materials. The Downsize/Rightsize-in-Place configuration would result in transporting plutonium components between LANL (or SRS) and Pantex, and transporting secondary and case components between ORR and Pantex. Incident-free impacts associated with this transportation are small, while accident impacts are minor. The Maximum Consolidation configuration would also result in transporting plutonium components and secondary and case components. Transportation would occur between LANL and NTS. Relative to the Downsize/Rightsize-in-Place configuration, any transportation impacts would be less due to shorter distances and less populated roadways. The Maximum Consolidation configuration would also result in transporting HE components between LANL and NTS, but no significant impacts are expected.

S.3.5 Alternatives Considered but Eliminated from Detailed Study and Related Issues

This section of the PEIS has been revised in response to comments received on the Draft PEIS concerning its scope and the alternatives considered. To begin, it is important to review the basic logic used in constructing this PEIS and to restate the nature of the decisions expected to be made based on the contents of the PEIS.

Section S.2 describes the national security policy framework that defines the purpose and need for DOE's nuclear weapons mission for the foreseeable future. It also describes the development of proposed actions and reasonable alternatives in response to recent changes in national security policy. Section S.2 also puts those changes in broad technical perspective. Successive levels of technical detail are provided in chapters 3 and 4 of Volume I, and in Volumes II and III. The discussions that follow refer to the appropriate sections of this PEIS to avoid unnecessary repetition.

As stated in the Notice of Intent (60 FR 31291) published on June 14, 1995, DOE intends that the ROD on this PEIS will:

- Identify the future missions of the Stockpile Stewardship and Management Program; and
- Determine the configuration (facility locations) of the Complex necessary to accomplish the Program missions

While the terms "stockpile stewardship" and "stockpile management" are relatively new, the Program is not new when considered in terms of its substructure capabilities (section S.1). What the terms are meant to convey is a change in Program focus away from large-scale development and production of new-design nuclear weapons with nuclear testing, to one that focuses on the safety and reliability of a smaller, aging stockpile without nuclear testing. Even with this change in focus, however, national security policies require DOE to maintain the capabilities of the ongoing Program. The proposed actions flow logically from the mission purpose and need, given the policy constraints placed on the Program. Enhanced experimental capability is proposed because it is the surrogate source of experimental data that are needed to continually assess and certify a safe and reliable stockpile constrained by the absence of nuclear testing. Rightsizing manufacturing capacities is proposed in direct response to the reduced requirements of a smaller, aging stockpile constrained by the absence of new-design weapon production. Reestablishing pit manufacturing capability is proposed because it restores a required capability of the Program that was temporarily lost as a consequence of the closure of the Rocky Flats Plant.

In developing this PEIS, DOE judged the above three proposed actions to be significant at the programmatic level. Some additional strategies of the Stockpile Stewardship and Management Program, such as enhanced computational capability, were judged not to have significance for this PEIS because they did not have the potential for significant environmental impacts relative to the ongoing Program at a site, nor was the mission capability being considered for transfer to another site. The programmatic level environmental impacts of the ongoing Program at each of the eight sites in the Complex are described in chapter 4 of Volume I. Projects and facilities to support the ongoing Program are subject to site-specific NEPA review.

The issue of Stockpile Stewardship and Management Program alternatives is complex because nuclear weapons require a complete integrated set of technical capabilities and an appropriately sized manufacturing capacity. The technical capabilities are generally characterized as research, design, development, and testing; reliability assesument and certification; and manufacturing and surveillance operations (section S.2.1 and figure S.2-2). From a technical point of view, none of these capabilities can be deleted if DOE is to maintain a safe and reliable stockpile (section S.2.3). In addition, DOE has been directed to maintain these capabilities by national security policy from the President and Congress (section S.2.3).

S.3.5.1 *Alternatives in General*

Commentors questioned the different treatment of stewardship and management alternatives, mainly the lack of stewardship alternatives. Stewardship and management alternatives are treated differently in the PEIS because they address fundamentally different problems. Stockpile stewardship capabilities form the basis of U.S. judgments about the safety, reliability, and performance of U.S. nuclear weapons, and in a larger context, U.S. judgments about the nuclear weapons capabilities of others (section S.2.3). DOE did not consider it reasonable to propose stewardship alternatives that would diminish stewardship capabilities, particularly given the fact that historic confidence in the safety and performance of the stockpile was derived from nuclear testing that is no longer part of the ongoing stewardship program. National security policy requires DOE to maintain, and in some areas enhance, the stewardship capabilities of the three weapons laboratories and NTS (section S.2.1). The PEIS also explains the basis for this in a technical context, including the need for two independent nuclear design laboratories (section S.2.3). Therefore, this PEIS has no proposed actions that transfer ongoing stockpile stewardship missions from one site to another, or that would otherwise diminish ongoing stewardship missions.

National security policy also requires DOE to maintain stockpile management capabilities and appropriate manufacturing capacity for a smaller stockpile. Unlike stockpile stewardship capabilities, the smaller stockpile does permit some reasonable siting alternatives for stockpile management capabilities and capacities to accomplish the mission purpose and need within the current national security policy framework (section S.2.3).

S.3.5.2 *Enhanced Experimental Capability*

DOE has considered that there are differing opinions on the technical merit of DOE's proposed actions with regard to enhanced experimental capability. Nuclear weapons design information, including the complex physics of nuclear weapon explosions, is classified for reasons of national security and nonproliferation. Even if this information were unclassified, the physics problems remain daunting; hence, the reason why nuclear testing was so important to the past program. Both the classification of information and technical complexity of the issues form natural barriers to public communication. The technical complexity alone engenders significant debate among qualified experts, especially in the area of high energy density physics. This PEIS attempts to explain the weapon physics issues in an unclassified, comprehensible manner regarding its relation to mission purpose and need (section S.2), proposed actions and alternatives (section 3.3 of Volume I), and project-specific technical detail (Volume III). In the absence of nuclear testing, there are two basic alternatives: (1) rely on existing facilities as sources of experimental data described by the No Action alternative, and (2) pursue the enhanced capability of the proposed facilities to provide the sources of experimental data needed.

Role of Existing Experimental Facilities. In DOE's technical judgment, the existing facilities described by the No Action alternative are inadequate to meet the challenge of assessing and certifying a safe and reliable stockpile over the longer term. It is also DOE's technical judgment that it is impossible to speculate at this time whether any of the existing facilities could be retired, because they would be obsolete or redundant, as a result of a decision to construct and operate any or all of the three proposed new stewardship facilities. The uncertainties inherent in the R&D nature of the stewardship program would make that kind of exercise essentially guesswork. The development of machines to simulate the intricacies of a nuclear detonation requires a highly sophisticated scientific R&D program. It very likely will take 5 to 10 years to begin obtaining reliable data from the new facilities. Until those facilities are operational, DOE cannot reliably predict how the additional capabilities they provide will mesh with the capabilities of previously existing machines to further the goals of the Program. It is only through incremental advances in the state of the science that decisions can eventually be made regarding the retirement of obsolete or redundant facilities.

DOE is committed to making maximum efficient use of the stewardship capabilities at its disposal. However, it is not reasonable to speculate at this time about how future stewardship requirements might affect existing facilities and capabilities.

Next Generation Experimental Facilities. Commentors suggested that potential next generation experimental facilities be analyzed as part of the proposed action. This PEIS includes a discussion of potential next-generation experimental facilities and the reasons why they are not proposed actions or alternatives (section S.2.4 and section 3.3.4 of Volume I). These facilities, while contemplated on the basis of anticipated technical need, have not reached the stage of design maturity through R&D for DOE to include a decisionmaking analysis at this time. However, this PEIS does broadly describe, in general terms or by reference, what is known today about their potential environmental impacts. The environmental impacts from these facilities as contemplated today would not be significantly different from existing "similar" facilities. By characterizing the potential impacts in this way, the decisionmaker will be aware of the potential program-level cummulative impacts of the next-generation facilities when deciding whether to pursue a program of enhanced experimental capability. If DOE proposes to construct and operate such facilities in the future, appropriate NEPA review will be performed.

New Weapon Design. Commentors have suggested that the proposal for enhanced experimental capabilities is directed more at the capability to design new weapons in the absence of nuclear testing than at maintaining the safety and reliability of the existing stockpile and that stewardship alternatives could be different if the facilities were directed only at maintaining the existing stockpile. This PEIS explains why these capabilities are needed to maintain the safety and reliability of a smaller, aging stockpile in the absence of nuclear testing (section S.2). The existing U.S. stockpile of nuclear weapons is highly engineered and technically sophisticated in its design for safety, reliability, and performance. The stewardship capabilities required to make technical judgments about the existing stockpile are likewise technically sophisticated; therefore, it would be unreasonable to say that these stewardship capabilities could not be applied to the design of new weapons, albeit with less confidence than if new weapons could be nuclear tested.

However, the development of new weapon designs requires integrated nuclear testing such as occurs in nuclear explosive tests. Short of nuclear testing, no single stockpile stewardship activity, nor any combination of activities, could confirm that a new-design weapon would work. In fact, a key effect of a "zero-yield" CTBT would be to prevent the confident development of new-design weapons. National security policy requires DOE to maintain the capability to design and develop new weapons, and it will be a national security policy decision to use or not use that capability. Choosing not to use enhanced experimental capability for new weapons designs would not change the technical issues for the existing stockpile and, therefore, the stewardship alternatives would not change.

The issue of new-design weapons is separate from DOE's need to perform modifications to existing weapons that require research, design, development, and testing. The phrase used in this PEIS, "without the development and production of new-design weapons," is meant to convey the fact that the historical continuous cycle of large scale development and production of new weapons designs replacing older weapon designs has been halted. For example, during the 1980s, about a dozen new-design weapons were in full-scale development or production. Over the decade, production of new-design weapons replaced dismantled weapons nearly one for one. Today, only modifications to parts of existing weapons are being performed or planned; dismantlement has continued. This results in a smaller, aging stockpile that must be assessed and certified without nuclear testing. This is now the primary focus of the stewardship program.

Nonproliferation. Commentors have suggested that enhanced experimental capability is a proliferation risk. The national security policy framework discussed in this PEIS seeks a new balance between U.S. arms control and nonproliferation objectives and U.S. national security requirements for nuclear deterrence while pursuing these objectives (section S.2.1). In addition, a discussion is provided on some of the more difficult issues that must be considered in determining the balance, including a discussion of experimental capability (section S.2.5). In particular, the issue of nonproliferation and the proposed NIF was studied in detail. The study, prepared by the DOE Office of Arms Control and Nonproliferation, has been the subject of extensive public involvement, interagency review, and review by outside experts. The study concluded that the technical proliferation concerns of NIF are manageable and can therefore be made acceptable and that NIF can contribute positively to U.S. arms control and nonproliferation policy goals (appendix section I.2.1 of Volume III). NIF is a proliferation concern because of its broader scientific applications and expected frequent use by researchers worldwide, and, like the other proposed enhanced experimental facilities because of its possible relevance to the development of new weapon designs. However, the development of new weapon designs requires integrated testing. None of the proposed facilities, either alone or together, could perform such integrated testing of new concepts, and therefore cannot replace nuclear testing for the development of new weapon designs. The role of these facilities will be to help assess and certify the safety and reliability of the nuclear weapons remaining in the stockpile in the absence of nuclear testing. The national security policy framework and the technical issues that drive the proposed action for enhanced experimental capability remain the same.

Subcritical Experiments. With regard to the treatment of ongoing stewardship activities or enhanced experimental capability, subcritical experiments are an example of how changes in terminology have caused some confusion about what is evaluated in this PEIS under the No Action alternative. Subcritical experiments have been conducted at NTS over many years. Historically, operations at NTS have included tests or experiments that included both HE and special nuclear materials that were intended to produce no nuclear yield or negligible nuclear energy releases. These experiments frequently remained subcritical (i.e., they did not achieve self-sustaining fission chain reactions). The term "subcritical experiments" does not define a new form of activity or mission. It is intended to underscore the fact that in the future such experiments will be configured to ensure that the condition of criticality cannot be achieved. This issue has been clarified in the NTS Site-Wide EIS.

S.3.5.3 *Safe and Reliable Stockpile*

Some commentors have suggested that nuclear weapon reliability is not important in the post-Cold War era. National security policy as established by the President and Congress requires a safe and reliable stockpile. In order for the nuclear deterrent to be credible within the current national security policy framework, it must be reliable in a militarily effective way. A program designed to ensure the safety but not the reliability of the stockpile would require DOE to speculate on an alternate concept of nuclear deterrence and a national security policy framework to support it. See also the discussion of denuclearization in section S.3.5.4.

Commentors have also suggested acceptance of lower standards of reliability as an alternative to enhanced stewardship capabilities. This PEIS explains how the assesument and certification of nuclear performance is carried out, and how this process differs from the more conventional statistical methods used for assessing reliability of the nonnuclear portion of the weapon. Assesument and certification of nuclear performance is a technical judgment by the weapons laboratories based on scientific theory, experimental data, and computational modeling (sections S.2.2 and S.2.3). The question is not whether to accept a lower standard of nuclear performance (less nuclear explosive yield), but whether or not there is a technical basis to confidently know how well the weapon will perform at all. Enhanced stewardship capability is focused on the technical ability to confidently judge nuclear safety and performance in the absence of nuclear testing.

Aside from being inconsistent with national security policy, attempting to separate weapon safety and reliability is more technically complex than it sounds. A modern nuclear weapon is highly integrated in its design for safety, reliability, and performance. It contains electrical energy sources and many explosive energy sources in addition to the main charge HE. The principal safety concern is accidental detonation of the HE causing dispersal of radioactive materials (plutonium and uranium). Modern weapons are designed and system-engineered to provide a predictable response in accident environments (e.g., fire, crush, or drop). However, because of the technical complexity of potential accident scenarios (i.e., combined environments) and the fact that complete nuclear weapons cannot be used for experimental data, assesument of the design and the effect of changes that might be occurring due to stockpile environments must rely on other sources of experimental data and complex computer modeling. Enhanced experimental capability specifically related to the weapon secondary is a nuclear performance concern. Enhanced computational capability in general, and enhanced experimental capability related to the weapon primary in particular, are both nuclear safety and performance concerns.

S.3.5.4 *Description of Alternative Approaches*

Commentors have suggested that DOE consider alternative forms of stewardship. While their comments are responded to in Volume IV, this section discusses DOE's consideration of the broad range of views on this issue. The Congressional Research Service report, Nuclear Weapons Stockpile Stewardship: Alternatives for Congress, December 14, 1995, provides a reasonable description of the various viewpoints on alternatives and a framework for discussion. (The report uses the term stockpile stewardship generically to describe the Stockpile Stewardship and Management Program.) The following discussion of alternative approaches is taken from the summary of that report.

Denuclearizers would eliminate nuclear weapons worldwide in the foreseeable future, perhaps one to two decades. Until then, they would have a minimal U.S. stewardship program whose personnel, as curators of weapons knowledge, would monitor weapons. **Restorers** would maintain nuclear weapons with the only proven method, an ongoing program of research, development, design, testing, and production, downsized to meet post-Cold War needs. Three intermediate positions seek to maintain weapons indefinitely without nuclear testing. **Remanufacturers** believe that since current weapons have been tested and certified as meeting military requirements, this Nation can maintain them indefinitely by "remanufacturing"--reproducing them to the exact specifications of the originals. Remanufacturers would go to great lengths to do so in order to avoid risks that even slight changes to warheads might introduce. **Enhancers**, who take the Administration's position on stewardship, see identical remanufacture as impossible. They believe some changes in design, process, and materials are unavoidable and others are desirable. A robust science program, they hold, is the best that can be done without testing to monitor warheads, anticipate problems, modify warheads when problems arise, and revalidate stockpile effectiveness on an ongoing basis. They would have a small manufacturing program. **Maintainers** fall between remanufacturers and enhancers. They focus on how to maintain warheads. They prefer to avoid changes to warheads but would not go to great lengths to do so. They view a strong science program as essential, but only to the extent that its elements connect directly to maintaining weapons. They emphasize manufacturing as the ultimate guarantor of U.S. ability to solve warhead problems. They, along with enhancers, favor some link to testing if confidence cannot be maintained in any other way.

Beyond the broad overview of alternative approaches to stockpile stewardship and management, the main text of the report discusses variations within each of the five points of view. Given the political and technical complexity of the Program, many approaches can appear to be distinct or reasonable alternatives for detailed study. In fact, while the enhancer's viewpoint as described above most closely resembles the Program described in this PEIS, the Program actually embraces elements of all five viewpoints. The following discussion illustrates this point and focuses on the main issue(s) that, in DOE's view, eliminate the other approaches as distinct or reasonable alternatives for this PEIS.

Denuclearization. This approach is reflected in this PEIS to the extent that national security policy is pointed toward the goals of denuclearization. Since the end of the Cold War, more than 8,000 U.S. nuclear weapons have been dismantled, no new-design weapons are being produced, three former nuclear weapons industrial plants have been closed, and the United States is observing a nuclear test moratorium and seeking a "zero-yield" CTBT. Maintenance of a safe and reliable stockpile is not inconsistent with working toward the NPT goal of eliminating nuclear weapons worldwide at some unspecified time in the future. However, denuclearization is not a reasonable alternative for this PEIS because it is not feasible based on current national security policy.

The main issue discussed in this section is consideration of an alternative with a very small (10s or 100s) or zero stockpile. Two of the stockpile sizes analyzed in this PEIS, a START I Treaty- and START II protocol-sized stockpile, are the only ones currently defined and directed by national security policy. The PEIS also analyzes a hypothetical 1,000 weapon stockpile for the purpose of a sensitivity analysis for manufacturing capacity decisions. The NWSM specifies the types of weapons and quantities of each weapon type by year (section S.1). The NWSM is developed based on DOD force structure requirements necessary to maintain nuclear deterrence and comply with existing arms control treaties while pursuing further arms control reductions. This PEIS explains the complexity of this process and why DOE does not believe it reasonable to speculate using a large number of arbitrary assumptions (section S.2.1). DOE has considered that a future national security policy framework could define a path to a smaller stockpile. However, DOE has the following perspective on this issue.

Stockpile stewardship capabilities are currently viewed by the United States as a means to further U. S. nonproliferation objectives in seeking a "zero-yield" CTBT. Likewise, it would be reasonable to assume that U.S. confidence in its stewardship capabilities would remain as important, if not more important, in future arms control negotiations to reduce its stockpile further. The path to a very small (10s or 100s) or zero stockpile would require the negotiation of complex international treaties, most likely with provisions that require intrusive international verification inspections of nuclear weapons related facilities. Therefore, DOE believes it reasonable to assume that complex treaty negotiations, when coupled with complex implementation provisions, would likely stretch over several decades.

On a gradual path to a very small or zero stockpile, stockpile size alone would not change the purpose and need, proposed actions, and alternatives in this PEIS as they relate to stewardship capabilities. The issues of maintaining the core competencies of the United States in nuclear weapons, and the technical problems of a smaller, aging stockpile in the absence of nuclear testing, remain the same.

On a gradual path to a very small or zero stockpile, this PEIS evaluates reasonable approaches to stockpile management capability and capacity. At some point on this path, further downsizing of existing industrial plants or the alternative of consolidating manufacturing functions at stewardship sites would become more attractive as manufacturing capacity becomes a less important consideration. However, in the near term, the preferred alternative of downsizing the existing industrial plants would still be a reasonable action because the projected downsizing investment pays back within a few years through reduced operating expense; in addition, the downsizing actions are consistent with potential future decisions regarding plant closures. In regard to the proposed action of reestablishing pit manufacturing capability, DOE does not propose to establish higher manufacturing capacities than are inherent in the reestablishment of the basic manufacturing capability. In developing the criteria for reasonable stockpile management alternatives, DOE was careful not to propose the introduction of significant new types of environmental hazards to any prospective site. On a gradual path to a very small or zero stockpile, stockpile size alone would not change the purpose and need, proposed actions, and alternatives in this PEIS with regard to stockpile management capabilities and capacities.

To achieve eventual denuclearization, some commentors have asserted that DOE should adopt a passive curatorship approach to maintaining the declining nuclear weapons stockpile. The concept of curatorship is already being implemented at the existing sites in the form of knowledge preservation programs. While not necessary in an era of continuous development and production of new-design weapons and nuclear testing, knowledge preservation is now part of DOE's overall effort to maintain core competency in the weapons complex. However, as an inherently imperfect reconstruction, this effort can never ensure completeness of information nor relevance to future stockpile problems. More importantly, knowledge preservation does not address the fundamental issue of confidence in future technical judgments about issues that are yet to arise regarding the safety and performance of the stockpile. In highly technical matters, confidence arises from having appropriate data to support conclusions. In the absence of nuclear testing, the science-based approach to stockpile stewardship is focused on achieving the capability to acquire appropriate data.

From an environmental impact point of view, this PEIS displays the environmental impacts of each site's ongoing Program operations on an annual basis. The impacts of alternatives for proposed actions are displayed individually on the same basis. If one assumes that denuclearization leads to eventual site closure, then this PEIS, together with the Tritium Supply and Recycling PEIS, presents the environmental impacts of closing the four remaining industrial plants. While this PEIS does not directly consider the closure of the weapons laboratories and NTS, it is not at all clear what nuclear weapons capabilities the U.S. would retain even if it decided on a zero stockpile. However, the environmental impacts of the ongoing Program (No Action alternative) are essentially what would be phased out, with or without the proposed actions. DOE does not believe that speculative combinations of this data on speculative time lines provides any useful information for decisionmaking.

Restoration. The restorer's point of view is reflected in this PEIS to the extent that current national security policy requires DOE to maintain all the historical capabilities of the Program, including the capability for new-design weapons and nuclear testing. However, restoration is not a reasonable alternative for this PEIS because it requires a national security policy decision to reverse the constraints placed on the Program, namely, by resuming nuclear testing and new-design weapons production.

The environmental impacts of the restoration approach would be the same as those described in this PEIS to the extent that such a decision did not require manufacturing capacities higher than analyzed in this PEIS. In addition, this PEIS includes a brief description of the environmental impacts of nuclear testing (section 4.12 of Volume I); the Site-Wide EIS for NTS contains detailed information.

Remanufacturing . The remanufacturer's point of view is reflected in this PEIS by the fact that remanufacturing to specification will be attempted when possible and when appropriate to the problem being solved. With more than a half dozen different weapon types projected to remain in the stockpile, and with each weapon type containing thousands of parts, remanufacturing will undoubtedly occur for a significant number of repair and replacement activities. However, remanufacturing is not reasonable as a distinct exclusive alternative to the ongoing stockpile stewardship program or the proposed action of enhanced experimental capability for the technical reasons discussed below. In addition, it would not be a reasonable alternative because it does not fully support national security policies that require the conduct of a science-based stockpile stewardship and maintenance of the capability to design and produce new weapons.

Remanufacturing weapon components to their original specification, or maintaining weapons to their original design specifications, would superficially appear to be a reasonable approach to maintaining the safety and reliability of the stockpile in the absence of nuclear testing. Precise replication, however, is often not possible. Subtle changes in materials, processing, and fabrication techniques are an ever-present problem. In some cases, specialty materials and components become unavailable for commercial or environmental reasons. Implicit in the remanufacturing assumption is that the design blueprint, manufacturing process, and the materials used are specified in exact detail in every way. However, there is an unwritten element of "know how" that knowledgeable and experienced personnel contribute to any complicated manufacturing process (for this reason, controlling the acquisition of "know-how" is a major nuclear weapons nonproliferation objective). Materials and processes are not always specified in important ways because, at the time, they were not known to be important. The problem is illustrated by the following hypothetical example:

A material produced for a critical weld has a specification for a trace impurity; the manufacturing process consistently produced the material with a trace impurity less than the maximum allowed and the welds were satisfactory; the manufacturing process is changed for some reason, such as cost or environmental concerns; the material is now being produced with less trace impurity than before the process was changed; the material is still within specification; however, the welds are no longer satisfactory; it was unknown at the time that the higher level of the trace impurity was necessary to produce a satisfactory weld.

While remanufacturing sounds simple in principle, it is likely in fact to present complex issues of design, manufacturing process, and material variables. A simplified view of remanufacturing cannot serve as a "stand alone" manufacturing approach, let alone an alternative approach to enhanced stewardship capability. In the absence of underground nuclear testing, nuclear components (pits and secondaries) cannot be functionally tested. Stewardship capabilities provide the analytical tools (experimental and computational) to assess the significance of a problem observed during surveillance and to decide if the problem should be fixed; and if fixed, to certify that the fix will work (section S.2.3). In the past, the decision to fix or not fix an observed problem could be made with nuclear testing (section S.2.2). Stockpile stewardship strategies focus on the basic material science and the enhanced experimental and computational tools necessary to better predict age-related defects and to make sound technical judgments on nuclear safety and performance in the absence of nuclear testing.

The DARHT EIS (DOE/EIS-0228, section 2.3.2) provides an additional discussion of the limitations of a remanufacturing-to-specification approach. It discusses, as an example, the actions taken to evaluate and resolve unanticipated deterioration of HE in the now-retired W68 warhead for a submarine-launched ballistic missile. In that case it was necessary to replace the HE with a more chemically stable formulation. In addition, some other materials were no longer commercially available, requiring changes in the rebuilt weapons. Nuclear testing was ultimately used to verify that the necessary changes were acceptable. DOE does not consider it feasible to maintain all potentially obsolescent commercial sources and processes used for materials in existing weapons; aging would still occur in stored reserves of such materials.

With regard to stockpile management, remanufacturing without enhanced stewardship capability would also have notable drawbacks. DOE plans to maintain the capability to produce secondaries, and proposes to reestablish the capability to produce pits, by producing small quantities (10s) of each annually to maintain capability. This capacity should be sufficient to replace components attrited from the stockpile by surveillance testing. Remanufacturing these components, without the enhanced stewardship analytical capability to determine if and when replacement is necessary, is likely to require higher levels of production than DOE believes necessary to maintain production capability. Also, remanufacturing a nuclear component to the original specifications will not prevent age-related problems related to those specifications from recurring. Since these components use plutonium and uranium, radiation exposure to personnel and generation of radioactive waste would also be higher than necessary. If repeated remanufacturing were required, further unnecessary risks would result from additional weapon A/D operations and additional transport of nuclear components between sites.

From an environmental impact point of view, the remanufacturing concept would have greater impacts for the proposed action of reestablishing pit capability because DOE proposes to use a cleaner, less waste-generating process than was used at the Rocky Flats Plant. All other environmental impacts would not be distinguishable from those described in this PEIS because existing manufacturing processes form the Program baseline.

Maintenance . The maintainer's point of view is reflected in this PEIS to the extent that it is consistent with the No Action alternative. Under this approach, weapons maintenance would be the focus of stockpile stewardship. This approach would rely on enhanced surveillance and dual revalidation, whereby the weapons laboratories would conduct independent technical examinations of weapons to validate their safety and reliability. Any problems that arose would be solved through either remanufacture or "fixes" proposed by the weapons laboratories. These attributes are all part of the ongoing Program that will continue into the future. The principal difference between the Program as presented in this PEIS and this point of view is differing judgment on how much enhanced experimental capability would be needed to assess and certify a safe and reliable stockpile over the long term. The maintainers believe that less (or no) additional experimental capability would be required if DOE placed more emphasis on enhanced surveillance and dual revalidation.

DOE believes that this approach would not provide a sufficient basis for assessing and certifying the safety and reliability of the stockpile. Although enhanced surveillance will play an important role in the future of the Program, it serves a limited purpose. Surveillance activities identify stockpile problems through the examination and analysis of weapons sampled from the stockpile. An enhanced surveillance program would serve to identify problems with greater confidence and increased warning time. However, it would not provide a sole basis for assessing the significance of the problem or determining its solution. The ability of the laboratories to validate that the problem has been corrected, in the absence of nuclear testing, depends on their experimental and computational capabilities. In DOE's judgment, as explained in section S.2.3, those capabilities are inadequate. Therefore, to the extent that maintainance would not provide sufficient enhanced experimental capability, it is not a reasonable alternative.

From an environmental impact point of view, the maintenance concept is not distinguishable from the impacts of the No Action alternative for stockpile stewardship and the proposed actions for stockpile management.

S.4 PREFERRED ALTERNATIVE

CEQ regulations require an agency to identify its preferred alternative(s) in the Final EIS (40 CFR 1502.14[e]). The preferred alternative is the alternative that the agency believes would best fulfill its statutory mission, considering environmental, economic, technical, and other factors. This PEIS provides information on the environmental impacts. Cost, schedule, and technical analyses have also been prepared and are presented in the *Analysis of Stockpile Management Alternatives report and the Stockpile Management Preferred Alternatives Report* , which are available in the appropriate DOE Public Reading Rooms for public review.

DOE has identified the following preferred alternatives of the Stockpile Stewardship and Management Program:

Stockpile Stewardship :

- Construct and operate NIF at LLNL
- Construct and operate CFF at LLNL

- Construct and operate the Atlas Facility at LANL

Stockpile Management :

- Secondary and Case Component Fabrication--downsize the Y-12 Plant at ORR
- Pit Component Fabrication--reestablish capability and appropriate capacity at LANL
- A/D--downsize at Pantex
- HE Fabrication--downsize at Pantex
- Nonnuclear Component Fabrication--downsize at KCP
- Based on the analyses performed to support this PEIS, the preferred alternatives for strategic reserve storage are as follows: (1) HEU strategic reserve storage at Y-12 and (2) plutonium pit strategic reserve storage in Zone 12 at Pantex. The preferred alternatives for strategic reserve storage could change based upon decisions to be made in regard to the Storage and Disposition PEIS. Decisions on strategic reserve storage will not be made in the upcoming ROD for the Stockpile Stewardship and Management Program. Storage decisions are not expected to be made until both the Stockpile Stewardship and Management PEIS and the Storage and Disposition PEIS are completed.

The preferred alternative for plutonium-242 oxide at SRS is to transport the material to LANL for storage.

The preferred PEIS alternatives do not represent decisions by DOE. Rather, they reflect DOE's current preferences based on existing information. The ROD, when issued, will describe DOE's decisions for the Stockpile Stewardship and Management PEIS proposed actions.

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1 From a January 1995 speech by Ambassador Graham, Special Representative of the President for Arms Control Non-Proliferation and Disarmament.

2 The effects of radiation on nuclear weapons and military systems are referred to as "weapons effects" throughout this PEIS.

3 Other than in specific discussions, the word surveillance is used generically throughout this document in place of the Stockpile Evaluation Program.

4 Proposed facilities. Stockpile Stewardship and Management PEIS includes both a programmatic assesument and a project-specific analysis of these potential experimental facilities.

5 Facilities used to investigate the physics of nuclear weapons secondaries may also be used to investigate some physics phenomena related to nuclear weapons primaries and weapons effects.

6 No new facilities solely to investigate weapons effects phenomena are being proposed at this time.

7 Surveillance is included in all capabilities.

8 Includes nonintrusive modification pit reuse and the option of strategic reserve storage of plutonium and HEU.

9 KCP functions would be distributed among two or three of the laboratories.

10 Staging and storage of working inventories of nuclear materials and components are included.

11 Research and development capability only.

12 Includes strategic storage of HEU reserve.

S.2 PURPOSE OF AND NEED FOR THE STOCKPILE STEWARDSHIP AND MANAGEMENT ACTION

The Stockpile Stewardship and Management Program is broad in scope and technically complex. The Program currently involves the integrated activities of three national laboratories, four industrial plants, and a nuclear test site. Further, the Program must be consistent with, and supportive of, U.S. national security policies, which have changed considerably since the end of the Cold War. Therefore, to better understand the Stockpile Stewardship and Management PEIS purpose, need, proposed action, and alternatives, it is useful to view the Program from two different perspectives. One perspective (see section S.2.1) is from the top level of national security policies for nuclear deterrence, arms control, and nonproliferation. These policies include ongoing responsibilities, strategies, and directives. The other perspective (see section S.2.2) focuses on the relevant technical efforts to maintain a safe and reliable U.S. nuclear weapons stockpile. Flow diagrams representing the logic of each perspective are included in figures S.2-1 and S.2-2.

S.2.1 National Security Policy Considerations

There are four principal national security policy overlays and four related treaties that define Program conditions for the reasonably foreseeable future. They are:

- Presidential Decision Directives (PDD)
- National Defense Authorization Act of 1994 (Pub. L. 103-160)
- DOD Nuclear Posture Review (NPR)
- NWSM
- Proposed CTBT
- NPT
- START I Treaty
- START II protocol

Of the above, the START II protocol is the most useful in helping define a specific time period to bound the reasonably foreseeable future.

Nuclear Posture Review

Beginning in 1991, several Presidential policy decisions, some unilateral and some made in conjunction with international treaties, resulted in DOD conducting the comprehensive NPR, which was approved by the President in 1994. The NPR defines and integrates past and present U.S. policies for nuclear deterrence, arms control, and nonproliferation objectives. The unclassified NPR strategies that pertain to the Stockpile Stewardship and Management Program were presented at the eight public scoping meetings conducted in the summer of 1995. There was general public interest in understanding this complex issue, especially as it relates to treaties, policies, and stockpile size. A summary of how the post-Cold War treaties relate to the NPR strategies and the stockpile follows.

Strategic Arms Reduction Talks. The NPR assumes that the START I Treaty and START II protocol will be fully implemented. However, since the START I Treaty is not yet fully implemented and the START II protocol is not scheduled to be fully implemented until 2003, the NPR strategy protects the U.S. option to reconstitute the stockpile to START I levels should unfavorable events occur in the former Soviet Union. The treaties only control the number of strategic nuclear weapons that can be loaded on treaty-specified and -verified strategic missiles and bombers. These nuclear weapons are limited to 6,000 by the START I Treaty and 3,500 by the START II protocol. The treaties do not control the total stockpile size or the composition of strategic and nonstrategic nuclear weapons of either side. The U.S. stockpile will be larger than 6,000 under START I and 3,500 under START II since the stockpile also includes retaining weapons for nonstrategic nuclear forces, DOD operational spares, and spares to replace weapons attrited by DOE surveillance testing. In the START II case, the stockpile may also include retaining weapons to reconstitute to the START I level. However, the terms "START I-sized stockpile" and "START II-sized stockpile" are relevant to the Stockpile Stewardship and Management PEIS as explained in the discussion of the NWSM.

Comprehensive Test Ban Treaty. It is the declared policy of the United States to seek ratification of a "zero-yield" CTBT as soon as possible. The United States has been observing a moratorium on nuclear testing since 1992. The NPR strategy reflects this policy and the strategy has a significant effect on shaping the Stockpile Stewardship and Management Program. As explained in section S.2.2, it is anticipated that repairs or replacements to an aging U.S. stockpile will be needed. Assesument and certification of the safety and reliability of stockpile repairs or replacements without nuclear testing is a significant challenge to the Stockpile Stewardship and Management Program. In declaring the policy to seek a CTBT, the President also declared that the continued safety and reliability of the U.S. nuclear stockpile is a "supreme national interest" of the United States.

Nuclear Nonproliferation Treaty. Article VI of the NPT obligates the parties "to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." However, the NPT does not provide any time period for achieving this goal. Even relatively simple bilateral treaties, such as START I and START II, require more than 10 years to implement, not counting the years of negotiations. In the words of Ambassador Thomas Graham, "Regrettably, none of us is clairvoyant, and so it is unwise to predict with any degree of precision the future international reality and consequently, the complete arms control agenda." [1] For the Stockpile Stewardship and Management PEIS, speculation on the terms and conditions of a "zero level" U.S. stockpile with international verification, as some have suggested during the scoping meetings, goes beyond the bounds of a reasonably foreseeable future. For the same reason, DOE has not chosen to speculate on a return of the nuclear arms race requiring a stockpile larger than START I size. However, in keeping with the NPT goals, the NPR strategy does express the U.S. intent to pursue further reductions in nuclear forces beyond START II. Therefore, the implications of further reductions below the START II-sized stockpile are discussed in this PEIS where they are relevant.

Nuclear Weapon Stockpile Memorandum

Although the NWSM is a classified document, its effect in shaping the Stockpile Stewardship and Management PEIS can be explained in an unclassified context. Without access to the classified NWSM, one might assume that the exact details of the projected stockpile size and composition under START I and START II could have a significant effect on the Stockpile Stewardship and Management PEIS. This is not the case for the following reasons:

- The stockpile composition (i.e., the number of different weapon types), does not vary significantly in either a START I- or START II-sized stockpile. All weapon types are tritium-boosted, thermonuclear weapons that could be affected by the same types of safety and reliability problems requiring repair, replacement, and certification in the absence of nuclear testing. The basic weapons laboratory and industrial capabilities required for the foreseeable future do not vary significantly from planned differences in size or composition of either a START I- or START II-sized stockpile.
- Industrial capacity is only indirectly affected by projected variances in stockpile size and composition. Stockpile size must be linked with historical stockpile data to arrive at estimates of average annual industrial capacity needed to produce components for repair or replacement. Even without the limitations on the use of historical stockpile data described in section S.2.2, this cannot be done with mathematical precision and therefore reasonable technical judgment must be applied. The result is to forecast a need for a smaller industrial base with capacities on a scale of hundreds of weapons per year versus the thousands of weapons per year that existed prior to the end of the Cold War. A range of annual requirements is considered for impact analysis in the Stockpile Stewardship and Management PEIS that bounds potential variances in the NWSM under the START II protocol. In addition, a qualitative sensitivity analysis is performed on the hypothetical low case that is well below the START II-sized stockpile projection and the high case associated with a START I-sized stockpile.

Presidential Decision Directives and Public Law

Over the past few years, there have been several publicly announced PDDs that have shaped the Stockpile Stewardship and Management Program. In the National Defense Authorization Act *of 1994* (Pub. L. 103-160), Congress acted to reinforce many of the same points. A summary of their effect in shaping the Stockpile Stewardship and Management PEIS follows:

- The continued maintenance of a safe and reliable nuclear weapons stockpile will remain a cornerstone of the U.S. nuclear deterrent for the foreseeable future.
- The core intellectual and technical competencies of the United States in nuclear weapons will be maintained. This includes competencies in research, design, development, and testing (including nuclear testing); reliability assesument; certification; manufacturing; and surveillance capabilities.
- The United States will develop new ways to maintain a high level of confidence in the safety, reliability, and performance of its nuclear weapons stockpile in the absence of nuclear testing. The strategy for this action will be structured around the use of past nuclear test data in combination with enhanced computational modeling, experimental facilities, and simulators to further comprehensive understanding of the behavior of nuclear weapons and the effects of

radiation on military systems. 2

- The continued vitality of all three DOE nuclear weapons laboratories will be essential in addressing the challenges of maintaining a safe and reliable nuclear weapons stockpile without nuclear testing and without the production of new-design weapons.

S.2.2 Safety and Reliability of the United States Stockpile

This section focuses on the technical effects of national security policy decisions on shaping the purpose, need, proposed actions, and alternatives of the Stockpile Stewardship and Management Program. The stockpile is currently judged to be safe and reliable by DOE. National security policy changes will significantly change the characteristics of the future nuclear weapons stockpile and the manner in which it will need to be certified as safe and reliable.

Stockpile History

Since the beginning of the Cold War, the United States has maintained a nuclear deterrent force as safe and reliable as the evolution of military requirements and technology development would permit. A safe and reliable U.S. nuclear weapons stockpile has been a cornerstone of maintaining a credible nuclear deterrent. The size of the U.S. nuclear weapons stockpile peaked in the 1960s. In the 1970s, it was significantly reduced due to the easing of Cold War tensions with the former Soviet Union. In the late 1970s and through most of the 1980s, Cold War tensions with the former Soviet Union significantly increased and the U.S. nuclear deterrent force was modernized in response. However, the size of the U.S. nuclear weapons stockpile remained stable during the 1980s with the production of new-design weapons replacing dismantled weapons nearly one for one.

The beginning of the 1990s brought the collapse of the Warsaw Pact and the former Soviet Union and a significant effort to end the Cold War. During the first half of the 1990s, many changes occurred in U.S. policy and planning for its nuclear deterrent force. Much has already been accomplished, including the dismantlement, without replacement, of more than 8,000 U.S. nuclear weapons since the end of the Cold War; however, much more will need to be accomplished with the former Soviet Union over the next 10 years to stay the course. Large uncertainties remain concerning the nuclear weapons stockpile of the former Soviet Union, and it is the policy of the United States to protect its national security options for its nuclear deterrent, including the reconstitution of its nuclear forces. The following excerpt is from the President's national security strategy statement in July 1994:

Even with the Cold War over, our Nation must maintain military forces that are sufficient to deter diverse threats ... We will retain strategic nuclear forces sufficient to deter any future hostile foreign leadership with access to strategic nuclear forces from acting against our vital interests and to convince it that seeking a nuclear advantage would be futile. Therefore we will continue to maintain nuclear forces of sufficient size and capability to hold at risk a broad range of assets valued by such political and military leaders.

Smaller, Aging Stockpile

Until recently there has been no reason to expect that weapons would remain in the stockpile longer than they have in the past. Continuous modernization to improve safety and reliability kept the stockpile young as new-design weapon types replaced old ones. Now, with no new-design weapons being produced, the United States will have a steadily aging stockpile. The average age of the stockpile has never approached the typical lifetime specified in the weapon requirements (approximately 20 years for the most modern U.S. nuclear weapons). The average age of the stockpile is currently about 13 years. The NWSM forecasts the average age will now climb roughly 1 year per year and will reach the 20 year mark by 2005, at which time the oldest weapons will be about 35 years old.

Historical Stockpile Data

The following paragraphs describe the effects of historical stockpile data in shaping the Stockpile Stewardship and Management Program. This information was extracted from an unclassified report, Stockpile Surveillance: Past and Future (tri-laboratory report requested by DOE and issued as Sandia Laboratory Report, SAND 95-2751, September 1995), which was co-authored by the three weapons laboratories and is available to the public. The past role of nuclear testing is emphasized because such testing can no longer be relied on to provide unambiguous high confidence in the future safety and reliability of an aging stockpile.

Stockpile Evaluation Program. [3]Continuous evaluation of the safety and reliability of the stockpile has always been a major part of the U.S. nuclear weapons program. Since the introduction of sealed-pit weapons more than 35 years ago, a formal surveillance program of nonnuclear laboratory and flight testing has been in existence. More than 13,800 weapons have been evaluated in this program. The Stockpile Evaluation Program, with its reliance on functional testing, has provided information that can be used in the statistical analysis of nonnuclear component and subsystem reliability. This program has detected about 75 percent of all problems ultimately detected, and it has been the principal mechanism for discovering defects and initiating subsequent repairs and replacements. However, not all aspects of a nuclear weapon can be statistically assessed this way. Weapons research and development (R&D) at the three weapons laboratories and nuclear testing have played an important part in assessing the stockpile and in making corrective changes when needed.

Past Role of Nuclear Testing. Nuclear tests have been a critical part of the nuclear weapons program. They have contributed to a broad range of activities from development of new weapons to stockpile confidence tests to tests that either identified a concern or showed that remedial actions were not needed. However, the United States has not conducted a sufficient number of nuclear tests for any one weapon type to provide a statistical basis of reliability assesument for the nuclear explosive package. This is why the word "performance" instead of "reliability" is used when discussing a nuclear explosive package.

Although nuclear tests were never a part of the formal Stockpile Evaluation Program, they played an important role in maintaining the safety and performance of the weapons in the stockpile. Every advantage was taken of developmental nuclear tests to eliminate potential nuclear explosive problems. In some cases, nuclear testing during development of one weapon type uncovered a problem that was pertinent to a previous design already in the stockpile, which then had to be corrected. Nuclear tests identified certain classes of stockpile problems not observable in the surveillance program. Nuclear tests have been used to resolve issues raised by the Stockpile Evaluation Program, such as whether a particular corrosion problem affected the nuclear yield of a weapon. Nuclear tests have also been used to verify the efficacy of design changes. For example, the adequacy of certain mechanical safing techniques was determined through nuclear testing. In the case of a catastrophic defect, tests have been used to certify totally new designs to replace an existing design. Finally, in some cases, nuclear testing proved that a potential problem did not exist.

Beginning in the late 1970s, DOD and DOE agreed to a formal series of underground nuclear tests of weapons withdrawn from the stockpile. These tests were referred to as Stockpile Confidence Tests. They differed from developmental nuclear tests because the weapons were from actual production, had experienced stockpile conditions, and had minimal changes made to either nuclear or nonnuclear components prior to the test. There have been 17 such confidence tests since 1972, including 4 tests in the early 1970s that were not officially designated as Stockpile Confidence Tests. Confidence tests have been conducted for each of the weapon types expected to remain in the stockpile well into the next century.

In addition to the 17 confidence tests, at least 51 additional underground nuclear tests have been conducted since 1972 involving nuclear components from the stockpile, components from the actual weapon production line, or components built according to stockpile design specifications and tested after system deployment. The objectives of these tests included weapon effects, weapons R&D, confirmation of a fix, or investigation of safety or performance concerns. Three of these tests (in addition to one confidence test) revealed or confirmed a problem that required corrective action. Four tests (in addition to three confidence tests) confirmed a fix to an identified problem. Additionally, five tests were performed to investigate safety concerns affecting three different weapon types. These five tests verified that a problem did not exist.

The confidence in the performance of the nuclear explosive package has been based on underground nuclear test data, aboveground experiments, computer simulations, surveillance data, and technical judgment. The directors of the three weapons laboratories must certify the nuclear performance of the weapons designed by their laboratory.

In a future without additional nuclear testing, the core capabilities of the weapons laboratories that were developed to eliminate potential problems in new weapon designs must now be employed to assess stockpile problems. However, in the absence of nuclear testing, the ability to assess nuclear components is more difficult; new methods of assesument, discussed later, will have to be developed to help compensate for this loss.

Stockpile Data Summary. The historical stockpile database includes more than 2,400 findings from more than 45 weapon types. Findings are any abnormal conditions pertaining to stockpile weapons, such as out-of-specification data. Findings are then investigated and assessed as to whether or not they are a problem. Excluding multiple occurrences of the same anomalous condition, table S.2.2-1 provides a summary of the distinct findings and actionable findings since 1958. Actionable findings are those that require some form of corrective action. All major components and subsystems have had problems that required corrective actions. The number of findings for nonnuclear components is much larger than that for nuclear components largely because there are so many more nonnuclear components in a nuclear weapon that require testing more frequently. However, the ratio of actionable findings to distinct findings is much greater for the nuclear components. Thus, when a finding has occurred for a nuclear component, it has generally been a serious one requiring corrective action. Often these corrective actions to nuclear components have required changes to all of the weapons comprising the weapon type affected.

For the nuclear explosive package, there were approximately 110 findings on 39 weapon types requiring some remediation either to the entire build of that design or to all weapons produced after the particular finding. In addition to rebuilds and changes in production procedures, other actions included imposing restrictions on the weapon, accepting a performance decrement, and in several cases, conducting a nuclear test to determine that the finding did not require any physical change. There have been other instances not counted as actionable where a material was chemically changing and the weapon was closely monitored to see if further action was necessary or it was an isolated case that did not require remediation.

Table S.2.2-1. *Summary of Distinct and Actionable Findings Since 1958*

Type of Components	Distinct Findings	Actionable Findings	
		Findings	Weapon Types
Nuclear	145	110	39
Nonnuclear	703	306	38

Source: SNL 1996a.

Certified Repairs or Replacements will be Needed

Based on the age of the planned stockpile over the next 10 years, historical data would project an average of one to two actionable findings per year in the planned stockpile and an average of one to two change proposals approved per year, with one of these resulting in a major change. Even with a START II-sized stockpile, one change can affect thousands of weapons. These projections are most likely minimum numbers. The stockpile they were derived from was, on average, younger than the planned stockpile will be in future years, and the number of components in the weapon types was less than the number of components in weapon types of the planned stockpile. Furthermore, the aging characteristics of some of the materials used in the weapon types remaining in the stockpile are not well understood.

The previous paragraphs describe how problems were identified in stockpile weapons during the period when nuclear testing and active weapons development were being conducted along with the Stockpile Evaluation Program. At the present time, with no anticipated new weapons and no nuclear testing, new approaches are needed to assess weapons for potential problems and anticipate aging concerns, especially in the nuclear explosive package. This is important because the smaller, less diverse U.S. stockpile will be more vulnerable to single-component and common-cause failures (i.e., failures or defects compromising the safety or reliability of, respectively, a single weapon system or several systems sharing a common design feature).

DOE will continue to rely on well-established methods while the weapons laboratories develop new methods of measurement and evaluation to address aging, safety, reliability, and performance issues. As the new methods mature for either nuclear or nonnuclear components, they will be incorporated into the Stockpile Evaluation Program. In the future, for example, DOE will rely on improved experimental capabilities, coupled with an improved computational capability, to address issues associated with the nuclear explosive package. These experimental capabilities, along with enhanced surveillance methods, are now crucial to help assess and predict the state of the stockpile and to provide long lead time information about incipient problems.

S.2.3 Purpose and Need

Broadly stated, changes to U.S. national security policies for nuclear deterrence now place two significant constraints on the way in which DOE has traditionally accomplished its statutory nuclear weapons mission:

- The United States has declared a moratorium on nuclear testing and will seek ratification of a "zero-yield" CTBT.
- The United States has stopped the development and production of new-design nuclear weapons.

With these constraints, U.S. national security policy directs DOE to:

- Maintain the core intellectual and technical competencies of the United States in nuclear weapons including:
- Research, design, development, testing, reliability assesument, certification, manufacturing, and surveillance
- All three nuclear weapons laboratories and the capability to resume nuclear testing if needed
- Maintain a safe and reliable U.S. nuclear weapons stockpile

The NPR, PDDs, and Pub. L. 103-160 all address the need to maintain the core competencies of the United States in nuclear weapons without nuclear testing. The NPR strategy adds the expectation of no new-design weapon production; therefore, the NWSM does not currently direct or forecast such a requirement.

The Stockpile Stewardship and Management Program must accomplish these fundamental purposes in a safe, efficient, and environmentally responsible manner. National security policies do not eliminate any of the current or historical core competencies and capabilities of the DOE weapons laboratories, industrial plants, or NTS. They are basic needs that must be maintained for the foreseeable future. These needs are summarized in a focused discussion of their relationship to the development of the PEIS proposed actions and alternatives. A classified appendix has also been prepared to support the PEIS.

Stockpile Stewardship--The Weapons Laboratories and Nevada Test Site

The three weapons laboratories possess most of the core intellectual and technical competencies of the United States in nuclear weapons. These competencies embody more than 50 years of weapons knowledge and experience that cannot be found anywhere else in the United States. Since the end of the Cold War, laboratory staffing in the weapons program has declined significantly due to the effects of policy changes on program and budget. Further significant reductions or consolidations of the weapons laboratories would counter efforts to maintain core competencies and to develop the new technologies necessary to ensure continued high confidence in a safe and reliable stockpile. Current stockpile activities in this regard, such as ongoing retrofits of enduring stockpile weapons and safe dismantlement of weapons no longer required, would also be hampered. For the foreseeable future it would be unreasonable to pursue an alternative course for the weapons laboratories. In addition, because there can be no absolute guarantee of complete success in the development of enhanced experimental and computational capabilities, the United States will maintain the capability to conduct nuclear tests under a "supreme national interest" provision in the anticipated CTBT. DOE will need to maintain the capability for nuclear testing and experimentation at NTS and the necessary technical capabilities at the weapons laboratories to design and conduct such tests.

The science and engineering technology base at the three weapons laboratories controls all DOE technical requirements for a U.S. nuclear weapon. The laboratories perform the basic research, design, system engineering, development testing, reliability assesument, and certification of nuclear performance. In addition, they provide or control all technical specifications that are used by the industrial base for manufacturing and surveillance operations and for maintenance operations conducted by DOD. Data from these operations are provided to the weapons laboratories for assesument and technical resolution of problems.

When stockpile problems develop, all of the core laboratory capabilities may come into play. The cause of the problem is identified and an assesument made of its impact on safety, reliability, or performance. If the problem is to be fixed, alternative solutions are developed. These can range from simple repair of a defective feature to complete redesign of the weapon component or subsystem.

The focus is always on the acquisition of relevant test data to make these judgments. Once a fix is determined, it must be designed, prototyped, and development tested by the laboratories before the design is released for manufacture. This generally includes weapon system-level laboratory and flight tests for nonnuclear features and, in the past, nuclear tests if the changes could affect the weapon's nuclear performance. If the fix is to be manufactured, the laboratories provide the quality assurance test specifications. For nonnuclear components, a significant amount of functional test data is acquired during manufacture and is used to begin building a statistical estimate of component reliability. Subsequent laboratory and flight testing in the surveillance program accumulates additional data that include the effects of aging and exposure to stockpile environments. Thus, over time, high confidence in the safety and statistical reliability of nonnuclear components and subsystems can be established.

The situation is not the same for nuclear components and the assesument of nuclear performance. Nuclear components cannot be functionally tested during manufacture or surveillance. The data acquired during manufacture only show that the component was manufactured as designed. Surveillance data indicate whether the component is changing as a result of aging or exposure to stockpile environments. Manufacturing and surveillance data can identify concerns, but these data do not provide all of the necessary information to assess nuclear performance. Assesument and certification of nuclear performance is a nonstatistical, technical judgment by the weapons laboratories based on scientific theory, experimental data, and computational modeling. The scientific practice of "peer review" has been fundamental to these judgments. Experts from the two nuclear design laboratories review each other's data and conclusions on important issues, thereby providing an independent check and balance.

In the past, nuclear testing filled the gaps in basic understanding of the complex physics phenomena; it provided high confidence in the certification of nuclear safety and performance. Without nuclear testing, science-based stockpile stewardship will focus on obtaining the more accurate scientific and experimental data that will be needed for more accurate computer simulations of nuclear performance. The new experimental data must also be validated against past nuclear test data. Assesument of stockpile problems and certification of repairs or replacements of nuclear components will have to rely on improvements to these tools. The existing tools were used in conjunction with nuclear testing and are inadequate if used alone.

From a broader national security perspective, the core intellectual and technical competencies of the weapons laboratories provide the technical basis for the pursuit of U.S. arms control and nuclear nonproliferation objectives. Their extensive core competencies have provided most of the nuclear weapons arms control technologies developed and employed by the United States. The weapons laboratories will have to continue to provide this essential service in the future. For the same reasons, the weapons laboratories also provide significant technical support for U.S. efforts on nuclear weapons nonproliferation and counter-proliferation programs.

Stockpile Management--The Industrial Base

None of the manufacturing and surveillance capabilities of the current industrial base can be eliminated on the basis of the post-Cold War changes in national security policies. The industrial base also possesses core competencies, such as manufacturing product, process, and quality control know-how. However, with a smaller stockpile and no new-design weapons production, industrial capacity can be reduced to meet anticipated manufacturing requirements for stockpile repair and replacement activities. A summary discussion of each of the major functions needed is provided in this section.

Broadly stated, there are six major manufacturing and surveillance functional areas in the weapons industrial base:

- Weapon A/D
- Pit components
- Secondary and case components
- HE components
- Nonnuclear components
- Tritium supply and recycling

As explained in section S.1.4, tritium supply and recycling was evaluated in a separate PEIS.

Weapon Assembly/Disassembly. Pantex is the only DOE site currently authorized to assemble or disassemble stockpile weapons. Special facilities built to explosives safety criteria are required; in addition, some facilities are designed to limit nuclear material dispersal in case of an HE accident. These facilities exist in large numbers at Pantex, and because they are relatively discrete structures, downsizing-in-place is a viable alternative. NTS has a much smaller set of these special structures that were constructed for use in assembling nuclear test devices. However, NTS has few of the support facilities required for volume assembly or disassembly of stockpile weapons. A major programmatic consideration is the cost of re-creating facilities that already exist at Pantex. Due to ongoing weapon dismantlement requirements, the alternative to transfer this function to NTS would be slow but achievable within a 10-year period.

Pit Components. These components are designed by LANL and LLNL and were formerly produced at the Rocky Flats Plant, which is no longer available for this function. The LLNL facility is not large enough to accommodate both stewardship and management activities; therefore, only LANL is considered to be a reasonable alternative if this function is reestablished at a weapons laboratory. Also, LANL has the more extensive and complete plutonium facility infrastructure. SRS is also considered a viable alternative for reestablishing this function because it has a plutonium processing infrastructure, although it does not have a precision component manufacturing capability. Other than the synergism with maintaining core competencies at the weapons laboratories, a major program consideration would be the scale of manufacturing capacity required for the foreseeable future.

The preceding discussion applies to new pit fabrication as well as both intrusive and nonintrusive modification pit reuse manufacturing capability and capacity. Intrusive modification pit reuse requires handling and processing of the plutonium internal to the pit. Nonintrusive modification pit reuse involves the external features of the pit and does not require an extensive plutonium infrastructure; the risk of contamination and the generation of radioactive waste is very low for nonintrusive modification activities. Therefore, the weapons A/D Facility is also an alternative for nonintrusive modification pit reuse.

Secondary and Case Components. The Y-12 Plant (Y-12) at ORR produces the secondary and case components. These components are designed by LANL and LLNL; therefore, each of those facilities would be reasonable alternative sites if this function is transferred to the weapons laboratories. Both of these laboratories have a uranium technology base and facility infrastructure, although they have only a very limited R&D manufacturing capability. Other than the synergism with maintaining core competencies at the weapons laboratories, a major program consideration would be the cost of transferring product technologies and the re-creation of capital facilities that already exist at Y-12. Due to the complicated nature of nuclear facilities and plans for retrofit of an enduring stockpile weapon involving these components, a transition to either LANL or LLNL would be slow but achievable within a 10-year period. Downsizing Y-12 is considered to be a reasonable alternative.

High Explosive Components. Pantex currently manufactures HE components in special facilities built to explosives safety criteria. Downsizing the facilities at Pantex is a reasonable alternative. Comparable facilities also exist at both LANL and LLNL, and either laboratory has sufficient capacity to meet estimated future manufacturing requirements. Costs for this function are relatively low in any case. If a decision is made to transfer this function to the weapons laboratories, it could be done more quickly than the transfer of other functions. However, Pantex would have to retain disposition and disposal capability for the HE inventories currently onsite and those expected from near-term weapon dismantlement. A major program consideration would be the synergism of this function in maintaining the core competencies of the weapons laboratories.

Nonnuclear Components. KCP currently manufactures the majority of the nonnuclear components. The KCP facilities are not unique in structural design and are amenable to downsizing in place. The manufacturing technologies are complex and varied due to the large number of component types and high reliability requirements. SNL designs most of the components that KCP manufactures; therefore, SNL would become the major nonnuclear component supplier if a decision is made to transfer this function to the weapons laboratories. Other than potential synergism with maintaining core competencies at the weapons laboratories, a major program consideration would be the cost of transferring product technologies and re-creating facilities that already exist at KCP. Requirements for ongoing support of the enduring stockpile would make this a slow transition, but it would be achievable within a 10-year period.

S.2.4 Proposed Action and Alternatives

All of the existing basic capabilities of the laboratory and industrial base continue to be needed even though there have been changes in national security policy since the end of the Cold War. These changes do not affect the standards for stockpile safety and reliability. Therefore, the proposed action concentrates on three major issues that result from the national security policies and constraints placed on the program. The three program elements of the proposed action are:

- Providing enhanced experimental capability
- Rightsizing the industrial base
- Reestablishing manufacturing capability and capacity for pit components

Reasonable alternatives for the proposed action are briefly discussed below. Section S.3 describes these alternatives in more detail.

Enhanced Experimental Capability

Understanding nuclear weapon performance requires knowledge of the performance of the individual elements: the primary (pit and HE), the secondary, and the functional interaction between the primary and the secondary inside the case. Computer model-based validation and certification will be the key to DOE's ability to determine, with confidence, many of the future safety and performance characteristics of the stockpile in the absence of nuclear testing. This requires two principal elements: advanced computational models and facilities to provide experimental data that can be used to adjust (normalize) the computational models in conjunction with past nuclear test data. DOE is proposing three facilities to complement the existing capabilities to provide these data. Two are new facilities and one is the upgrade of an existing facility.

NIF and the Atlas Facility are proposed new facilities. The Atlas Facility would be collocated in TA-35 with the existing Pegasus II Facility at LANL, and the two facilities would use common infrastructures and support facilities. CFF is a proposed environmental and diagnostic upgrade to the existing Flash X-Ray (FXR) Facility at LLNL. As described in section S.3.2, these three new facilities would perform separate functions and provide different types of experimental data. Thus, they are complementary in nature and are not alternatives to one another. In each case, the alternative to constructing and operating the facility is No Action (i.e., relying on existing facilities to provide data). In addition, site alternatives are evaluated for NIF, since it is not associated with an existing facility. Volume III of this PEIS contains project-specific analyses for each of these facilities.

The stockpile stewardship program is expected to continuously evolve as better information becomes available and technological advancements occur. DOE is in the early planning stages for a number of what can be described as "next generation" stewardship facilities. These facilities are discussed in section S.3.2. They will build on the knowledge gained from existing and proposed new facilities. Since these facilities are in the conceptual planning stages, they are not sufficiently defined to be analyzed in this PEIS. When these technologies reach the appropriate level so as to be ripe for decisionmaking, DOE would complete NEPA documentation for them.

Rightsizing the Industrial Base

One of the primary goals of stockpile management is to rightsize functions to provide an effective and efficient manufacturing capability for a smaller stockpile. Such rightsizing must be accomplished in a manner that preserves core competencies in manufacturing and surveillance. This PEIS analyzes two alternative approaches to rightsizing the stockpile management functions described in section S.2.3: (1) transfer manufacturing and surveillance activities from the industrial sites to the weapons laboratories and NTS and (2) downsize the industrial plants in place. Relocation alternatives were selected on the basis of existing technical and facility infrastructure at the laboratories and NTS. Section S.3.4 discusses these alternatives in more detail.

Reestablishing Manufacturing Capability and Capacity for Pit Components

Plutonium pit manufacturing is a special case among those stockpile management functions discussed in section S.2.3. In 1992, DOE ceased plutonium pit manufacturing operations at the Rocky Flats Plant due to concerns about the safety of the plant and national security policy decisions to cease the production of new-design nuclear weapons. Reestablishing pit manufacturing capability and capacity was to be part of the Reconfiguration PEIS. This function is now part of the proposed action in this Stockpile Stewardship and Management PEIS.

Pit manufacturing capability and capacity, like that of all other major weapons components and subsystems, is essential for protecting national security options with regard to the nuclear deterrent. In addition, repair or replacement of pits for existing stockpile weapons may be required in the future. Reasonable alternative sites for reestablishing this function were selected from sites that already possess some measure of the appropriate technical or facility infrastructure.

S.2.5 Nonproliferation

On August 11, 1995, the President announced his commitment to seek a "zero-yield" CTBT. He also established several safeguards that condition the U.S. entry into a CTBT. One of these safeguards is the conduct of science-based stewardship, including the conduct of experimental programs. This safeguard will enable the United States to enter into such a treaty while maintaining a safe and reliable nuclear weapons stockpile consistent with U.S. national security policies.

One benefit of science-based stockpile stewardship is to demonstrate the U.S. commitment to NPT goals; however, the U.S. nuclear posture is not the only factor that might affect whether or not other nations might develop nuclear weapons of their own. Some nations that are not declared nuclear states have the ability to develop nuclear weapons. Many of these nations rely on the U.S. nuclear deterrent for security assurance. The loss of confidence in the safety or reliability of the weapons in the U.S. stockpile could result in a corresponding loss of credibility of the U.S. nuclear deterrent and could provide an incentive to other nations to develop their own nuclear weapons programs.

The United States has halted the development and production of new-design nuclear weapons. The experimental testing program will be used to assess the safety and reliability of the nuclear weapons in the remaining stockpile. Much of this testing is classified and could not lead to proliferation without a breach of security. Use of classified data from past U.S. nuclear tests is also a vital part of the overall process for validation of new experimental data. Most of the component technology used for the proposed enhanced experimental capability is unclassified and is available in open literature, and many other nations have developed a considerable capability.

Proliferation drivers for other states, such as international competition or the desire to deter conventional armed forces, would remain unchanged regardless of whether DOE implemented the proposed action analyzed in this PEIS. In the NPT, the parties agree not to transfer nuclear weapons or other devices, or control over them, and not to assist, encourage, or induce nonnuclear states to acquire nuclear weapons. However, the treaty does not mandate stockpile reductions by nuclear states, and it does not address actions of nuclear states in maintaining their stockpiles.

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Volume I Metric Conversion Chart

To Convert Into Metric			**To Convert Out of Metric**		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092903	square meters	square meters	10.7639	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet

cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Force					
dynes	0.00001	newtons	newtons	100,000	dynes
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

Metric Prefixes

Prefix	Symbol	Multiplication Factor
exa-	E	1 000 000 000 000 000 000 = 10^{18}
peta-	P	1 000 000 000 000 000 = 10^{15}
tera-	T	1 000 000 000 000 = 10^{12}
giga-	G	1 000 000 000 = 10^{9}
mega-	M	1 000 000 = 10^{6}
kilo-	k	1 000 = 10^{3}

hecto-	h	$100 = 10^{2}$
deka-	da	$10 = 10^{1}$
deci-	d	$0.1 = 10^{-1}$
centi-	c	$0.01 = 10^{-2}$
milli-	m	$0.001 = 10^{-3}$
micro-	µ	$0.000\ 001 = 10^{-6}$
nano-	n	$0.000\ 000\ 001 = 10^{-9}$
pico-	p	$0.000\ 000\ 000\ 001 = 10^{-12}$
femto-	f	$0.000\ 000\ 000\ 000\ 001 = 10^{-15}$
atto-	a	$0.000\ 000\ 000\ 000\ 000\ 001 = 10^{-18}$

Acronyms and Abbreviations

A/D	assembly/disassembly
AEC	Atomic Energy Commission
AHF	Advanced Hydrotest Facility
AQCR	Air Quality Control Region
ARS	Advanced Radiation Source
BEBA	beyond evaluation basis accident
BEEF	Big Explosives Experimental Facility
BEIR	biological effects of ionizing radiation
CAA	*Clean Air Act*
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFF	Contained Firing Facility
CFR	Code of Federal Regulations
Complex	Nuclear Weapons Complex
CTBT	Comprehensive Test Ban Treaty
CWA	*Clean Water Act*
DARHT	Dual Axis Radiographic Hydrodynamic Test (Facility)
D&D	decontamination and decommissioning
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DP	DOE Office of the Assistant Secretary for Defense Programs
EA	environmental assessment
EBA	evaluation basis accident
EIS	environmental impact statement
EM	DOE Office of the Assistant Secretary for Environmental Management

EPA	Environmental Protection Agency
ES&H	environment, safety, and health
FONSI	Finding of No Significant Impact
FXR	Flash X-Ray (Facility)
HAP	hazardous air pollutants
HE	high explosives
HEPA	high efficiency particulate air (filter)
HEPPF	High Explosive Pulsed Power Facility
HEU	highly enriched uranium
HI	hazard index
HLW	high-level waste
HQ	hazard quotient
ICRP	International Commission on Radiological Protection
INEL	Idaho National Engineering Laboratory
IP	implementation plan
ISCST	Industrial Source Complex Short-Term (model)
K-25	K-25 site, Oak Ridge Reservation
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIF	National Ignition Facility
NLVF	North Las Vegas Facility
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List

NPR	Nuclear Posture Review
NPT	Nuclear Nonproliferation Treaty
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
NWSM	Nuclear Weapon Stockpile Memorandum
NWSP	Nuclear Weapon Stockpile Plan
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
Pantex	Pantex Plant
PBFA II	Particle Beam Fusion Accelerator
PDD	Presidential Decision Directive
PEIS	programmatic environmental impact statement
PHERMEX	Pulsed High Energy Radiation Machine Emitting X-Rays (Facility)
PL	Public Law
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RD&T	research, development, and testing
RIMS	Regional Input-Output Modeling System
ROD	Record of Decision
ROI	region of influence
SAR	Safety Analysis Report
SARA	Superfund Amendments and Reauthorization Act
SDWA	*Safe Drinking Water Act*
SHPO	State Historic Preservation Officer
SNL	Sandia National Laboratories/New Mexico
SRS	Savannah River Site
START	Strategic Arms Reduction Talks

TA	technical area
TLV-TWA	threshold limit value-time weighted average
TRU	transuranic
TSCA	*Toxic Substances Control Act*
TSP	total suspended particulates
USFWS	U.S. Fish and Wildlife Service
VOCs	volatile organic compounds
Y-12	Y-12 Plant, Oak Ridge Reservation
WIPP	Waste Isolation Pilot Plant

CHAPTER 1: INTRODUCTION

Chapter 1 begins with an overview of the Stockpile Stewardship and Management Program and the Department of Energy's roles and responsibilities. This chapter also includes a discussion of the background of the Program, a brief description of the organization of the document, and the Department of Energy's National Environmental Policy Act of 1969 strategy for stockpile stewardship and management. Chapter 1 concludes with a discussion of related National Environmental Policy Act actions and other programmatic, project-specific, and site-wide reviews that are currently being prepared.

1.1 Overview

The Department of Energy (DOE) is the Federal agency responsible for providing the Nation with nuclear weapons and ensuring that those weapons remain safe and reliable. This programmatic environmental impact statement (PEIS) analyzes the potential consequences to the environment if certain changes to the Nuclear Weapons Complex (Complex) are implemented to support DOE's Stockpile Stewardship and Management Program.

Stockpile stewardship and stockpile management describe DOE's management of the nuclear weapons program. While these terms are not new, DOE has recently redefined them in light of its current roles and responsibilities. Stockpile stewardship comprises the activities associated with research, design, development, and testing of nuclear weapons, and the assessment and certification of their safety and reliability. These activities have been performed at the three DOE weapons laboratories and the Nevada Test Site (NTS). Stockpile management comprises operations associated with producing, maintaining, refurbishing, surveilling, and dismantling the nuclear weapons stockpile. These activities have been performed at the DOE nuclear weapons industrial facilities.

Since the inception of nuclear weapons in the 1940s, DOE and its predecessor agencies have been responsible for stewardship and management of the Nation's stockpile. In response to the end of the Cold War and changes in the world's political regimes, the emphasis of the U.S. nuclear weapons program has shifted dramatically over the past few years from developing and producing new weapons to dismantlement and maintenance of a smaller, enduring stockpile. Accordingly, the nuclear weapons stockpile is being significantly reduced, the United States is no longer manufacturing new-design nuclear weapons, and DOE has closed or consolidated some of its former weapons industrial facilities. Additionally, in 1992 the United States declared a moratorium on underground nuclear testing, and in 1995 President Clinton extended the moratorium and decided to pursue a "zero yield" Comprehensive Test Ban Treaty (CTBT). Even with these significant changes, DOE's responsibilities for the nuclear weapons stockpile continue, and the President and Congress have directed DOE to continue to maintain the safety and reliability of the enduring nuclear weapons stockpile.

In response to direction from the President and Congress, DOE has developed its Stockpile

Stewardship and Management Program to provide a single, highly integrated technical program for maintaining the continued safety and reliability of the nuclear weapons stockpile. It has evolved from predecessor programs that served this mission over previous decades. With no underground nuclear testing, and no new-design nuclear weapons production, DOE expects existing weapons to remain in the stockpile well into the next century. This means that the weapons will age beyond original expectations and an alternative to underground nuclear testing must be developed to verify the safety and reliability of weapons. To meet these new challenges, DOE's science-based Stockpile Stewardship and Management Program has been developed to increase understanding of the basic phenomena associated with nuclear weapons, to provide better predictive understanding of the safety and reliability of weapons, and to ensure a strong scientific and technical basis for future U.S. nuclear weapons policy objectives.

The size and composition of the U.S. nuclear weapons stockpile is determined annually by the President. The Department of Defense prepares the Nuclear Weapon Stockpile Plan (NWSP) based on military requirements and coordinates the development of the plan with DOE concerning its ability to support the plan. The NWSP, which is classified, covers the current year and a 5-year planning period. It specifies the types and quantities of weapons required and sets limits on the size and nature of stockpile changes that can be made without additional approval by the President. The Secretaries of Defense and Energy jointly sign the Nuclear Weapon Stockpile Memorandum (NWSM), which includes the NWSP and a long-range planning assessment. As such, the NWSM is the basis for all DOE stockpile support planning. Figure 1.1-1 depicts the NWSM process.

Chapter 2 discusses the relevant factors, such as treaties, that shape the NWSM. Also explained is the fact that potential variances in stockpile size, such as a Strategic Arms Reduction Talks (START) I Treaty-sized stockpile versus a START II protocol-sized stockpile, affect only the issue of manufacturing capacity required for the foreseeable future. National security policies in the post-Cold War era require that all the historical capabilities of the weapons laboratories, industrial plants, and NTS be maintained. Capability is the practical ability to perform a basic function or activity. Stockpile stewardship and management capabilities are independent of foreseeable future stockpile sizes. Stockpile management manufacturing capacities are examined in this PEIS, including those required to support a hypothetical low case stockpile size below START II. This was done to examine the sensitivity of potential decisions to transfer manufacturing activities to the weapons laboratories and NTS versus downsizing the industrial plants in place.

DOE must maintain a Complex with sufficient capability and capacity to meet current and future weapons requirements. For those activities associated with the ongoing stockpile stewardship program, DOE proposes to add enhanced capabilities to existing stockpile stewardship facilities to fulfill requirements. For those activities associated with the ongoing stockpile management program, DOE does not propose to construct any major new weapons industrial facilities. Rather, DOE proposes to " rightsize" existing facilities or consolidate them to fulfill expected requirements for manufacture of repair or replacement components for an aging U.S. stockpile.

This Programmatic Environmental Impact Statement for Stockpile Stewardship and Management addresses potential changes to the future missions of the three weapons laboratories, the four weapons industrial plants, and NTS. A No Action alternative is also described and analyzed. Figure 1.1-2 shows the locations of the eight DOE sites comprising the current Complex.

To estimate the potential environmental impacts from modifying/constructing and operating the facilities proposed for stockpile management, DOE assumes that facilities would be sized and operated to support a base case stockpile size consistent with the START II protocol. This PEIS also discusses impacts that would be expected for supporting a larger stockpile based on START I Treaty levels, and a hypothetical stockpile smaller than the START II protocol.

With regard to stockpile management facilities, potential environmental impacts from the base case are analyzed quantitatively in the greatest detail, while impacts from the high and low cases are discussed qualitatively. The facilities proposed for stockpile stewardship are independent of projected stockpile size.

Figure 1.1-1.--Nuclear Weapons Stockpile memorandum Process.
Figure 1.1-2.--Current Stockpile Stewardship and Management Sites (Includes Recent Consolidation of Three Former Sites).

1.2 Alternatives Analyzed in the *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*

The alternatives analyzed in this PEIS are described in detail in chapter 3 and summarized in this section. Alternatives are analyzed for both stockpile stewardship and stockpile management.

The stockpile stewardship portion of this PEIS evaluates the potential environmental impacts of the proposed actions and the reasonable alternatives for carrying out the stockpile stewardship functions. As described in section 3.3, the three independently justified proposed facilities include: the National Ignition Facility (NIF), the Contained Firing Facility (CFF), and the Atlas Facility. Four sites (figure 1.1-2) are potentially affected by the stockpile stewardship alternatives: Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratories (SNL), and NTS (includes NLVF). This PEIS also assesses the No Action alternative of relying on existing experimental facilities and continuing the missions at these four sites to fulfill the stockpile stewardship mission.

The science-based stockpile stewardship program is expected to continuously evolve as better information becomes available and technological advancements occur. Additional experimental facilities, such as the Advanced Hydrotest Facility, the High Explosives Pulsed Power Facility, the Advanced Radiation Source, and the Jupiter Facility, are considered to be next generation facilities (see section 3.3.4) that may be required in the future to support stockpile stewardship objectives. However, these facilities are not proposed actions in this PEIS because they have not reached the stage of development and definition that is necessary for evaluation and decisionmaking.

The stockpile management portion of this PEIS evaluates the potential environmental impacts of the reasonable alternatives for carrying out the stockpile management functions. As described in section 3.4, alternatives are assessed for nuclear weapons assembly/disassembly (A/D) and for fabricating pit, secondary and case, high explosives (HE), and nonnuclear components. Eight sites (figure 1.1-2) are potentially affected: Oak Ridge Reservation (ORR), Savannah River Site (SRS), Kansas City Plant (KCP), Pantex Plant (Pantex), LANL, LLNL, SNL, and NTS. This PEIS also assesses the No Action alternative of relying on existing facilities and continuing the missions at the current sites to fulfill the stockpile management mission.

1.3 Background

To aid the reader's understanding of this PEIS, background information on the evolution of this PEIS and an unclassified description of a nuclear weapon follow.

1.3.1 Evolution of the *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*

Stockpile stewardship and management responsibilities have been ongoing for decades and the Program now reflects the cumulative effects of relatively recent U.S. national security policy changes. This PEIS experienced three general stages of evolution.

The first stage of evolution began in January 1991, when the Secretary of Energy announced that DOE would prepare a PEIS examining alternatives for reconfiguring the Complex. The framework for the Reconfiguration PEIS was described in the January 1991 Nuclear Weapons Complex Reconfiguration Study (DOE/DP-0083), a detailed examination of alternatives for the future Complex. This Reconfiguration Study contemplated large, stand-alone replacement facilities for the plutonium fabrication capability of the Rocky Flats Plant, as well as possible replacement and relocation of other Complex missions.

During the 1992 through 1994 timeframe, the second stage of the evolution reflected changes in DOE's thinking due to the reduction in weapons resulting from the end of the Cold War, unilateral stockpile reductions, and the START II protocol. Because of the planned significant stockpile reductions, the scope of the Reconfiguration Study changed to reflect a smaller and more integrated Complex than previously envisioned. Additionally, DOE placed increased importance on the stewardship of special nuclear materials that were determined to be in excess of the Nation's weapons needs.

DOE concluded in October 1994 that the framework described in the Reconfiguration Study no longer fit current circumstances or supported any realistic proposal for reconfiguring the Complex. Contributing factors to that conclusion included public comments from Reconfiguration Study scoping meetings, the fact that production of new-design nuclear weapons was not required for the foreseeable future, and DOE's decision to prepare a separate *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement (DOE/EIS-0229-D, draft* *published in February 1996).*

As a result of these changed circumstances, the third stage evolved, whereby DOE separated the previously planned Reconfiguration PEIS into two new PEISs: the *Programmatic Environmental Impact Statement for Tritium Supply and Recycling* and this *Stockpile Stewardship and Management PEIS.* As explained in section 1.6, the Tritium Supply and Recycling PEIS has been completed and this Stockpile Stewardship and Management PEIS has been revised to better reflect current and expected Program requirements.

1.3.2 Nuclear Weapons

A general understanding of nuclear weapons, including the components that make up a weapon and the physical processes involved, helps one understand the scope of the Stockpile Stewardship and Management PEIS and what is to be accomplished by the Program. Figure 1.3.2-1 presents a simplified diagram of a modern nuclear weapon. An actual nuclear weapon produced in the United States is much more complicated, consisting of many thousands of parts.

The nuclear weapon primary is composed of a central core called a pit, which is usually made of plutonium-239 and/or highly enriched uranium (HEU). This is surrounded by a layer of HE, which when detonated, compresses the pit, initiating a nuclear reaction. This reaction is generally thought of as the nuclear fission "trigger," which activates the secondary assembly component to produce a thermonuclear fusion reaction. The remaining nonnuclear components consist of everything from arming and firing systems to batteries and parachutes. The production and assembly of many of these components is accomplished at dedicated industrial facilities. The A/D of nuclear weapons is done only at Pantex.

Figure 1.3.2-1.--Nuclear Weaponse Design.

1.4 Organization of this Programmatic Environmental Impact Statement

This PEIS consists of four volumes. Volume I contains the main text; Volume II contains technical appendixes that support the analyses in Volume I and additional project information; and Volume III contains the project-specific environmental analyses for the proposed NIF, CFF, and Atlas Facility. Volume IV contains the comments received on the Draft PEIS during the public review period and the DOE responses. The Summary is a separate publication.

Volume I contains 10 chapters, which include the following information:

Chapter 1--Introduction. Stockpile Stewardship and Management Program background and the environmental analysis process.

Chapter 2--Purpose and Need. Reasons why DOE needs to take action and the objectives DOE proposes to achieve.

Chapter 3--Proposed Action and Alternatives. How DOE proposes to meet the specified need and achieve the objectives. This chapter also includes a summary comparison of the potential environmental impacts of the PEIS alternatives.

Chapter 4--Affected Environment and Environmental Impacts. Aspects of the environment (i.e., natural, built, and social) that might be affected by the PEIS alternatives and analyses of the potential impacts on the environment. Impacts are compared to the projected environmental conditions that would be expected to support the base case if no action were taken (the No Action alternative).

Chapter 5--Regulatory Requirements. Environmental, safety, and health regulations that would apply to the PEIS alternatives and agencies consulted for their expertise.

Chapters 6 through 10. A list of references; a list of preparers; a list of agencies, organizations, and persons to whom copies of this PEIS were sent; a glossary; and an index.

Volume II contains eight appendixes of technical information supporting the environmental analyses presented in Volume I. These appendixes contain the following information: Stockpile Stewardship and Management Program facilities; air quality; *threatened, endangered, and special status species*; socioeconomics; human health; facility accidents; intersite transportation; and environmental management.

Volume III contains three appendixes that comprise the project-specific environmental analyses for the NIF, CFF, and Atlas Facility proposed actions.

Volume IV (Comment Response Document) contains a description of the public hearing process, information on the document's organization and instructions for its use, a brief summary of changes to the Draft PEIS, and all comments received and DOE responses.

1.5 *National Environmental Policy Act* Strategy for Stockpile Stewardship and Management

This PEIS has been prepared in accordance with Section 102(2)(c) of the *National Environmental Policy Act* (NEPA) of 1969, as amended (42 U.S.C. 4321 et seq.), and implemented by regulations promulgated by the Council on Environmental Quality (CEQ) (40 CFR 1500-1508) and DOE regulations (10 CFR 1021). Under NEPA, Federal agencies, such as DOE, that propose major actions that could significantly affect the quality of the human environment are required to prepare an environmental impact statement (EIS) to ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. For broad actions, such as the Stockpile Stewardship and Management Program, a PEIS is prepared.

DOE's NEPA compliance strategy for the Stockpile Stewardship and Management Program consists of two phases. The first phase includes the Stockpile Stewardship and Management PEIS and subsequent Record(s) of Decision (ROD). Decisions will be based on relevant factors including economic and technical considerations, DOE statutory mission requirements, policy considerations, and environmental impacts. In addition to the analyses in this PEIS, engineering studies, cost, schedule, and technical feasibility analyses will be considered in the ROD. The ROD is expected to identify the effects of U.S. national security policy changes on Program missions and determine the configuration (facility locations) necessary to accomplish the Program missions.

During the second phase of the NEPA strategy, which would follow this PEIS ROD, DOE would prepare any necessary project-specific NEPA documents to implement any programmatic decision. However, as explained below, this PEIS also includes project-specific environmental analyses for the experimental facilities proposed for stockpile stewardship.

For the three facilities in the proposed action for stockpile stewardship--NIF, CFF, and the Atlas Facility--the Stockpile Stewardship and Management PEIS is intended to include sufficient project-specific analyses to complete NEPA requirements for siting, construction, and operation, and thus, satisfy both phases of the NEPA compliance strategy. This PEIS supports the programmatic decisions on whether to proceed with the facility and, if so, where to site the facility. The project-specific analysis describes the detailed construction and operational impacts for each facility at the alternate sites. Each proposed facility's project-specific analysis can be found in Volume III of this PEIS.

1.6 Related Recently Completed *National Environmental Policy Act* Actions

Two other actions that DOE has already evaluated in separate EISs, in accordance with CEQ regulations for interim actions (40 CFR 1506.1), are within the scope of the Stockpile Stewardship and Management PEIS. These are the *Tritium Supply and Recycling* PEIS and the *Dual Axis Radiographic Hydrodynamic Test* (DARHT) *Facility Environmental Impact Statement.* These two actions, and their relationship to the Stockpile Stewardship and Management PEIS, are described below.

1.6.1 *Programmatic Environmental Impact Statement for Tritium Supply and Recycling*

The Tritium Supply and Recycling PEIS evaluated the potential environmental impacts associated with alternatives for siting, constructing, and operating tritium supply and recycling facilities. The purpose of the Tritium Supply and Recycling Program is to provide long-term, assured tritium supply and recycling to support the Nation's nuclear weapons stockpile. The Tritium Supply and Recycling Draft PEIS (DOE/EIS-0161) was issued in March 1995 and was followed by public hearings in April 1995. A Final PEIS was issued in October 1995, followed by the ROD, published in the *Federal Register* (60 FR 63878), on December 12, 1995.

In the ROD, DOE announced that it will embark on a dual track strategy for acquiring a new tritium production capability that involves the use of existing commercial light water reactors via the purchase of a reactor or purchase of irradiation services (with the option to purchase the reactor), and the development of a linear accelerator. DOE will seek to fully prove the feasibility of both approaches over the next 3 years, then implement the most promising approach, while completing the design and necessary procedures (e.g., regulatory approval) for the other path to allow it to serve as a backup to the preferred path. If an accelerator is built, it will be located at SRS.

Tritium, a radioactive gas that decays at a rate of more than 5 percent per year, is a necessary component of every nuclear weapon in the existing stockpile and must be replenished periodically in order for the weapons to operate as designed. No new tritium has been produced since 1988, when the last of the DOE's tritium production reactors at SRS was shut down. Currently, tritium recycled from weapons retired from the stockpile is used to meet stockpile requirements. However, based on a START II protocol stockpile size, even with tritium recycling, new tritium will be needed by 2011. Because it could take up to 15 years for a tritium source, once selected, to begin producing tritium, it was necessary for DOE to make a decision on tritium supply in advance of this Stockpile Stewardship and Management PEIS. The decision resulting from the Tritium Supply and Recycling PEIS is accounted for in the No Action alternative of this PEIS.

1.6.2 *Dual Axis Radiographic Hydrodynamic Test Facility Environmental Impact Statement*

The DARHT Facility *EIS* analyzed the environmental consequences of alternative ways to accomplish enhanced high-resolution radiography for the purposes of performing hydrodynamic tests and dynamic experiments. These tests are used to obtain diagnostic information on the behavior of nuclear weapons primaries and to evaluate the effects of aging on nuclear weapons. The DARHT Facility's construction was about 34 percent complete when construction was halted under a U.S. District Court preliminary injunction issued on January 27, 1995, pending completion of the DARHT Facility EIS and issuance of the ROD. The DARHT Facility EIS evaluated the potential environmental impacts of six alternatives; the preferred approach entailed completing and operating the proposed DARHT Facility at LANL and implementing a phased enhanced containment strategy for testing at the DARHT Facility, so that most tests would be conducted inside steel vessels. The DARHT Facility Draft EIS (DOE/EIS-0228) was issued in May 1995 and was followed by public hearings in May and June 1995. A Final PEIS was issued in August 1995, followed by the ROD, published in the *Federal Register* (60 FR 53588) on October 16, 1995.

In the ROD, DOE announced that it will complete and operate the DARHT Facility at LANL while implementing a program to conduct most tests inside steel vessels, with containment to be phased in over 10 years. Following the ROD, DOE filed a motion for dissolution of the injunction. On April 16, 1996, the U.S. District Court concluded that the purpose of the injunction has been satisfied, and therefore lifted the injunction and dismissed the case.

DOE will rely on hydrodynamic testing in the absence of underground nuclear testing to ensure the stockpile's safety and reliability. Under any course of action analyzed in this Stockpile Stewardship and Management PEIS, DOE will still need to continue hydrodynamic testing and acquire near-term enhanced radiographic capability such as that provided by the DARHT Facility. DOE determined that implementing the DARHT Facility ROD will not prejudice any decisions in the Stockpile Stewardship and Management Program. The impacts of the DARHT Facility for each resource area are addressed in the No Action impact discussions for LANL in section 4.6.3.

1.7 Other *National Environmental Policy Act* Reviews

In addition to the two interim actions identified above, DOE is currently preparing other programmatic, project-specific, and site-wide NEPA documents. These documents, and their relationship to the Stockpile Stewardship and Management PEIS, are discussed below.

1.7.1 Waste Management Programmatic Environmental Impact Statement

Alternatives for managing radioactive, hazardous, and mixed (radioactive and hazardous) wastes are analyzed in the Waste Management Programmatic Draft Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (DOE/EIS-0200-D), issued in August 1995. When completed, the Waste Management PEIS will support DOE decisions on the management of, and facilities for, the treatment, storage, and/or disposal of radioactive, hazardous, and mixed wastes.

Wastes would be generated by the Stockpile Stewardship and Management Program. Although there may be changes from site to site, for the Complex as a whole, the wastes will be similar in form and quantity to wastes currently generated by DOE facilities and analyzed in the Waste Management PEIS. Wastes generated by the Program would be managed in accordance with decisions made as a result of the Waste Management PEIS. Nonetheless, for the purposes of thoroughly analyzing the impacts of the proposed action, the treatment, storage, and/or disposal of these wastes in existing facilities is analyzed in the Stockpile Stewardship and Management PEIS.

Both the Stockpile Stewardship and Management PEIS and the Waste Management PEIS consider national strategies. The Waste Management PEIS considers alternatives that include local, regional, and/or consolidated waste management facilities. This Stockpile Stewardship and Management PEIS addresses alternatives that could result in the relocation of current missions and/or closure of existing sites. These two strategies are mutually consistent; however, the RODs will require coordination.

1.7.2 *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement*

The Storage and Disposition PEIS will analyze alternatives for the long-term storage of all weapons-usable fissile materials, primarily HEU and plutonium, and the disposition of weapons-usable fissile materials, primarily plutonium the President has declared to be surplus to national defense needs. *The Implementation Plan for the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* was issued in March 1995, and the Draft PEIS was issued in February 1996.

Both this Stockpile Stewardship and Management PEIS and the Storage and Disposition PEIS analyze reasonable alternatives for the long-term storage of strategic reserves of plutonium and HEU. Because the overall scope of each PEIS is significantly different, different long-term strategic reserve storage alternatives are reasonable for each PEIS. For example, the Stockpile Stewardship and Management PEIS evaluates alternatives for strategic reserve storage (in the form of pits and secondaries) at the weapons A/D Facility, which is where these strategic reserves might be first used. The Storage and Disposition PEIS has a relatively broader scope regarding fissile material storage, which will include the storage of all surplus material, naval reactor fuel, and naval reactor fuel feed stock, as well as nonweapons research and development materials. It analyzes alternatives, among others, that would collocate strategic reserves with surplus fissile materials.

Preparation of these two PEISs is being closely coordinated to ensure that all reasonable alternatives for long-term strategic reserve storage are assessed. Decisions on strategic storage will not be made in the upcoming ROD for the Stockpile Stewardship and Management Program. Storage decisions are not expected to be made until both the Stockpile Stewardship and Management Final PEIS and the Storage and Disposition Final PEIS are completed.

1.7.3 *Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components*

The Draft Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components (Pantex Site-Wide EIS) (DOE/EIS-0225D), which was issued in March 1996, analyzes the alternatives and environmental impacts associated with conducting nuclear weapons operations at Pantex for approximately the next 5 to 10 years. Included in the Pantex Site-Wide Draft EIS is an analysis of a plan to increase the interim storage of plutonium pits from 12,000 to 20,000 pits. The EIS also analyzes alternative locations to Pantex for interim pit storage operations.

In May 1994, when DOE announced its intention to prepare the Pantex Site-Wide EIS, DOE believed that the Pantex Site-Wide EIS ROD would precede decisionmaking on the long-term storage of pits by at least several years. Accordingly, the Pantex Site-Wide Draft EIS was scoped to address alternative locations for interim pit storage (i.e., until the long-term decisions were made and implemented).

Since May 1994, DOE has initiated two additional NEPA documents that address the storage of pits. This Stockpile Stewardship and Management PEIS will support decisions on the long-term storage of pits that will be needed for national security requirements (strategic reserve pits). As discussed above, the Storage and Disposition PEIS will support decisions on the long-term storage of all pits (strategic reserve and surplus) and the approach for dispositioning pits that are surplus to national security requirements.

Both of these PEISs have progressed to the point where they are scheduled to have their RODs issued by the fall of 1996, at or about the same time as the ROD for the Pantex Site-Wide EIS, which is scheduled for November 1996. Therefore, DOE is proposing that as long as the RODs of both PEISs and the Pantex Site-Wide EIS occur within a short period of time of one another, decisions on the long-term storage of pits would be made in the RODs of the PEISs. A decision relating to the interim storage of pits at Pantex would be made in the ROD of the Pantex Site-Wide EIS pending implementation of the selected long-term storage option.

However, if there is a significant delay in the RODs for either of the PEISs, or if DOE does not make a decision on the long-term storage of pits in those RODs, then there would be a need to make a decision on the location of interim storage of pits uninformed by a decision on long-term storage. In any event, the Pantex Site-Wide EIS will be completed with the analysis of interim storage alternatives, including addressing the issues and comments received from the public on that EIS, to support a decision relating to the storage of pits until a long-term storage decision has been made and implemented.

This PEIS includes Pantex as an alternative site for the following stockpile management missions: HE fabrication, weapons A/D, and strategic reserve storage. Programmatic decisions on these alternatives will be identified in the ROD for this PEIS; however, a decision on storage may occur later than decisions on the other two missions.

1.7.4 *Site-Wide Environmental Impact Statement for the Los Alamos National Laboratory*

The LANL Site-Wide Draft EIS is currently being prepared and analyzes alternatives for LANL's operation over the next 5 to 10 years. The Stockpile Stewardship and Management PEIS includes LANL as an alternative site for two stockpile stewardship facilities (NIF and Atlas) and the following stockpile management missions: pit fabrication, secondary and case fabrication, HE fabrication, and nonnuclear fabrication. Programmatic decisions on these alternatives will be identified in the ROD for this PEIS.

1.7.5 *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*

The NTS Site-Wide EIS (DOE/EIS 0243), analyzes alternatives for NTS's operation over the next 5 to 10 years. The Stockpile Stewardship and Management PEIS includes NTS as an alternative site for both a stockpile stewardship facility (NIF) and two stockpile management missions: weapons A/D and strategic reserve storage. Programmatic decisions on these alternatives will be identified in the ROD for this PEIS; however, a decision on storage may occur later than a decision on weapons A/D.

1.8 Public Participation

Public participation for the PEIS consisted of two primary activities: the scoping process and the public comment process. CEQ regulations require "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues to be addressed and for identifying the significant issues related to a Proposed Action (40 CFR 1501.7)." This is usually called the public scoping process. Section 4.1 of the Implementation Plan Stockpile Stewardship and Management Programmatic Environmental Impact Statement (DOE-EIS-0236IP, December 1995) describes the scoping process. The following sections describe the public comment process on the Draft PEIS.

1.8.1 Public Comment Process on the Draft Programmatic Environmental Impact Statement

In February 1996, DOE published the *Stockpile Stewardship and Management Draft PEIS that* evaluated the siting, construction, and operation of the proposed stockpile stewardship facilities and the modification/construction and operation of facilities proposed for stockpile management at eight alternative sites within the Complex. The 60-day public comment period for the Draft PEIS began on March 8, 1996, and ended on May 7, 1996. However, late comments were considered to the extent practical.

During the comment period, public hearings were held in Los Alamos, NM; Albuquerque, NM; Las Vegas, NV; Oak Ridge, TN; Kansas City, MO; Livermore, CA; Washington, DC; Amarillo, TX; Santa Fe, NM; and North Augusta, SC. Five of the public hearings were joint meetings to obtain comments on both the Stockpile Stewardship and Management PEIS and the Storage and Disposition PEIS. Two of the joint meetings (Pantex and SRS) also included the Pantex Site-Wide EIS. In addition, the public was encouraged to provide comments via mail, fax, electronic bulletin board (Internet), and telephone (toll-free 800 number). Figure 1.8.1-1 shows the dates and locations of the hearings.

The public hearings held for the Draft PEIS were conducted using an interactive workshop-type format. The format chosen allowed for a two-way interaction between DOE and the public and encouraged informed public input and comments on the document. Neutral facilitators were present at the hearings to direct and clarify discussions and comments. Court reporters were also present to provide a verbatim transcript of the proceedings and record any formal comments.

All public hearing comment summaries were combined with comments received by mail, fax, Internet, or telephone during the public comment period. Volume IV of this PEIS, the Comment Response Document, describes the public comment process in detail, presents comment summaries and responses, and provides copies of all comments received.

Figure 1.8.1-1.--Public Hearing Locations and Dates, 1996.

1.8.2 Major Comments Received on the Draft Programmatic Environmental Impact Statement

A large number of the comments received on the Draft PEIS related to concerns that the analysis of particular alternatives and/or alternative sites did not adequately consider such factors as cost and technical feasibility. Although these concerns made up the majority of the comments, many other comments related to the resources analyzed, NEPA and regulatory issues, and DOE and Federal policies as they related to this PEIS. The major issues identified by commentors include the following:

- The potential conflict between the Stockpile Stewardship and Management Program and the Nuclear Nonproliferation Treaty goals, and the pursuit of a CTBT
- Using the funds allocated for the Stockpile Stewardship and Management Program for social programs and on research of alternative sources of energy
- The generation, storage, and disposal of radioactive and hazardous wastes and the associated risks
- The impacts of the alternatives on human health (both from radiation and hazardous chemicals) and how these risks were determined and evaluated
- The relationship of this PEIS to other DOE documents and programs, particularly the Pantex and NTS Site-Wide EISs, the Waste Management and the Storage and Disposition PEISs, and the need to make decisions based on all associated programs and activities concurrently
- The need for decisions to be based on many different factors, including environmental, cost, and safety concerns
- The need for DOE to consider a zero-level stockpile, remanufacturing, and denuclearization as alternatives
- Maintaining deterrence with surveillance, curatorship, and remanufacturing without the need for the proposed facilities
- The need for DOE to adequately consider the ongoing stewardship program
- The need for DOE to perform detailed analysis of future stockpile stewardship facilities

All of the issues identified above are summarized and responded to in detail in chapter 3 of Volume IV. Substantial revisions to this PEIS resulting from public comments are discussed below.

Revisions in the Final PEIS include additional discussion and analysis in the following areas: alternatives considered but eliminated (section 3.1.2); the No Action alternative (appendix A, Stockpile Stewardship and Management Facilities, sections A.1.5, A.1.6, A.1.7, and A.1.8); socioeconomics at ORR, Pantex, and KCP; accident impacts at Pantex; normal operation impacts for radiological and chemical sections; cumulative impacts (section 4.13); and minor changes to LANL water resources section (section 4.6.2.4). A new section was also added to appendix F (section F.4, Secondary Impacts of Accidents). Each of these areas is discussed in more detail in the following section.

1.8.3 Changes from the Draft Programmatic Environmental Impact Statement

In response to comments submitted after issuance of the Draft PEIS and due to additional technical details not available at the time of issuance of the Draft, Volumes I, II, and III of the Final PEIS contain revisions and changes. The revisions and changes made since the issuance of the Draft PEIS are indicated by a double underline for minor word changes or by a sidebar in the margin for paragraph or larger changes. In addition, Volume I and each appendix in Volume III provide a unique reference list to enable the reader to further review and research selected topics. Volume IV (*Comment Response Document*) of the PEIS contains the comments received during public review of the Draft PEIS and the DOE responses to those comments. DOE has public reading rooms near each affected site and in Washington, DC, where these referenced documents may be reviewed or obtained for review. A brief discussion of the more significant changes is provided in the following paragraphs.

>Alternatives Considered but Eliminated from Detailed Study and Related Issues. In response to public comments expressing a concern that DOE had not analyzed a reasonable range of alternatives, section 3.1.2 was expanded. The changes were in response to specific questions concerning compliance with treaties, stockpile size, maintenance and remanufacturing options, and the stockpile stewardship alternatives including No Action. The discussions in section 3.1.2 provide greater detail and more clarification on why alternatives were eliminated from detailed study in this PEIS. Together, chapter 2 and section 3.1.2 explain the framework and the constraints of national security policy that have shaped the proposed actions and reasonable alternatives for this PEIS.

No Action Alternative. Several commentors did not think that the No Action alternative was clearly explained in the Draft PEIS. More specifically, they were not sure which existing facilities at LANL, LLNL, SNL, and NTS were part of the ongoing stockpile stewardship program. As a result, the description of No Action was modified in appendix A to include a listing of major DOE Office of Defense Programs function facilities at LANL, LLNL, SNL, and NTS. Additionally, the discussion of impacts of No Action at LANL (section 4.6.3) was revised as appropriate to include the effects of the DARHT Facility.

Socioeconomics at Oak Ridge Reservation, Kansas City Plant, and Pantex Plant. Based on public comments and revised workforce size estimates, the socioeconomic impact sections for the downsizing alternatives at ORR (section 4.2.3.8), KCP (section 4.4.3.8), and Pantex (section 4.5.3.8) have been revised. The analyses were also expanded to cover the base case single-shift option in greater detail. At these three sites, downsizing of existing facilities is the preferred alternative. For such downsizing, the base case single-shift scenario represents the bounding analysis for the workforce. The change in worker estimates did not cause any of the major indicators in the socioeconomic analysis to change in any significant manner.

Accident Impacts at Pantex Plant. The analyses of impacts due to an aircraft impact and resulting release of plutonium by a fire or an explosion were modified to include more updated data on probability and source terms developed for the Pantex Site-Wide EIS. Section 4.5.3.9 and appendix sections F.2.1.1 and F.2.1.2 were revised to incorporate the new analytical results. Based on the updated data, the potential impacts and risks to the public from the composite accident presented in this PEIS would be less than previously reported in the Draft PEIS. This change was not significant.

Normal Operation Radiological/Chemical Impacts. The discussion of the normal operation radiological affected environment for LANL, section 4.6.2.9, has been updated to include the latest data from Environmental Surveillance at Los Alamos During 1993 (LA-12973-ENV, October 1995).

The normal operation radiological impact sections 4.2.3.9, 4.3.3.9, and 4.6.3.9 have also been revised to include the contribution of recent facilities at ORR, SRS, and the new environmental surveillance data for LANL. The chemical health effects, section 4.6.3.9 for LANL and section 4.7.3.9 for LLNL, were revised based on new analyses using updated dispersion rates. Tables in appendix section E.3.4 supporting these sections were also updated. The majority of these changes affected the No Action alternative analyses. None of the changes to these sections significantly changed the analysis of impacts for the "action" alternatives.

Cumulative impacts. The cumulative impact section, 4.13, has been modified to incorporate a discussion of normal operation radiological impacts and other changes based on more recent data from NEPA documents and RODs. The changes to this section did not have a meaningful effect on the analysis/comparative evaluation of alternatives.

Los Alamos National Laboratory Water Resources. Changes were incorporated in section 4.6.2.4 (Water Resources) for LANL based on more recent water use and water quality data. The Draft PEIS had erroneously stated that the LANL water allotment would be fully used by about 2000. The Final PEIS correctly reports that this allotment would be fully used by about 2052. This change did not have a meaningful effect on the analysis/comparative evaluation of alternatives. Minor revisions reflecting the baseline changes were also made to the LANL water resources impact section, 4.6.3.4.

Health Effects Studies. Appendix section E.4, which outlines epidemiological studies at the alternative sites, was rewritten to provide more detail and incorporate more recent and other applicable studies. Although these epidemiology sections do not affect the environmental analysis of future stockpile stewardship and management missions, they do provide relevant information regarding potential health effects from past actions. These changes did not have a meaningful effect on the analysis/comparative evaluation of alternatives.

New Section. A new section has also been added to the Final PEIS (appendix section F.4, Secondary Impacts of Accidents). This section evaluates the secondary impacts of accidents that affect elements of the environment other than humans (e.g., farmland). The section was added because of public comments. The results of this analysis show that secondary impacts from accidents would generally not extend beyond site boundaries, except at Pantex and LLNL, where it is possible that some surface contamination could occur. This new analysis did not have a meaningful effect on the analysis/ comparative evaluation of alternatives.

CHAPTER 2: PURPOSE OF AND NEED FOR THE STOCKPILE STEWARDSHIP AND MANAGEMENT ACTION

Chapter 2 describes the purpose of and need for the Stockpile Stewardship and Management Program. It includes a discussion of national security policy considerations and the technical effects of national security policy on shaping the Program's purpose and need. The proposed action and alternatives are also discussed. The final section summarizes the chapter and introduces the logic flow diagrams that depict the framework of the Program from national policy and stockpile perspectives.

2.1 Introduction

The Stockpile Stewardship and Management gram is broad in scope and technically complex. The Program currently involves the integrated activities of three national laboratories, four industrial plants, and a nuclear test site. Further, the Program must be consistent with, and supportive of, U.S. national security policies, which have changed considerably since the end of the Cold War. Therefore, to better understand the Programmatic Environmental Impact Statement (PEIS)for Stockpile Stewardship and Management purpose, need, proposed action, and alternatives, it is useful to view the Program from two different perspectives. One perspective (see section 2.2) is from the top level of national security policies for nuclear deterrence, arms control, and nonproliferation. These policies include ongoing responsibilities, strategies, and directives. The other perspective (see section 2.3) focuses on the relevant technical efforts to maintain a safe and reliable U.S. nuclear weapons stockpile. Flow diagrams representing the logic of each perspective are referenced in the chapter summary (see section 2.7) and appear at the end of chapter 2.

2.2 National Security Policy Considerations

There are four principal national security policy overlays and four related treaties that define Program conditions for the reasonably foreseeable future. They are:

- Presidential Decision Directives (PDDs)
- National Defense Authorization Act of 1994 (Pub. L. 103-160)
- The Department of Defense (DOD) Nuclear Posture Review (NPR)
- Nuclear Weapon Stockpile Memorandum (NWSM)
- Proposed Comprehensive Test Ban Treaty (CTBT)
- Nuclear Nonproliferation Treaty (NPT)
- Strategic Arms Reduction Talks (START) I Treaty
- START II protocol

Of the above, the START II protocol is the most useful in helping define a specific time period to bound the reasonably foreseeable future.

2.2.1 Nuclear Posture Review

Beginning in 1991, several Presidential policy decisions, some unilateral and some made in conjunction with international treaties, resulted in DOD conducting the comprehensive NPR, which was approved by the President in 1994. The NPR defines and integrates past and present U.S. policies for nuclear deterrence, arms control, and nonproliferation objectives. The unclassified NPR strategies that pertain to the Stockpile Stewardship and Management Program were presented at the eight public scoping meetings conducted in the summer of 1995. There was general public interest in understanding this complex issue, especially as it relates to treaties, policies, and stockpile size. A summary of how the post-Cold War treaties relate to the NPR strategies and the stockpile follows.

Strategic Arms Reduction Talks. The NPR assumes that the START I Treaty and START II protocol will be fully implemented. However, since the START I Treaty is not yet fully implemented and the START II protocol is not scheduled to be fully implemented until 2003, the NPR strategy protects the U.S. option to reconstitute the stockpile to START I levels should unfavorable events occur in the former Soviet Union. The treaties only control the number of strategic nuclear weapons that can be loaded on treaty-specified and -verified strategic missiles and bombers. These nuclear weapons are limited to 6,000 by the START I Treaty and 3,500 by the START II protocol. The treaties do not control the total stockpile size or the composition of strategic and nonstrategic nuclear weapons of either side. The U.S. stockpile will be larger than 6,000 under START I and 3,500 under START II since the stockpile also includes weapons retained for nonstrategic nuclear forces, DOD operational spares, and spares to replace weapons attrited by Department of Energy (DOE) surveillance testing. In the START II case, the stockpile may also include weapons retained to reconstitute to the START I level. However, the terms "START I-sized stockpile" and "START II-sized stockpile" are relevant to the Stockpile Stewardship and Management PEIS as explained in section 2.2.2 and chapter 3.

Comprehensive Test Ban Treaty. It is the declared policy of the United States to seek ratification of a "zero yield" CTBT as soon as possible. The United States has been observing a moratorium on nuclear testing since 1992. The NPR strategy reflects this policy and the strategy has a significant effect on shaping the Stockpile Stewardship and Management Program. As explained in section 2.3.4, it is anticipated that repairs or replacements to an aging U.S. stockpile will be needed. Assessment and certification of the safety and reliability of stockpile repairs or replacements without nuclear testing is a significant challenge to the Program. In declaring the policy to seek a CTBT, the President also declared that the continued safety and reliability of the U.S. nuclear stockpile is a "supreme national interest" of the United States.

Nuclear Nonproliferation Treaty. Article VI of the NPT obligates the parties "to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." However, the NPT does not provide any time period for achieving this goal. Even relatively simple bilateral treaties, such as START I and START II, require more than 10 years to implement, not counting the years of negotiations. In the words of Ambassador

Thomas Graham, "Regrettably, none of us is clairvoyant, and so it is unwise to predict with any degree of precision the future international reality and consequently, the complete arms control agenda.[1] For the Stockpile Stewardship and Management PEIS, speculation on the terms and conditions of a "zero level" U.S. stockpile with international verification, as some have suggested during the scoping meetings, goes beyond the bounds of the reasonably foreseeable future. For the same reason, DOE has chosen not to speculate on a return of the nuclear arms race requiring a stockpile larger than START I size. However, in keeping with the NPT goals, the NPR strategy does express the U.S. intent to pursue further reductions in nuclear forces beyond START II. Therefore, the implications of further reductions below the START II-sized stockpile are discussed in this PEIS where they are relevant.

2.2.2 Nuclear Weapon Stockpile Memorandum

Although the NWSM is a classified document, its effect in shaping the Stockpile Stewardship and Management PEIS can be explained in an unclassified context. Without access to the classified NWSM, one might assume that the exact details of the projected stockpile size and composition under START I and START II could have a significant effect on the Stockpile Stewardship and Management PEIS. This is not the case for the following reasons:

- The stockpile composition (i.e., the number of different weapon types), does not vary significantly in either a START I- or START II-sized stockpile. All weapon types are tritium-boosted, thermonuclear weapons that could be affected by the same types of safety and reliability problems requiring repair, replacement, and certification in the absence of nuclear testing. The basic weapons laboratory and industrial capabilities required for the foreseeable future do not vary significantly from planned differences in size or composition of either a START I- or START II-sized stockpile.
- Industrial capacity is only indirectly affected by projected variances in stockpile size and composition. Stockpile size must be linked with historical stockpile data to arrive at estimates of average annual industrial capacity needed to produce components for repair or replacement. Even without the limitations on the use of historical stockpile data described in section 2.3.3, this cannot be done with mathematical precision and, therefore, reasonable technical judgment must be applied. The result is to forecast a need for a smaller industrial base with capacities on a scale of hundreds of weapons per year versus the thousands of weapons per year that existed prior to the end of the Cold War. A range of annual requirements is considered for impact analysis in the Stockpile Stewardship and Management PEIS that bounds potential variances in the NWSM under the START II protocol. In addition, a qualitative sensitivity analysis is performed on the hypothetical low case that is well below the START II-sized stockpile projection and the high case associated with a START I-sized stockpile (see section 3.1.1.2).

2.2.3 Presidential Decision Directives and Public Law

Over the past few years, there have been several publicly announced PDDs that have shaped the Stockpile Stewardship and Management Program. In the National Defense Authorization Act of 1994 (Pub. L. 103-160), Congress acted to reinforce many of the same points. A summary of their effect in shaping the Stockpile Stewardship and Management PEIS follows:

- The continued maintenance of a safe and reliable nuclear weapons stockpile will remain a cornerstone of the U.S. nuclear deterrent for the foreseeable future.
- The core intellectual and technical competencies of the United States in nuclear weapons will be maintained. This includes competencies in research, design, development, and testing (including nuclear testing); reliability assessment; certification; manufacturing; and surveillance capabilities.
- The United States will develop new ways to maintain a high level of confidence in the safety, reliability, and performance of the U.S. nuclear weapons stockpile in the absence of nuclear testing. The strategy for this action will be structured around the use of past nuclear test data in combination with enhanced computational modeling, experimental facilities, and simulators to further comprehensive understanding of the behavior of nuclear weapons and the effects of radiation on military systems.[2]
- The continued vitality of all three DOE nuclear weapons laboratories will be essential in addressing the challenges of maintaining a safe and reliable nuclear weapons stockpile without nuclear testing and without the production of new-design weapons.

2.3 Safety and Reliability of the United States Stockpile

This section focuses on the technical effects of national security policy decisions on shaping the purpose, need, proposed actions, and alternatives of the Stockpile Stewardship and Management Program. The stockpile is currently judged to be safe and reliable by DOE. National security policy changes will significantly change the characteristics of the future nuclear weapons stockpile and the manner in which it will need to be certified as safe and reliable.

2.3.1 Stockpile History

Since the beginning of the Cold War, the United States has maintained a nuclear deterrent force as safe and reliable as the evolution of military requirements and technology development would permit. A safe and reliable U.S. nuclear weapons stockpile has been a cornerstone of maintaining a credible nuclear deterrent. The size of the U.S. nuclear weapons stockpile peaked in the 1960s. In the 1970s, it was significantly reduced due to the easing of Cold War tensions with the former Soviet Union. In the late 1970s and through most of the 1980s, Cold War tensions with the former Soviet Union significantly increased and the U.S. nuclear deterrent force was modernized in response. However, the size of the U.S. nuclear weapons stockpile remained stable during the 1980s with the production of new-design weapons replacing dismantled weapons nearly one for one.

The beginning of the 1990s brought the collapse of the Warsaw Pact and the former Soviet Union and a significant effort to end the Cold War. During the first half of the 1990s, many changes occurred in U.S. policy and planning for its nuclear deterrent force. Much has already been accomplished, including the dismantlement, without replacement, of more than 8,000 U.S. nuclear weapons since the end of the Cold War; however, much more will need to be accomplished with the former Soviet

Union over the next 10 years to stay the course. Large uncertainties remain concerning the nuclear weapons stockpile of the former Soviet Union, and it is the policy of the United States to protect its national security options for its nuclear deterrent, including the reconstitution of its nuclear forces. The following excerpt is from the President's national security strategy statement in July 1994:

- Even with the Cold War over, our Nation must maintain military forces that are sufficient to deter diverse threats. . . . We will retain strategic nuclear forces sufficient to deter any future hostile foreign leadership with access to strategic nuclear forces from acting against our vital interests and to convince it that seeking a nuclear advantage would be futile. Therefore we will continue to maintain nuclear forces of sufficient size and capability to hold at risk a broad range of assets valued by such political and military leaders.

2.3.2 Smaller, Aging Stockpile

Until recently there has been no reason to expect that weapons would remain in the stockpile longer than they have in the past. Continuous modernization to improve safety and reliability kept the stockpile young as new-design weapon types replaced old ones. Now, with no new-design weapons being produced, the United States will have a steadily aging stockpile. The average age of the stockpile has never approached the typical lifetime specified in the weapon requirements (approximately 20 years for the most modern U.S. nuclear weapons). The average age of the stockpile is currently about 13 years. The NWSM forecasts the average age will now climb roughly 1 year per year and will reach the 20 year mark by 2005, at which time the oldest weapons will be about 35 years old.

2.3.3 Historical Stockpile Data

The following paragraphs describe the effects of historical stockpile data in shaping the Stockpile Stewardship and Management Program. This information was extracted from an unclassified report, Stockpile Surveillance: Past and Future (tri-laboratory report requested by DOE and issued as Sandia Laboratory Report, SAND 95-2751, September 1995), which was co-authored by the three weapons laboratories and is available to the public. The past role of nuclear testing is emphasized because such testing can no longer be relied on to provide unambiguous high confidence in the future safety and reliability of an aging stockpile.

Stockpile Evaluation Program. [3] Continuous evaluation of the safety and reliability of the stockpile has always been a major part of the U.S. nuclear weapons program. Since the introduction of sealed-pit weapons more than 35 years ago, a formal surveillance program of nonnuclear laboratory and flight testing has been in existence. More than 13,800 weapons have been evaluated in this program. The Stockpile Evaluation Program, with its reliance on functional testing, has provided information that can be used in the statistical analysis of nonnuclear component and subsystem reliability. This program has detected about 75 percent of all problems ultimately detected, and has been the principal mechanism for discovering defects and initiating subsequent repairs and replacements. However, not all aspects of a nuclear weapon can be statistically assessed this way. Weapons research and development (R&D) at the three weapons laboratories and nuclear testing have played an important part in assessing the stockpile and in making corrective changes when needed.

Past Role of Nuclear Testing. Nuclear tests have been a critical part of the nuclear weapons program. They have contributed to a broad range of activities from development of new weapons to stockpile confidence tests to tests that either identified a concern or showed that remedial actions were not needed. However, the United States has not conducted a sufficient number of nuclear tests for any one weapon type to provide a statistical basis of reliability assessment for the nuclear explosive package. This is why the word "performance" instead of "reliability" is used when discussing a nuclear explosive package.

Although nuclear tests were never a part of the formal Stockpile Evaluation Program, they played an important role in maintaining the safety and performance of the weapons in the stockpile. Every advantage was taken of developmental nuclear tests to eliminate potential nuclear explosive problems. In some cases, nuclear testing during development of one weapon type uncovered a problem that was pertinent to a previous design already in the stockpile, which then had to be corrected. Nuclear tests identified certain classes of stockpile problems not observable in the surveillance program. Nuclear tests have been used to resolve issues raised by the Stockpile Evaluation Program, such as whether a particular corrosion problem affected the nuclear yield of a weapon. Nuclear tests have also been used to verify the efficacy of design changes. For example, the adequacy of certain mechanical safing techniques was determined through nuclear testing. In the case of a catastrophic defect, tests have been used to certify totally new designs to replace an existing design. Finally, in some cases, nuclear testing proved that a potential problem did not exist.

Beginning in the late 1970s, DOD and DOE agreed to a formal series of underground nuclear tests of weapons withdrawn from the stockpile. These tests were referred to as Stockpile Confidence Tests. They differed from developmental nuclear tests because the weapons were from actual production, had experienced stockpile conditions, and had minimal changes made to either nuclear or nonnuclear components prior to the test. There have been 17 such confidence tests since 1972, including 4 tests in the early 1970s that were not officially designated as Stockpile Confidence Tests. Confidence tests have been conducted for each of the weapon types expected to remain in the stockpile well into the next century.

In addition to the 17 confidence tests, at least 51 additional underground nuclear tests have been conducted since 1972 involving nuclear components from the stockpile, components from the actual weapon production line, or components built according to stockpile design specifications and tested after system deployment. The objectives of these tests included weapon effects, weapons R&D, confirmation of a fix, or investigation of safety or performance concerns. Three of these tests (in addition to one confidence test) revealed or confirmed a problem that required corrective action. Four tests (in addition to three confidence tests) confirmed a fix to an identified problem. Additionally, five tests were performed to investigate safety concerns affecting three different weapon types. These five tests verified that a problem did not exist.

The confidence in the performance of the nuclear explosive package has been based on underground nuclear test data, aboveground experiments, computer simulations, surveillance data, and technical judgment. The directors of the three weapons laboratories must certify the nuclear performance of the weapons designed by their laboratory.

In a future without additional nuclear testing, the core capabilities of the weapons laboratories that were developed to eliminate potential problems in new weapon designs must now be employed to assess stockpile problems. However, in the absence of nuclear testing, the ability to assess nuclear components is more difficult; new methods of assessment, discussed later, will have to be developed to help compensate for this loss.

Stockpile Data Summary. The historical stockpile database includes more than 2,400 findings from more than 45 weapon types. Findings are any abnormal conditions pertaining to stockpile weapons, such as out-of-specification data. Findings are then investigated and assessed as to whether or not they are a problem. Excluding multiple occurrences of the same anomalous condition, table 2.3.3-1 provides a summary of the distinct findings and actionable findings since 1958. Actionable findings are those that require some form of corrective action. All major components and subsystems have had problems that required corrective actions. The number of findings for nonnuclear components is much larger than that for nuclear components largely because there are so many more nonnuclear components in a nuclear weapon that require testing more frequently. However, the ratio of actionable findings to distinct findings is much greater for the nuclear components. Thus, when a finding has occurred for a nuclear component, it has generally been a serious one requiring corrective action. Often these corrective actions to nuclear components have required changes to all of the weapons comprising the weapon type affected.

TABLE 2.3.3-1.-Summary of Distinct and Actionable Findings Since 1958

		Actionable Findings	
Type of Components	**Distinct Findings**	**Findings**	**Weapon Types**
Nuclear	145	110	39
Nonnuclear	703	306	38

Source: SNL 1996a.

For the nuclear explosive package, there were approximately 110 findings on 39 weapon types requiring some remediation either to the entire build of that design or to all weapons produced after the particular finding. In addition to rebuilds and changes in production procedures, other actions included imposing restrictions on the weapon, accepting a performance decrement, and in several cases, conducting a nuclear test to determine that the finding did not require any physical change. There have been other instances not counted as actionable where a material was chemically changing and the weapon was closely monitored to see if further action was necessary or it was an isolated case that did not require remediation.

2.3.4 Certified Repairs or Replacements Will be Needed

Based on the age of the planned stockpile over the next 10 years, historical data would project an average of one to two actionable findings per year in the planned stockpile and an average of one to two change proposals approved per year, with one of these resulting in a major change. Even with a START II-sized stockpile, one change can affect thousands of weapons. These projections are most likely minimum numbers. The stockpile they were derived from was, on average, younger than the planned stockpile will be in future years, and the number of components in the weapon types was less than the number of components in weapon types of the planned stockpile. Furthermore, the aging characteristics of some of the materials used in the weapon types remaining in the stockpile are not well understood.

The previous paragraphs describe how problems were identified in stockpile weapons during the period when nuclear testing and active weapons development were being conducted along with the Stockpile Evaluation Program. At the present time, with no anticipated new weapons and no nuclear testing, new approaches are needed to assess weapons for potential problems and anticipate aging concerns, especially in the nuclear explosive package. This is important because the smaller, less diverse U.S. stockpile will be more vulnerable to single-component and common-cause failures (i.e., failures or defects compromising the safety or reliability of, respectively, a single weapon system or several systems sharing a common design feature).

DOE will continue to rely on well-established methods while the weapons laboratories develop new methods of measurement and evaluation to address aging, safety, reliability, and performance issues. As the new methods mature for either nuclear or nonnuclear components, they will be incorporated into the Stockpile Evaluation Program. In the future, for example, DOE will rely on improved experimental capabilities, coupled with an improved computational capability, to address issues associated with the nuclear explosive package. These experimental capabilities, along with enhanced surveillance methods, are now crucial to help assess and predict the state of the stockpile and to provide long lead time information about incipient problems.

2.4 Purpose and Need

Broadly stated, changes to U.S. national security policies for nuclear deterrence now place two significant constraints on the way in which DOE has traditionally accomplished its statutory nuclear weapons mission:

- The United States has declared a moratorium on nuclear testing and will seek ratification of a "zero yield" CTBT.
- The United States has stopped the development and production of new-design nuclear weapons.

With these constraints, U.S. national security policy directs DOE to:

- Maintain the core intellectual and technical competencies of the United States in nuclear weapons including:
    - Research, design, development, testing, reliability assessment, certification, manufacturing, and surveillance
    - All three nuclear weapons laboratories and the capability to resume nuclear testing if needed
- Maintain a safe and reliable U.S. nuclear weapons stockpile

The NPR, PDDs, and Pub. L. 103-160 all address the need to maintain the core competencies of the United States in nuclear weapons without nuclear testing. The NPR strategy adds the expectation of no new-design weapon production; therefore, the NWSM does not currently direct or forecast such a requirement.

The Stockpile Stewardship and Management Program must accomplish these fundamental purposes in a safe, efficient, and environmentally responsible manner. National security policies do not eliminate any of the current or historical core competencies and capabilities of the DOE weapons laboratories, industrial plants, or the Nevada Test Site (NTS). They are basic needs that must be maintained for the foreseeable future. These needs are summarized in a focused discussion of their relationship to the development of the PEIS proposed actions and alternatives. A classified appendix has also been prepared to support this PEIS.

2.4.1 Stockpile Stewardship--The Weapons Laboratories and Nevada Test Site

The three weapons laboratories possess most of the core intellectual and technical competencies of the United States in nuclear weapons. These competencies embody more than 50 years of weapons knowledge and experience that cannot be found anywhere in the United States. Since the end of the Cold War, laboratory staffing in the weapons program has declined significantly due to the effects of policy changes on program and budget. Further significant reductions or consolidations of the weapons laboratories would counter efforts to maintain core competencies and to develop the new technologies necessary to ensure continued high confidence in a safe and reliable stockpile. Current stockpile activities in this regard, such as ongoing retrofits of enduring stockpile weapons and safe dismantlement of weapons no longer required, would also be hampered. For the foreseeable future it would be unreasonable to pursue an alternative course for the weapons laboratories. In addition, because there can be no absolute guarantee of complete success in the development of enhanced experimental and computational capabilities, the United States will maintain the capability to conduct nuclear tests under a "supreme national interest" provision in the anticipated CTBT. DOE will need to maintain the capability for nuclear testing and experimentation at NTS and the necessary technical capabilities at the weapons laboratories to design and conduct such tests.

The science and engineering technology base at the three weapons laboratories controls all DOE technical requirements for a U.S. nuclear weapon. The laboratories perform the basic research, design, system engineering, development testing, reliability assessment, and certification of nuclear performance. In addition, they provide or control all technical specifications that are used by the industrial base for manufacturing and surveillance operations and for maintenance operations conducted by DOD. Data from these operations are provided to the weapons laboratories for assessment and technical resolution of problems.

When stockpile problems develop, all of the core laboratory capabilities may come into play. The cause of the problem is identified and an assessment made of its impact on safety, reliability, or performance. If the problem is to be fixed, alternative solutions are developed. These can range from simple repair of a defective feature to complete redesign of the weapon component or subsystem.

The focus is always on the acquisition of relevant test data to make these judgments. Once a fix is determined, it must be designed, prototyped, and development tested by the laboratories before the design is released for manufacture. This generally includes weapon system-level laboratory and flight tests for nonnuclear features and, in the past, nuclear tests if the changes could affect the weapon's nuclear performance. If the fix is to be manufactured, the laboratories provide the quality assurance test specifications. For nonnuclear components, a significant amount of functional test data is acquired during manufacture and is used to begin building a statistical estimate of component reliability. Subsequent laboratory and flight testing in the surveillance program accumulates additional data that include the effects of aging and exposure to stockpile environments. Thus, over time, high confidence in the safety and statistical reliability of nonnuclear components and subsystems can be established.

The situation is not the same for nuclear components and the assessment of nuclear performance. Nuclear components cannot be functionally tested during manufacture or surveillance. The data acquired during manufacture only show that the component was manufactured as designed. Surveillance data indicate whether the component is changing as a result of aging or exposure to stockpile environments. Manufacturing and surveillance data can identify concerns, but these data do not provide all of the necessary information to assess nuclear performance. Assessment and certification of nuclear performance is a nonstatistical, technical judgment by the weapons laboratories based on scientific theory, experimental data, and computational modeling. The scientific practice of "peer review" has been fundamental to these judgments. Experts from the two nuclear design laboratories review each other's data and conclusions on important issues, thereby providing an independent check and balance.

In the past, nuclear testing filled the gaps in basic understanding of the complex physics phenomena; it provided high confidence in the certification of nuclear safety and performance. Without nuclear testing, science-based stockpile stewardship will focus on obtaining the more accurate scientific and experimental data that will be needed for more accurate computer simulations of nuclear performance. The new experimental data must also be validated against past nuclear test data. Assessment of stockpile problems and certification of repairs or replacements of nuclear components will have to rely on improvements to these tools. The existing tools were used in conjunction with nuclear testing and are inadequate if used alone.

From a broader national security perspective, the core intellectual and technical competencies of the weapons laboratories provide the technical basis for the pursuit of U.S. arms control and nuclear nonproliferation objectives. Their extensive core competencies have provided most of the nuclear weapons arms control technologies developed and employed by the United States. The weapons laboratories will have to continue to provide this essential service in the future. For the same reasons, the weapons laboratories also provide significant technical support for U.S. efforts on nuclear weapons nonproliferation and counter-proliferation programs.

2.4.2 Stockpile Management--The Industrial Base

None of the manufacturing and surveillance capabilities of the current industrial base can be eliminated on the basis of the post-Cold War changes in national security policies. The industrial base also possesses core competencies, such as manufacturing product, process, and quality control know-how. However, with a smaller stockpile and no new-design weapons production, industrial capacity can be reduced to meet anticipated manufacturing requirements for stockpile repair and replacement activities. A summary discussion of each of the major functions needed is provided in this section. A more detailed discussion can be found in section 3.4.

Broadly stated, there are six major manufacturing and surveillance functional areas in the weapons industrial base:

- Weapons assembly/disassembly (A/D)
- Pit components
- Secondary and case components
- High explosives (HE) components
- Nonnuclear components
- Tritium supply and recycling

As explained in chapter 1, tritium supply and recycling was evaluated in a separate PEIS.

Weapons Assembly/Disassembly. The Pantex Plant (Pantex) is the only DOE site currently authorized to assemble or disassemble stockpile weapons. Special facilities built to explosives safety criteria are required; in addition, some facilities are designed to limit nuclear material dispersal in case of an HE accident. These facilities exist in large numbers at Pantex, and because they are relatively discrete structures, downsizing-in-place is a viable alternative. NTS has a much smaller set of these special structures that were constructed for use in assembling nuclear test devices. However, NTS has few of the support facilities required for volume assembly or disassembly of stockpile weapons. A major programmatic consideration is the cost of re-creating facilities that already exist at Pantex. Due to ongoing weapon dismantlement requirements, the alternative to transfer this function to NTS would be slow but achievable within a 10-year period.

Pit Components. These components are designed by Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL) and were formerly produced at the Rocky Flats

Plant, which is no longer available for this function. The LLNL facility is not large enough to accommodate both stewardship and management activities; therefore, only LANL is considered to be a reasonable alternative if this function is reestablished at a weapons laboratory. Also, LANL has the more extensive and complete plutonium facility infrastructure. Savannah River Site is also considered a viable alternative for reestablishing this function because it has a plutonium processing infrastructure, although it does not have a precision component manufacturing capability. Other than the synergism with maintaining core competencies at the weapons laboratories, a major program consideration would be the scale of manufacturing capacity required for the foreseeable future.

The preceding discussion applies to new pit fabrication as well as both intrusive and nonintrusive modification pit reuse manufacturing capability and capacity. Intrusive modification pit reuse requires handling and processing of the plutonium internal to the pit. Nonintrusive modification pit reuse involves the external features of the pit and does not require an extensive plutonium infrastructure; the risk of contamination and the generation of radioactive waste is very low for nonintrusive modification activities. Therefore, the weapons A/D Facility is also an alternative for nonintrusive modification pit reuse.

Secondary and Case Components. The Y-12 Plant (Y-12) at the Oak Ridge Reservation produces the secondary and case components. These components are designed by LANL and LLNL; therefore, each of those facilities would be reasonable alternative sites if this function is transferred to the weapons laboratories. Both of these laboratories have a uranium technology base and facility infrastructure, although they have only a very limited R&D manufacturing capability. Other than the synergism with maintaining core competencies at the weapons laboratories, a major Program consideration would be the cost of transferring product technologies and the re-creation of capital facilities that already exist at Y-12. Due to the complicated nature of nuclear facilities and plans for retrofit of an enduring stockpile weapon involving these components, a transition to either LANL or LLNL would be slow but achievable within a 10-year period. Downsizing Y-12 is considered to be a reasonable alternative.

High Explosives Components. Pantex currently manufactures HE components in special facilities built to explosives safety criteria. Downsizing the facilities at Pantex is a reasonable alternative. Comparable facilities also exist at both LANL and LLNL, and either laboratory has sufficient capacity to meet estimated future manufacturing requirements. Costs for this function are relatively low in any case. If a decision is made to transfer this function to the weapons laboratories, it could be done more quickly than the transfer of other functions. However, Pantex would have to retain disposition and disposal capability for the HE inventories currently onsite and those expected from near-term weapon dismantlement. A major Program consideration would be the synergism of this function in maintaining the core competencies of the weapons laboratories.

Nonnuclear Components. Kansas City Plant (KCP) currently manufactures the majority of the nonnuclear components. The KCP facilities are not unique in structural design and are amenable to downsizing in place. The manufacturing technologies are complex and varied due to the large number of component types and high reliability requirements. Sandia National Laboratories (SNL) designs most of the components that KCP manufactures; therefore, SNL would become the major nonnuclear component supplier if a decision is made to transfer this function to the weapons laboratories. Other than potential synergism with maintaining core competencies at the weapons laboratories, a major program consideration would be the cost of transferring product technologies and re-creating facilities that already exist at KCP. Requirements for ongoing support of the enduring stockpile would make this a slow transition, but it would be achievable within a 10-year period.

2.5 Proposed Action and Alternatives

All of the existing basic capabilities of the laboratory and industrial base continue to be needed even though there have been changes in national security policy since the end of the Cold War. These changes do not affect the standards for stockpile safety and reliability. Therefore, the proposed action concentrates on three major issues that result from the national security policies and constraints placed on the Program. The three program elements of the proposed action are:

- Providing enhanced experimental capability
- Rightsizing the industrial base
- Reestablishing manufacturing capability and capacity for pit components

Reasonable alternatives for the proposed action are briefly discussed below. Chapter 3 describes these alternatives in more detail.

2.5.1 Providing Enhanced Experimental Capability

Understanding nuclear weapon performance requires knowledge of the performance of the individual elements: the primary (pit and HE), the secondary, and the functional interaction between the primary and the secondary inside the case. Computer model-based validation and certification will be the key to DOE's ability to determine, with confidence, many of the future safety and performance characteristics of the stockpile in the absence of nuclear testing. This requires two principal elements: advanced computational models and facilities to provide experimental data that can be used to adjust (normalize) the computational models in conjunction with past nuclear test data. DOE is proposing three facilities to complement the existing capabilities to provide these data. Two are new facilities and one is the upgrade of an existing facility.

The National Ignition Facility (NIF) and the Atlas Facility are proposed new facilities. The Atlas Facility would be collocated in TA-35 with the existing Pegasus II Facility at LANL, and the two facilities would use common infrastructures and support facilities. The Contained Firing Facility is a proposed environmental and diagnostic upgrade to the existing Flash X-Ray Facility at LLNL. As described in section 3.3, these three new facilities would perform separate functions and provide different types of experimental data. Thus, they are complementary in nature and are not alternatives to one another. In each case, the alternative to constructing and operating the facility is No Action (i.e., relying on existing facilities to provide data). In addition, site alternatives are evaluated for NIF, since it is not associated with an existing facility. Volume III of this PEIS contains project-specific analyses for each of these facilities.

The stockpile stewardship program is expected to continuously evolve as better information becomes available and technological advancements occur. DOE is in the early planning stages for a number of what can be described as " next generation" stewardship facilities. These facilities are discussed in section 3.3.4. They will build on the knowledge gained from existing and proposed new facilities. Since these facilities are in the conceptual planning stages, they are not sufficiently well defined to be analyzed in this PEIS. When these technologies reach the appropriate level so as to be ripe for decisionmaking, DOE would complete National Environmental Policy Act (NEPA) documentation for them.

2.5.2 Rightsizing the Industrial Base

One of the primary goals of stockpile management is to rightsize functions to provide an effective and efficient manufacturing capability for a smaller stockpile. Such rightsizing must be accomplished in a manner that preserves core competencies in manufacturing and surveillance. This PEIS analyzes two alternative approaches to rightsizing the stockpile management functions described in section 2.4.2: (1) transfer manufacturing and surveillance activities from the industrial sites to the weapons laboratories and NTS and (2) downsize the industrial plants in place. Relocation alternatives were selected on the basis of existing technical and facility infrastructure at the laboratories and NTS. Section 3.4 discusses these alternatives in detail.

2.5.3 Reestablishing Manufacturing Capability and Capacity for Pit Components

Plutonium pit manufacturing is a special case among those stockpile management functions discussed in section 2.4.2. In 1992, DOE ceased plutonium pit manufacturing operations at the Rocky Flats Plant due to concerns about the safety of the plant and national security policy decisions to cease the production of new-design nuclear weapons. Reestablishing pit manufacturing capability and capacity was to be part of the Reconfiguration PEIS discussed in chapter 1. This function is now part of the proposed action in this Stockpile Stewardship and Management PEIS.

Pit manufacturing capability and capacity, like that of all other major weapons components and subsystems, is essential for protecting national security options with regard to the nuclear deterrent. In addition, repair or replacement of pits for existing stockpile weapons may be required in the future. Reasonable alternative sites for reestablishing this function were selected from sites that already possess some measure of the appropriate technical or facility infrastructure.

2.6 Nonproliferation

On August 11, 1995, the President announced his commitment to seek a "zero yield" CTBT. He also established several safeguards that condition U.S. entry into a CTBT. One of these safeguards is the conduct of science-based stewardship, including the conduct of experimental programs. This safeguard will enable the United States to enter into such a treaty while maintaining a safe and reliable nuclear weapons stockpile consistent with U.S. national security policies.

One benefit of science-based stockpile stewardship is to demonstrate U.S. commitment to NPT goals; however, the U.S. nuclear posture is not the only factor that might affect whether or not other nations might develop nuclear weapons of their own. Some nations that are not declared nuclear states have the ability to develop nuclear weapons. Many of these nations rely on the U.S. nuclear deterrent for security assurance. The loss of confidence in the safety or reliability of the weapons in the U.S. stockpile could result in a corresponding loss of credibility of the U.S. nuclear deterrent and could provide an incentive to other nations to develop their own nuclear weapons programs.

The United States has halted the development and production of new-design nuclear weapons. The experimental testing program will be used to assess the safety and reliability of the nuclear weapons in the remaining stockpile. Much of this testing is classified and could not lead to proliferation without a breach of security. Use of classified data from past U.S. nuclear tests is also a vital part of the overall process for validation of new experimental data. Most of the component technology used for the proposed enhanced experimental capability is unclassified and is available in open literature, and many other nations have developed a considerable capability.

Proliferation drivers for other states, such as international competition or the desire to deter conventional armed forces, would remain unchanged regardless of whether DOE implemented the proposed action analyzed in this PEIS. In the NPT, the parties agree not to transfer nuclear weapons or other devices, or control over them, and not to assist, encourage, or induce nonnuclear states to acquire nuclear weapons. However, the treaty does not mandate stockpile reductions by nuclear states, and it does not address actions of nuclear states in maintaining their stockpiles.

2.7 Summary

National security policies require DOE to maintain the historical nuclear weapon competencies and capabilities of three weapons laboratories, the industrial plants, and NTS. In addition, DOE must maintain an appropriately sized industrial capacity to manufacture repair and replacement components for weapons that remain in the stockpile. The environmental impacts of maintaining these historical capabilities will be established by the No Action characterization of the sites. With this baseline, the proposed actions and alternatives are analyzed incrementally for each relevant site. In this manner, the broad cumulative impact of the Program and the specific impacts of the proposed actions and alternatives can be displayed and discussed.

In preparation for the Stockpile Stewardship and Management PEIS public scoping process, DOE published a document entitled The Stockpile Stewardship and Management Program in May 1995. This document supplements this chapter with a broader discussion of Program strategies to address the major issues and policy constraints placed on the Program. There are five strategies discussed:

- Enhanced experimental and computational capabilities
- Enhanced weapon and materials surveillance technologies

- Effective and efficient production complex
- Long-range stockpile support
- Tritium production

In developing the Stockpile Stewardship and Management PEIS proposed actions, the significant aspects of "enhanced experimental capability" and "effective and efficient production complex" are directly addressed. As explained in chapter 1, the enhanced experimental capability of the Dual Axis Radiographic Hydrodynamic Test Facility and tritium production are addressed as related interim actions in separate environmental impact statements. The remaining elements of these strategies are primarily a redirection of R&D efforts at the weapons laboratories away from the design of new weapons toward the development of appropriate technologies to address the needs of a safe, reliable, and smaller, aging stockpile. As such, they are not judged to be significant NEPA issues and do not have broad environmental impacts beyond what is analyzed in this PEIS.

Figure 2.7-1 presents the framework used for discussing the Stockpile Stewardship and Management Program from a U.S. national security policy perspective. Figure 2.7-2 presents a view of the complete Stockpile Stewardship and Management Program from a stockpile perspective, integrating all aspects of the proposed action.

1 From a January 1995 speech by Ambassador Graham, Special Representative of the President for Arms Control Non-Proliferation and Disarmament.

2 The effects of radiation on nuclear weapons and military systems are referred to as "weapon effects" throughout this PEIS.

3 Other than in specific discussions, the word surveillance is used generically throughout this document in place of the Stockpile Evaluation Program.

CHAPTER 3: STOCKPILE STEWARDSHIP AND MANAGEMENT PROGRAM ALTERNATIVES

Chapter 3 provides descriptions of the alternative sites and the program alternatives for meeting the Nation's nuclear weapons stockpile stewardship and management requirements. The chapter begins with a summary of the development of the alternatives, followed by descriptions of the alternative sites and their current missions. The stockpile stewardship discussion provides a description of the three basic stewardship areas, along with the associated alternatives, including a brief description of concepts for next-generation stewardship facilities. The stockpile management discussion provides a description of the various management functions and their associated alternatives. Brief discussions of emerging technologies that may affect stockpile management facilities and functions in the future and a discussion of a potential next-generation plutonium fabrication facility follow. The chapter concludes with a comparison of the stockpile stewardship and management alternatives and a discussion of the preferred alternatives.

3.1 Development of Stockpile Stewardship and Management Program Alternatives

This programmatic environmental impact statement (PEIS) evaluates the direct, indirect, and cumulative impacts associated with the Stockpile Stewardship and Management Program alternatives that are summarized in figure 3.1-1. For the various alternatives, this includes evaluating the applicable impacts of new facility construction or existing facility modification. Also assessed are the operational impacts of long-term stewardship and management activities in support of the base case nuclear weapons stockpile, including transportation of materials and components between sites. This PEIS also provides a sensitivity analysis of differences, when applicable, from the base case alternatives for the high and low case stockpile. However, since it is expected that the annual workload may vary above and below the base case capacity assumptions, the base case is analyzed in the greatest detail.

3.1.1 Planning Assumptions and Basis for Analysis

In the Stockpile Stewardship and Management Program and in this PEIS, the Department of Energy (DOE) will:

- Emphasize compliance with applicable laws and regulations and accepted industrial and weapons safety practices that safeguard the health of workers and the general public, protect the environment, and ensure the security of nuclear material and weapons
- Analyze alternatives that are consistent with, and supportive of, national security policies
- Maximize efficiency and minimize cost and waste, consistent with programmatic needs
- Minimize the use of hazardous materials and the number and volume of waste streams consistent with programmatic needs through active pollution prevention programs and

measures

As explained in section 1.7, DOE is currently preparing site-wide environmental impact statements (EIS)s covering continued operations for some of the alternative sites evaluated in this PEIS. Some of the existing activities covered by these site-specific, site-wide EISs are similar to those of the No Action alternative of this PEIS. Although the near-term analytical periods for the site-wide EIS analyses are different from those of the Programmatic Environmental Impact Statement for Stockpile Stewardship and Management, which is focused on long-term activities, the preparation of these documents has been closely reviewed and coordinated. As work on these site-wide EISs proceeds, their analyses will continue to be reviewed to ensure consistency. To the extent that the site-wide EIS analyses provide better information, such information has been incorporated, as appropriate. In the preparation of the Stockpile Stewardship and Management Final PEIS, any updated information relating to the sites' affected environment was reviewed and appropriate changes were made if new information could potentially change results of the impact analyses.

DOE has developed several planning assumptions as the basis of analyses presented in this PEIS. These considerations are summarized below.

3.1.1.1 *No Action Alternative Assumptions*

- The No Action alternative for this PEIS is defined in a way that takes into account the fact that DOE for decades has had in place a program for the stewardship and management of the nuclear weapons stockpile. Consistent with CEQ guidance, the No Action alternative consists of those facilities necessary to maintain the status quo in terms of DOE's current program direction. These consist primarily of existing facilities where DOE currently conducts weapons activities, including modifications to those facilities necessary to maintain their current mission capabilities. However, the No Action alternative also includes a small number of minor new facilities that will also be needed simply to maintain current mission capabilities at individual sites. Finally, the No Action alternative includes two major new facilities which are proceeding independent of this PEIS, and for which DOE has prepared separate EISs under the interim action provisions of the CEQ regulations. These EISs are the Programmatic Environmental Impact Statement for Tritium Supply and Recycling (DOE/EIS-0161) and the EIS for the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility (DOE/EIS-0228).

3.1.1.2 *Stockpile Management Assumptions*

- Base case stockpile size for the PEIS analysis is consistent with the Strategic Arms Reduction Talks (START) II protocol, but larger than 3,500 weapons. This PEIS also analyzes a high and a low case stockpile size to determine how the environmental impacts may change due to changes in the stockpile size. The high case consists of maintaining the stockpile at a level consistent with the START I Treaty, but larger than 6,000 weapons. The hypothetical low case is a stockpile of approximately 1,000 weapons.
- Analysis is provided for facilities that would be sized to support estimated average annual manufacturing requirements resulting from the base case stockpile size assuming single-shift

operation, 5 days per week. This PEIS analyzes environmental impacts of the base case quantitatively, including an evaluation of three-shift operation, 5 days per week (surge operation), to provide a bounding analysis. For stockpile management, this PEIS assesses alternatives that would downsize or modify existing facilities. With the exception of one nonnuclear facility at Sandia National Laboratories (SNL) and the expansion of the Device Assembly Facility at Nevada Test Site (NTS), there would be no greenfield construction of new facilities for any of the stockpile management alternatives. Existing facilities that would be downsized or modified have inherent differences in capacities when operated in the base case three-shift surge mode. For a given stockpile management mission, the downsize alternatives generally have a greater inherent capacity than other alternatives. For the downsize alternatives, therefore, a portion of the environmental impacts are due to the higher output associated with the three-shift surge mode of operation.

- This PEIS also qualitatively assesses each stockpile management alternative against identical low and high case single-shift workloads. Differences in environmental impacts for these single-shift workloads are attributable primarily to inherent differences in the existing facility and support infrastructure of the different sites.

Table 3.1.1.2-1.-- ***Stockpile Management Facility Sizing Assumptions (Annual Activity on Single Operating Shift)***

Function	Low Case	Base Case	High Case
Weapons Assembly/Disassembly			
Rebuilds			
(disassemblies)	50	150	300
(assemblies)	50	150	300
Evaluation			
(disassemblies)	120	120	140
(rebuilds)	110	110	140
High Explosives Fabrication	50	150	300
Nonnuclear Fabrication			
Field and factory retrofits	up to 100	up to 300	up to 600
Nuclear Fabrication			
Pit fabrication	50 [1]	50 [1]	100
Pit reuse (nonintrusive modification)	50	100	200
Secondary and case fabrication	50 [1]	50 [1]	100

- The facility sizing assumptions for the various stockpile management facilities, based on the above assumptions, are shown in table 3.1.1.2-1.
- Impacts from construction, including modifying existing structures, and operation are

evaluated. The period of construction or downsizing for each alternative varies; however, for analytical purposes, this PEIS assumes that operations would begin in 2005. A 25-year lifetime was evaluated for operations.

- Proven technologies are presented in this PEIS as a baseline for the various management alternatives. Section 3.5 discusses emerging technologies that have the potential to offer even greater environmental advantages. The design goal of all facilities includes consideration of waste minimization and pollution prevention to minimize facility and equipment contamination, and to make the future decontamination and decommissioning (D&D) of facilities as simple and inexpensive as possible. This PEIS includes a general discussion of environmental impacts from D&D, including a discussion of the D&D process, the types of actions associated with D&D, and the general types of impacts associated with D&D. Any discussion of specific impacts would be too speculative because the extent of contamination, the degree of decontamination, and the environmental impacts associated with performing D&D cannot be known without performing a detailed study of the facility. Such analyses are more appropriate for tiered project-specific National Environmental Policy Act (NEPA) documents.
- Designs of facilities for the fabrication of nuclear components include provisions for handling and storing working inventories of nuclear materials. For plutonium, working inventories would be stored at Savannah River Site (SRS) or Los Alamos National Laboratory (LANL). For < highly enriched uranium (heu), working inventories would be stored at oak ridge reservation (orr), lanl, or lawrence livermore national laboratory (llnl).
- For plutonium, strategic reserve storage is evaluated at the Pantex Plant (Pantex) and NTS. For HEU, strategic reserve storage is evaluated at ORR, Pantex, and NTS. For the purposes of this PEIS, DOE does not intend to move the strategic reserves of HEU to Pantex or NTS if ORR is chosen as the secondary and case fabrication site.
- This PEIS contains an analysis of low-consequence/high-probability accidents (evaluation basis) and high-consequence/low-probability accidents (beyond evaluation basis). A spectrum of both types of accidents is analyzed. For radiological accidents, impacts are evaluated both for the general population residing within an 80-kilometer (km) (50-mile [mi]) radius (including the maximally exposed individual) and for noninvolved workers in collocated facilities. The accident analyses in this PEIS are based upon facility conditions that are expected to exist in 2005. In some cases, facility conditions in 2005 may differ from current facility conditions due to design upgrades.

In developing alternatives for pit components, the following additional assumptions were used for new pit fabrication and intrusive modification pit reuse:

- Plutonium would not be introduced into a site that does not currently have a plutonium infrastructure because of the high cost of new plutonium facilities and the complexity of introducing plutonium operations into sites without current plutonium capabilities.
- The plutonium research and development (R&D) mission and functions would remain at LANL and LLNL, and the plutonium pit surveillance mission would remain at LANL. Both sites would store the materials required to support these missions.

In developing alternatives for secondaries and cases, the following additional assumptions were used:

- HEU would not be introduced into a site that does not currently have an infrastructure because of a desire to use suitable existing structures where possible and because of the high cost of new facilities.
- The uranium R&D mission and functions would remain at LANL and LLNL. If the Y-12 Plant (Y-12) at ORR is selected to retain the secondary and case fabrication mission, these R&D missions would be undertaken in partnership with Y-12. These sites would store the materials required to support this mission.

3.1.1.3 Stockpile Stewardship Assumptions

- The range of stockpile sizes used for analysis of manufacturing capacity-related issues for stockpile management functions is not applicable to stockpile stewardship functions. As explained in chapter 2, national security policies require all the historical stockpile stewardship and management capabilities to be maintained. Capabilities are independent of stockpile size. Stockpile stewardship functions are basic capabilities. For the same reason it is not reasonable to assume a "zero level" stockpile for the foreseeable future (sections 2.2.1 and 3.1.2), it is also not reasonable to assume the United States would eliminate the basic capabilities it needs to maintain a safe and reliable stockpile within the same foreseeable future.
- National security policy requires a safe and reliable stockpile without further nuclear testing and with an aggressive pursuit of enhanced experimental capabilities (section 2.5.1). Three stockpile stewardship facilities are proposed in this PEIS: the National Ignition Facility (NIF), the Contained Firing Facility (CFF), and the Atlas Facility. These facilities are analyzed as supplements to the facilities and capabilities that currently exist for carrying out the stockpile stewardship mission. Each proposed facility is an independent component of the overall stockpile stewardship program, each has unique value, and, therefore, these proposed facilities are not competing alternatives.
- Assumptions, regarding accident analyses are the same as described under stockpile management.

3.1.2 Alternatives Considered but Eliminated from Detailed Study and Related Issues

This section of the PEIS has been revised in response to comments received on the Draft PEIS concerning its scope and the alternatives considered. To begin, it is important to review the basic logic used in constructing this PEIS and to restate the nature of the decisions expected to be made based on the contents of the PEIS.

Chapter 2 describes the national security policy framework that defines the purpose and need for DOE's nuclear weapons mission for the foreseeable future. It also describes the development of proposed actions and reasonable alternatives in response to recent changes in national security policy. Chapter 2 also puts those changes in broad technical perspective. Successive levels of technical detail are provided in chapters 3 and 4, and in Volumes II and III. The discussions that follow refer to the appropriate sections of this PEIS to avoid unnecessary repetition.

As stated in the Notice of Intent (60 FR 31291) published on June 14, 1995, DOE intends that the ROD on this PEIS will:

- Identify the future missions of the Stockpile Stewardship and Management Program; and
- Determine the configuration (facility locations) of the Complex necessary to accomplish the Program missions

While the terms "stockpile stewardship" and "stockpile management" are relatively new, the Program is not new when considered in terms of its substructure capabilities (section 1.1). What the terms are meant to convey is a change in Program focus away from large-scale development and production of new-design nuclear weapons with nuclear testing, to one that focuses on the safety and reliability of a smaller, aging stockpile without nuclear testing. Even with this change in focus, however, national security policies require DOE to maintain the capabilities of the ongoing Program. The proposed actions flow logically from the mission purpose and need, given the policy constraints placed on the Program. Enhanced experimental capability is proposed because it is the surrogate source of experimental data that are needed to continually assess and certify a safe and reliable stockpile constrained by the absence of nuclear testing. Rightsizing manufacturing capacities is proposed in direct response to the reduced requirements of a smaller, aging stockpile constrained by the absence of new-design weapon production. Reestablishing pit manufacturing capability is proposed because it restores a required capability of the Program that was temporarily lost as a consequence of the closure of the Rocky Flats Plant.

In developing this PEIS, DOE judged the above three proposed actions to be significant at the programmatic level. Some additional strategies of the Stockpile Stewardship and Management Program, such as enhanced computational capability, were judged not to have significance for this PEIS because they did not have the potential for significant environmental impacts relative to the ongoing Program at a site, nor was the mission capability being considered for transfer to another site. The programmatic level environmental impacts of the ongoing Program at each of the eight sites in the Complex are described in chapter 4. Projects and facilities to support the ongoing Program are subject to site-specific NEPA review.

The issue of Stockpile Stewardship and Management Program alternatives is complex because nuclear weapons require a complete integrated set of technical capabilities and an appropriately sized manufacturing capacity. The technical capabilities are generally characterized as research, design, development, and testing; reliability assessment and certification; and manufacturing and surveillance operations (section 2.2 and figure 2.7-2). From a technical point of view, none of these capabilities can be deleted if DOE is to maintain a safe and reliable stockpile (section 2.4). In addition, DOE has been directed to maintain these capabilities by national security policy from the President and Congress (section 2.4).

3.1.2.1 *Alternatives in General*

Commentors questioned the different treatment of stewardship and management alternatives, mainly the lack of stewardship alternatives. Stewardship and management alternatives are treated differently in the PEIS because they address fundamentally different problems. Stockpile stewardship capabilities form the basis of U.S. judgments about the safety, reliability, and performance of U.S. nuclear weapons, and in a larger context, U.S. judgments about the nuclear weapons capabilities of others (section 2.4.1). DOE did not consider it reasonable to propose stewardship alternatives that would diminish stewardship capabilities, particularly given the fact that historic confidence in the safety and performance of the stockpile was derived from nuclear testing that is no longer part of the ongoing stewardship program. National security policy requires DOE to maintain, and in some areas enhance, the stewardship capabilities of the three weapons laboratories and NTS (section 2.2). The PEIS also explains the basis for this in a technical context, including the need for two independent nuclear design laboratories (section 2.4.1). Therefore, this PEIS has no proposed actions that transfer ongoing stockpile stewardship missions from one site to another, or that would otherwise diminish ongoing stewardship missions.

National security policy also requires DOE to maintain stockpile management capabilities and appropriate manufacturing capacity for a smaller stockpile. Unlike stockpile stewardship capabilities, the smaller stockpile does permit some reasonable siting alternatives for stockpile management capabilities and capacities to accomplish the mission purpose and need within the current national security policy framework (section 2.4.2).

3.1.2.2 *Enhanced Experimental Capability*

DOE has considered that there are differing opinions on the technical merit of DOE's proposed actions with regard to enhanced experimental capability. Nuclear weapons design information, including the complex physics of nuclear weapon explosions, is classified for reasons of national security and nonproliferation. Even if this information were unclassified, the physics problems remain daunting; hence, the reason why nuclear testing was so important to the past program. Both the classification of information and technical complexity of the issues form natural barriers to public communication. The technical complexity alone engenders significant debate among qualified experts, especially in the area of high energy density physics. This PEIS attempts to explain the weapon physics issues in an unclassified, comprehensible manner regarding its relation to mission purpose and need (chapter 2), proposed actions and alternatives (section 3.3), and project-specific technical detail (Volume III). In the absence of nuclear testing, there are two basic alternatives: (1) rely on existing facilities as sources of experimental data described by the No Action alternative, and (2) pursue the enhanced capability of the proposed facilities to provide the sources of experimental data needed.

Role of Existing Experimental Facilities. In DOE's technical judgment, the existing facilities described by the No Action alternative are inadequate to meet the challenge of assessing and certifying a safe and reliable stockpile over the longer term. It is also DOE's technical judgment that it is impossible to speculate at this time whether any of the existing facilities could be retired, because they would be obsolete or redundant, as a result of a decision to construct and operate any or all of the three proposed new stewardship facilities. The uncertainties inherent in the R&D nature of the stewardship program would make that kind of exercise essentially guesswork. The development of machines to simulate the intricacies of a nuclear detonation requires a highly sophisticated scientific R&D program. It very likely will take 5 to 10 years to begin obtaining reliable data from the new facilities. Until those facilities are operational, DOE cannot reliably predict how the additional capabilities they provide will mesh with the capabilities of previously existing machines to further the goals of the Program. It is only through incremental advances in the state of the science that decisions can eventually be made regarding the retirement of obsolete or redundant facilities.

DOE is committed to making maximum efficient use of the stewardship capabilities at its disposal. However, it is not reasonable to speculate at this time about how future stewardship requirements might affect existing facilities and capabilities.

Next Generation Experimental Facilities. Commentors suggested that potential next generation experimental facilities be analyzed as part of the proposed action. This PEIS includes a discussion of potential next-generation experimental facilities and the reasons why they are not proposed actions or alternatives (sections 2.5 and 3.3.4). These facilities, while contemplated on the basis of anticipated technical need, have not reached the stage of design maturity through R&D for DOE to include a decisionmaking analysis at this time. However, this PEIS does broadly describe, in general terms or by reference, what is known today about their potential environmental impacts. The environmental impacts from these facilities as contemplated today would not be significantly different from existing "similar" facilities. By characterizing the potential impacts in this way, the decisionmaker will be aware of the potential program-level cumulative impacts of the next-generation facilities when deciding whether to pursue a program of enhanced experimental capability. If DOE proposes to construct and operate such facilities in the future, appropriate NEPA review will be performed.

New Weapon Design. Commentors have suggested that the proposal for enhanced experimental capabilities is directed more at the capability to design new weapons in the absence of nuclear testing than at maintaining the safety and reliability of the existing stockpile and that stewardship alternatives could be different if the facilities were directed only at maintaining the existing stockpile. This PEIS explains why these capabilities are needed to maintain the safety and reliability of a smaller, aging stockpile in the absence of nuclear testing (chapter 2). The existing U.S. stockpile of nuclear weapons is highly engineered and technically sophisticated in its design for safety, reliability, and performance. The stewardship capabilities required to make technical judgments about the existing stockpile are likewise technically sophisticated; therefore, it would be unreasonable to say that these stewardship capabilities could not be applied to the design of new weapons, albeit with less confidence than if new weapons could be nuclear tested.

However, the development of new weapon designs requires integrated nuclear testing such as occurs in nuclear explosive tests. Short of nuclear testing, no single stockpile stewardship activity, nor any combination of activities, could confirm that a new-design weapon would work. In fact, a key effect of a "zero-yield" CTBT would be to prevent the confident development of new-design weapons. National security policy requires DOE to maintain the capability to design and develop new weapons, and it will be a national security policy decision to use or not use that capability. Choosing not to use enhanced experimental capability for new weapons designs would not change the technical issues for the existing stockpile and, therefore, the stewardship alternatives would not change.

The issue of new-design weapons is separate from DOE's need to perform modifications to existing weapons that require research, design, development, and testing. The phrase used in this PEIS, "without the development and production of new-design weapons," is meant to convey the fact that the historical continuous cycle of large scale development and production of new weapons designs replacing older weapon designs has been halted. For example, during the 1980s, about a dozen new-design weapons were in full-scale development or production. Over the decade, production of new-design weapons replaced dismantled weapons nearly one for one. Today, only modifications to parts of existing weapons are being performed or planned; dismantlement has continued. This results in a smaller, aging stockpile that must be assessed and certified without nuclear testing. This is now the primary focus of the stewardship program.

Nonproliferation. Commentors have suggested that enhanced experimental capability is a proliferation risk. The national security policy framework discussed in this PEIS seeks a new balance between U.S. arms control and nonproliferation objectives and U.S. national security requirements for nuclear deterrence while pursuing these objectives (section 2.2). In addition, a discussion is provided on some of the more difficult issues that must be considered in determining the balance, including a discussion of experimental capability (section 2.6). In particular, the issue of nonproliferation and the proposed NIF was studied in detail. The study, prepared by the DOE Office of Arms Control and Nonproliferation, has been the subject of extensive public involvement, interagency review, and review by outside experts. The study concluded that the technical proliferation concerns of NIF are manageable and can therefore be made acceptable and that NIF can contribute positively to U.S. arms control and nonproliferation policy goals (appendix section I.2.1 of Volume III). NIF is a proliferation concern because of its broader scientific applications and expected frequent use by researchers worldwide, and, like the other proposed enhanced experimental facilities because of its possible relevance to the development of new weapon designs. However, the development of new weapon designs requires integrated testing. None of the proposed facilities, either alone or together, could perform such integrated testing of new concepts, and therefore cannot replace nuclear testing for the development of new weapon designs. The role of these facilities will be to help assess and certify the safety and reliability of the nuclear weapons remaining in the stockpile in the absence of nuclear testing. The national security policy framework and the technical issues that drive the proposed action for enhanced experimental capability remain the same.

Subcritical Experiments. With regard to the treatment of ongoing stewardship activities or enhanced experimental capability, subcritical experiments are an example of how changes in terminology have caused some confusion about what is evaluated in this PEIS under the No Action alternative. Subcritical experiments have been conducted at NTS over many years. Historically, operations at NTS have included tests or experiments that included both HE and special nuclear materials that were intended to produce no nuclear yield or negligible nuclear energy releases. These experiments frequently remained subcritical (i.e., they did not achieve self-sustaining fission chain reactions). The term "subcritical experiments" does not define a new form of activity or mission. It is intended to underscore the fact that in the future such experiments will be configured to ensure that the condition of criticality cannot be achieved. This issue has been clarified in the NTS Site-Wide EIS.

3.1.2.3 *Safe and Reliable Stockpile*

Some commentors have suggested that nuclear weapon reliability is not important in the post-Cold War era. National security policy as established by the President and Congress requires a safe and reliable stockpile. In order for the nuclear deterrent to be credible within the current national security policy framework, it must be reliable in a militarily effective way. A program designed to ensure the safety but not the reliability of the stockpile would require DOE to speculate on an alternate concept of nuclear deterrence and a national security policy framework to support it. See also the discussion of denuclearization in section 3.1.2.4.

Commentors have also suggested acceptance of lower standards of reliability as an alternative to enhanced stewardship capabilities. This PEIS explains how the assessment and certification of nuclear performance is carried out, and how this process differs from the more conventional statistical methods used for assessing reliability of the nonnuclear portion of the weapon. Assessment and certification of nuclear performance is a technical judgment by the weapons laboratories based on scientific theory, experimental data, and computational modeling (sections 2.4.1 and 2.3). The question is not whether to accept a lower standard of nuclear performance (less nuclear explosive yield), but whether or not there is a technical basis to confidently know how well the weapon will perform at all. Enhanced stewardship capability is focused on the technical ability to confidently judge nuclear safety and performance in the absence of nuclear testing.

Aside from being inconsistent with national security policy, attempting to separate weapon safety and reliability is more technically complex than it sounds. A modern nuclear weapon is highly integrated in its design for safety, reliability, and performance. It contains electrical energy sources and many explosive energy sources in addition to the main charge HE. The principal safety concern is accidental detonation of the HE causing dispersal of radioactive materials (plutonium and uranium). Modern weapons are designed and system-engineered to provide a predictable response in accident environments (e.g., fire, crush, or drop). However, because of the technical complexity of potential accident scenarios (i.e., combined environments) and the fact that complete nuclear weapons cannot be used for experimental data, assessment of the design and the effect of changes that might be occurring due to stockpile environments must rely on other sources of experimental data and complex computer modeling. Enhanced experimental capability specifically related to the weapon secondary is a nuclear performance concern. Enhanced computational capability in general, and enhanced experimental capability related to the weapon primary in particular, are both nuclear safety and performance concerns.

3.1.2.4 *Description of Alternative Approaches*

Commentors have suggested that DOE consider alternative forms of stewardship. While their comments are responded to in Volume IV, this section discusses DOE's consideration of the broad range of views on this issue. The Congressional Research Service report, Nuclear Weapons Stockpile Stewardship: Alternatives for Congress, December 14, 1995, provides a reasonable description of the various viewpoints on alternatives and a framework for discussion. (The report uses the term stockpile stewardship generically to describe the Stockpile Stewardship and Management Program.) The following discussion of alternative approaches is taken from the summary of that report.

> **Denuclearizers** would eliminate nuclear weapons worldwide in the foreseeable future, perhaps one to two decades. Until then, they would have a minimal U.S. stewardship program whose personnel, as curators of weapons knowledge, would monitor weapons. **Restorers** would maintain nuclear weapons with the only proven method, an ongoing program of research, development, design, testing, and production, downsized to meet post-Cold War needs. Three intermediate positions seek to maintain weapons indefinitely without nuclear testing. **Remanufacturers** believe that since current weapons have been tested and certified as meeting military requirements, this Nation can maintain them indefinitely by "remanufacturing"--reproducing them to the exact specifications of the originals. Remanufacturers would go to great lengths to do so in order to avoid risks that even slight changes to warheads might introduce. **Enhancers**, who take the Administration's position on stewardship, see identical remanufacture as impossible. They believe some changes in design, process, and materials are unavoidable and others are desirable. A robust science program, they hold, is the best that can be done without testing to monitor warheads, anticipate problems, modify warheads when problems arise, and revalidate stockpile effectiveness on an ongoing basis. They would have a small manufacturing program. **Maintainers** fall between remanufacturers and enhancers. They focus on how to maintain warheads. They prefer to avoid changes to warheads but would not go to great lengths to do so. They view a strong science program as essential, but only to the extent that its elements connect directly to maintaining weapons. They emphasize manufacturing as the ultimate guarantor of U.S. ability to solve warhead problems. They, along with enhancers, favor some link to testing if confidence cannot be maintained in any other way.

Beyond the broad overview of alternative approaches to stockpile stewardship and management, the main text of the report discusses variations within each of the five points of view. Given the political and technical complexity of the Program, many approaches can appear to be distinct or reasonable alternatives for detailed study. In fact, while the enhancer's viewpoint as described above most closely resembles the Program described in this PEIS, the Program actually embraces elements of all five viewpoints. The following discussion illustrates this point and focuses on the main issue(s) that, in DOE's view, eliminate the other approaches as distinct or reasonable alternatives for this PEIS.

Denuclearization. This approach is reflected in this PEIS to the extent that national security policy is pointed toward the goals of denuclearization. Since the end of the Cold War, more than 8,000 U.S. nuclear weapons have been dismantled, no new-design weapons are being produced, three former nuclear weapons industrial plants have been closed, and the United States is observing a nuclear test moratorium and seeking a "zero-yield" CTBT. Maintenance of a safe and reliable stockpile is not inconsistent with working toward the NPT goal of eliminating nuclear weapons worldwide at some unspecified time in the future. However, denuclearization is not a reasonable alternative for this PEIS because it is not feasible based on current national security policy.

The main issue discussed in this section is consideration of an alternative with a very small (10s or

100s) or zero stockpile. Two of the stockpile sizes analyzed in this PEIS, a START I Treaty- and START II protocol-sized stockpile, are the only ones currently defined and directed by national security policy. The PEIS also analyzes a hypothetical 1,000 weapon stockpile for the purpose of a sensitivity analysis for manufacturing capacity decisions. The NWSM specifies the types of weapons and quantities of each weapon type by year (section 1.1). The NWSM is developed based on DOD force structure requirements necessary to maintain nuclear deterrence and comply with existing arms control treaties while pursuing further arms control reductions. This PEIS explains the complexity of this process and why DOE does not believe it reasonable to speculate using a large number of arbitrary assumptions (section 2.2). DOE has considered that a future national security policy framework could define a path to a smaller stockpile. However, DOE has the following perspective on this issue.

Stockpile stewardship capabilities are currently viewed by the United States as a means to further U. S. nonproliferation objectives in seeking a "zero-yield" CTBT. Likewise, it would be reasonable to assume that U.S. confidence in its stewardship capabilities would remain as important, if not more important, in future arms control negotiations to reduce its stockpile further. The path to a very small (10s or 100s) or zero stockpile would require the negotiation of complex international treaties, most likely with provisions that require intrusive international verification inspections of nuclear weapons related facilities. Therefore, DOE believes it reasonable to assume that complex treaty negotiations, when coupled with complex implementation provisions, would likely stretch over several decades. On a gradual path to a very small or zero stockpile, stockpile size alone would not change the purpose and need, proposed actions, and alternatives in this PEIS as they relate to stewardship capabilities. The issues of maintaining the core competencies of the United States in nuclear weapons, and the technical problems of a smaller, aging stockpile in the absence of nuclear testing, remain the same.

On a gradual path to a very small or zero stockpile, this PEIS evaluates reasonable approaches to stockpile management capability and capacity. At some point on this path, further downsizing of existing industrial plants or the alternative of consolidating manufacturing functions at stewardship sites would become more attractive as manufacturing capacity becomes a less important consideration. However, in the near term, the preferred alternative of downsizing the existing industrial plants would still be a reasonable action because the projected downsizing investment pays back within a few years through reduced operating expense; in addition, the downsizing actions are consistent with potential future decisions regarding plant closures. In regard to the proposed action of reestablishing pit manufacturing capability, DOE does not propose to establish higher manufacturing capacities than are inherent in the reestablishment of the basic manufacturing capability. In developing the criteria for reasonable stockpile management alternatives, DOE was careful not to propose the introduction of significant new types of environmental hazards to any prospective site. On a gradual path to a very small or zero stockpile, stockpile size alone would not change the purpose and need, proposed actions, and alternatives in this PEIS with regard to stockpile management capabilities and capacities.

To achieve eventual denuclearization, some commentors have asserted that DOE should adopt a passive curatorship approach to maintaining the declining nuclear weapons stockpile. The concept of curatorship is already being implemented at the existing sites in the form of knowledge preservation programs. While not necessary in an era of continuous development and production of new-design weapons and nuclear testing, knowledge preservation is now part of DOE's overall effort to maintain core competency in the weapons complex. However, as an inherently imperfect reconstruction, this effort can never ensure completeness of information nor relevance to future stockpile problems. More importantly, knowledge preservation does not address the fundamental issue of confidence in future technical judgments about issues that are yet to arise regarding the safety and performance of the stockpile. In highly technical matters, confidence arises from having appropriate data to support conclusions. In the absence of nuclear testing, the science-based approach to stockpile stewardship is focused on achieving the capability to acquire appropriate data.

From an environmental impact point of view, this PEIS displays the environmental impacts of each site's ongoing Program operations on an annual basis. The impacts of alternatives for proposed actions are displayed individually on the same basis. If one assumes that denuclearization leads to eventual site closure, then this PEIS, together with the Tritium Supply and Recycling PEIS, presents the environmental impacts of closing the four remaining industrial plants. While this PEIS does not directly consider the closure of the weapons laboratories and NTS, it is not at all clear what nuclear weapons capabilities the U.S. would retain even if it decided on a zero stockpile. However, the environmental impacts of the ongoing Program (No Action alternative) are essentially what would be phased out, with or without the proposed actions. DOE does not believe that speculative combinations of this data on speculative time lines provides any useful information for decisionmaking.

Restoration. The restorer's point of view is reflected in this PEIS to the extent that current national security policy requires DOE to maintain all the historical capabilities of the Program, including the capability for new-design weapons and nuclear testing. However, restoration is not a reasonable alternative for this PEIS because it requires a national security policy decision to reverse the constraints placed on the Program, namely, by resuming nuclear testing and new-design weapons production.

The environmental impacts of the restoration approach would be the same as those described in this PEIS to the extent that such a decision did not require manufacturing capacities higher than analyzed in this PEIS. In addition, this PEIS includes a brief description of the environmental impacts of nuclear testing (section 4.12); the Site-Wide EIS for NTS contains detailed information.

Remanufacturing . The remanufacturer's point of view is reflected in this PEIS by the fact that remanufacturing to specification will be attempted when possible and when appropriate to the problem being solved. With more than a half dozen different weapon types projected to remain in the stockpile, and with each weapon type containing thousands of parts, remanufacturing will undoubtedly occur for a significant number of repair and replacement activities. However, remanufacturing is not reasonable as a distinct exclusive alternative to the ongoing stockpile stewardship program or the proposed action of enhanced experimental capability for the technical reasons discussed below. In addition, it would not be a reasonable alternative because it does not fully support national security policies that require the conduct of a science-based stockpile stewardship and maintenance of the capability to design and produce new weapons.

Remanufacturing weapon components to their original specification, or maintaining weapons to their original design specifications, would superficially appear to be a reasonable approach to maintaining the safety and reliability of the stockpile in the absence of nuclear testing. Precise replication, however, is often not possible. Subtle changes in materials, processing, and fabrication techniques are an ever-present problem. In some cases, specialty materials and components become unavailable for commercial or environmental reasons. Implicit in the remanufacturing assumption is that the design blueprint, manufacturing process, and the materials used are specified in exact detail in every way. However, there is an unwritten element of "know how" that knowledgeable and experienced personnel contribute to any complicated manufacturing process (for this reason, controlling the acquisition of "know-how" is a major nuclear weapons nonproliferation objective). Materials and processes are not always specified in important ways because, at the time, they were not known to be important. The problem is illustrated by the following hypothetical example:

A material produced for a critical weld has a specification for a trace impurity; the manufacturing process consistently produced the material with a trace impurity less than the maximum allowed and the welds were satisfactory; the manufacturing process is changed for some reason, such as cost or environmental concerns; the material is now being produced with less trace impurity than before the process was changed; the material is still within specification; however, the welds are no longer satisfactory; it was unknown at the time that the higher level of the trace impurity was necessary to produce a satisfactory weld.

While remanufacturing sounds simple in principle, it is likely in fact to present complex issues of design, manufacturing process, and material variables. A simplified view of remanufacturing cannot serve as a "stand alone" manufacturing approach, let alone an alternative approach to enhanced stewardship capability. In the absence of underground nuclear testing, nuclear components (pits and secondaries) cannot be functionally tested. Stewardship capabilities provide the analytical tools (experimental and computational) to assess the significance of a problem observed during surveillance and to decide if the problem should be fixed; and if fixed, to certify that the fix will work (section 2.4.1). In the past, the decision to fix or not fix an observed problem could be made with nuclear testing (section 2.3). Stockpile stewardship strategies focus on the basic material science and the enhanced experimental and computational tools necessary to better predict age-related defects and to make sound technical judgments on nuclear safety and performance in the absence of nuclear testing.

The DARHT EIS (DOE/EIS-0228, section 2.3.2) provides an additional discussion of the limitations of a remanufacturing-to-specification approach. It discusses, as an example, the actions taken to evaluate and resolve unanticipated deterioration of HE in the now-retired W68 warhead for a submarine-launched ballistic missile. In that case it was necessary to replace the HE with a more chemically stable formulation. In addition, some other materials were no longer commercially available, requiring changes in the rebuilt weapons. Nuclear testing was ultimately used to verify that the necessary changes were acceptable. DOE does not consider it feasible to maintain all potentially obsolescent commercial sources and processes used for materials in existing weapons; aging would still occur in stored reserves of such materials.

With regard to stockpile management, remanufacturing without enhanced stewardship capability would also have notable drawbacks. DOE plans to maintain the capability to produce secondaries, and proposes to reestablish the capability to produce pits, by producing small quantities (10s) of each annually to maintain capability. This capacity should be sufficient to replace components attrited from the stockpile by surveillance testing. Remanufacturing these components, without the enhanced stewardship analytical capability to determine if and when replacement is necessary, is likely to require higher levels of production than DOE believes necessary to maintain production capability. Also, remanufacturing a nuclear component to the original specifications will not prevent age-related problems related to those specifications from recurring. Since these components use plutonium and uranium, radiation exposure to personnel and generation of radioactive waste would also be higher than necessary. If repeated remanufacturing were required, further unnecessary risks would result from additional weapon assembly/disassembly (A/D) operations and additional transport of nuclear components between sites.

From an environmental impact point of view, the remanufacturing concept would have greater impacts for the proposed action of reestablishing pit capability because DOE proposes to use a cleaner, less waste-generating process than was used at the Rocky Flats Plant. All other environmental impacts would not be distinguishable from those described in this PEIS because existing manufacturing processes form the Program baseline.

Maintenance . The maintainer's point of view is reflected in this PEIS to the extent that it is consistent with the No Action alternative. Under this approach, weapons maintenance would be the focus of stockpile stewardship. This approach would rely on enhanced surveillance and dual revalidation, whereby the weapons laboratories would conduct independent technical examinations of weapons to validate their safety and reliability. Any problems that arose would be solved through either remanufacture or "fixes" proposed by the weapons laboratories. These attributes are all part of the ongoing Program that will continue into the future. The principal difference between the Program as presented in this PEIS and this point of view is differing judgment on how much enhanced experimental capability would be needed to assess and certify a safe and reliable stockpile over the long term. The maintainers believe that less (or no) additional experimental capability would be required if DOE placed more emphasis on enhanced surveillance and dual revalidation.

DOE believes that this approach would not provide a sufficient basis for assessing and certifying the safety and reliability of the stockpile. Although enhanced surveillance will play an important role in the future of the Program, it serves a limited purpose. Surveillance activities identify stockpile problems through the examination and analysis of weapons sampled from the stockpile. An enhanced surveillance program would serve to identify problems with greater confidence and increased warning time. However, it would not provide a sole basis for assessing the significance of the problem or determining its solution. The ability of the laboratories to validate that the problem has been corrected, in the absence of nuclear testing, depends on their experimental and computational capabilities. In DOE's judgment, as explained in section 2.4, those capabilities are inadequate. Therefore, to the extent that maintenance would not provide sufficient enhanced experimental capability, it is not a reasonable alternative.

From an environmental impact point of view, the maintenance concept is not distinguishable from the impacts of the No Action alternative for stockpile stewardship and the proposed actions for stockpile management.

3.1.3 Underground Nuclear Testing

The last underground nuclear test conducted by the United States was in 1992. Since then, the United States has observed a moratorium on underground nuclear testing while pursuing a CTBT. On August 11, 1995, the President announced that, "one of my Administration's highest priorities is to negotiate a Comprehensive Test Ban Treaty to reduce the danger posed by nuclear weapons proliferation." In this announcement, the President also stated that he would seek a "zero yield" CTBT, which would "ban any nuclear weapon test explosion or any other nuclear explosion immediately upon entry into force." The President declared his commitment "to do everything possible to conclude the ComprehensiveTest Ban Treaty negotiations as soon as possible so that a treaty can be signed next year."

As part of this announcement, the President also stated that he had been assured "that we can meet the challenge of maintaining our nuclear deterrent under a Comprehensive Test Ban Treaty through a science-based stockpile stewardship program without nuclear testing." However, the President cautioned that "while I am optimistic that the stockpile stewardship program will be successful, as President, I cannot dismiss the possibility, however unlikely, that the program will fall short of its objectives." The President went on to say further: "In the event that I were informed by the Secretary of Defense and Secretary of Energy ... that a high level of confidence in the safety or reliability of a nuclear weapons type which the Secretaries consider to be critical to our nuclear deterrent could no longer be certified, I would be prepared, in consultation with Congress, to exercise our `supreme national interests' rights under the Comprehensive Test Ban Treaty in order to conduct whatever testing might be required."

One of the primary purposes of the Stockpile Stewardship and Management PEIS is to evaluate ways of maintaining a continued safe and reliable nuclear deterrent in the absence of nuclear testing. Thus, the proposal described in this PEIS does not include nuclear testing. However, because it is possible--although not probable--that the United States might one day exercise its "supreme national interests" rights and conduct underground nuclear testing to certify the safety and reliability of its nuclear weapons, this PEIS and the NTS Site-Wide EIS include an analysis of the environmental impacts of underground nuclear testing at NTS.

3.1.4 No Action Alternative

Under the No Action alternative, DOE would not take the actions proposed in this PEIS. Activities associated with stockpile stewardship and management would continue at the Complex sites using existing facilities, and no significant changes would occur.

With regards to stockpile stewardship, under the No Action alternative, activities at the three weapons laboratories (LANL, LLNL, and SNL) and NTS would continue using existing experimental facilities, but the proposed new experimental facilities would not be constructed. The major No Action facilities for the various stockpile stewardship functions include: the DARHT Facility and the Pulsed High Energy Machine Emitting X-Rays (PHERMEX) Facility at LANL, the Flash X-Ray (FXR) Facility at LLNL, and the Big Explosives Experimental Facility (BEEF) at NTS for studying the physics of the weapons primary; the Nova Facility at LLNL and the Pegasus II Facility at LANL for studying physics of the weapons secondary; and the Saturn and Particle Beam Fusion Accelerator (PBFA) Facilities at SNL for studying weapon effects. These facilities are more fully described in section 3.3, while the major activities at sites involved with stockpile stewardship are described in section 3.2.

Under the No Action alternative, stockpile management functions would remain at their current locations, no further rightsizing or consolidation beyond currently planned initiatives would take place, and pit manufacturing capability would not be reestablished. The major No Action facilities for the various stockpile management functions include: *A/D* and HE fabrication at Pantex; secondary and case fabrication at Y-12; nonnuclear fabrication facilities primarily at Kansas City Plant (KCP), with smaller capabilities at LANL and SNL; R&D plutonium fabrication capabilities at LANL and LLNL; and tritium supply and recycling facilities at SRS per the decisions in the Tritium Supply and Recycling ROD. These facilities are more fully described in section 3.4, while the major activities at sites involved with stockpile management are described in section 3.2.

From a programmatic perspective, the No Action alternative would not ensure DOE's ability to maintain core U.S. competencies in nuclear weapons in the long term while also maintaining a safe and reliable, smaller, aging U.S. stockpile. Because this is not acceptable, the No Action alternative is not considered to be reasonable. However, in accordance with the CEQ regulations, the No Action alternative is presented and assessed in this PEIS.

3.2 Alternative Sites

Eight locations (ORR, SRS, KCP, Pantex, LANL, LLNL, SNL, and NTS) are being considered as alternative sites for stockpile stewardship and management missions. All of these sites are currently performing DOE Office of the Assistant Secretary for Defense Programs (DP) activities.

3.2.1 Site Selection

One important strategy of the Stockpile Stewardship and Management Program is to maximize the use of existing infrastructure and facilities as the Complex transitions to be smaller and more efficient in the 21st century. Consequently, only those sites with existing infrastructure or facilities capable of supporting a given stockpile stewardship or stockpile management mission are considered reasonable site alternatives for detailed study in this PEIS. Sites without a technical infrastructure or facilities for a given mission would require significant new construction that would be costly and would create excessive technical risk compared to sites with existing infrastructure and facilities.

For stockpile stewardship, the three existing weapons laboratories and NTS are being considered for new or upgraded stockpile stewardship facilities. This is because the weapons testing mission and stockpile stewardship have always been primary responsibilities of the weapons laboratories and NTS, and existing facilities and capabilities can be built upon to meet the stewardship mission.

For stockpile management, all of the eight current Complex sites could be considered for one or more stockpile management functions. The three weapons laboratories and NTS have various production and manufacturing capabilities and infrastructure that could be improved upon to meet the stockpile management missions. As an example, for the A/D mission there are two reasonable site alternatives: Pantex, which currently performs this mission and has facilities that could be downsized for the future A/D mission; and NTS, which has a relatively new facility known as the Device Assembly Facility that could be upgraded and expanded to perform the A/D mission. Other sites, such as SRS or ORR, that do not have existing facilities or experience necessary to perform the A/D mission, are unreasonable options relative to the sites that have existing A/D facilities. This same logic is similarly applied for the other stockpile management missions.

3.2.2 Oak Ridge Reservation

ORR covers approximately 13,980 hectares (ha) (34,545 acres) in Oak Ridge, TN. ORR contains the Oak Ridge National Laboratory (ORNL), Y-12, and the < k-25 site (k-25). the primary focus of ornl is on conducting basic and applied scientific research and technology development. y-12 engages in national security activities, which are included in this peis. the oak ridge gaseous diffusion plant, which has been shut down, is located at k-25. k-25 now serves as an operations center for environmental restoration and waste management programs.

Table 3.2.2-1.-- ***Current Major Missions at Oak Ridge Reservation***

Mission	Description	Sponsor
Weapon Components	Maintain capability to fabricate uranium and lithium components and parts for nuclear weapons	Defense Programs (DP)
Stockpile Surveillance	Evaluation of components and subsystems returned from the stockpile	Defense Programs (DP)
Uranium and Lithium Storage	Store enriched uranium, depleted uranium, and lithium materials and parts	Defense Programs (DP)

Dismantlement	Dismantle nuclear weapon secondaries returned from the stockpile	Defense Programs (DP)
Special Nuclear Material	Process uranium	Defense Programs (DP); Nuclear Energy (NE)
Test Devices	Provide support to weapons laboratories	Defense Programs (DP)
Environmental Restoration and Waste Management	Waste management and decontamination and decommissioning activities at Oak Ridge National Laboratory and K-25	Environmental Management (EM)
Research and Development	Oak Ridge National Laboratory basic research and development in energy, health, and environment	Energy Research (ER); Environment, Safety, and Health (EH); Nuclear Energy (NE)
Isotope Production	Oak Ridge National Laboratory produces radioactive and stable isotopes not available elsewhere	Nuclear Energy (NE)

Y-12 receives, processes, and provides interim storage for unirradiated enriched uranium returned from dismantled weapons and DOE sites as described in the *Environmental Assessment and Finding of No Significant Impact, Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Level at the Y-12 Plant, Oak Ridge, Tennessee* (DOE/EA-0929). The capacity of existing processing and storage facilities is sufficient to accommodate all of the forecasted amounts of enriched uranium that would be placed in interim storage. The current missions and functions are described in table 3.2.2-1.

Defense Program Activities. The ORR DP assignments are performed at Y-12 and include maintaining the capability to produce secondaries and cases for nuclear weapons, storing and processing uranium and lithium materials and parts, dismantling nuclear weapons secondaries returned from the stockpile, and providing special production support to DOE weapons laboratories and to other DOE programs. To accomplish its storage mission, some processing of special nuclear materials may be required to recover materials from the returned secondaries. In addition, Y-12 performs stockpile surveillance activities on the components it produces.

3.2.3 Savannah River Site

SRS, located on approximately 80,130 ha (198,000 acres) near Aiken, SC, was established in 1950.

The major nuclear facilities at SRS have included fuel and target fabrication facilities, nuclear material production reactors, chemical separation plants used for recovery of plutonium and uranium isotopes, a uranium fuel processing area, and the Savannah River Technology Center, which provides process support. Historically, DOE has produced tritium at SRS; however, DOE has not produced new tritium since 1988. Plutonium and spent nuclear fuel processing to produce material for nuclear weapons at SRS, have been terminated. DOE is currently preparing a separate EIS to explore the use of these facilities to stabilize existing quantities of plutonium residues as well as other nuclear materials. Tritium recycling operations will continue at SRS with the Replacement Tritium Facility conducting the majority of these operations. Tritium decays and must be replaced periodically to meet weapons specifications. Tritium recycling facilities empty tritium from weapons reservoirs, purify it to eliminate the helium decay product, and fill replacement reservoirs with specification tritium for nuclear stockpile weapons. Filled reservoirs are delivered to Pantex for weapons assembly and directly to the Department of Defense as replacements for weapons reservoirs. As part of the previous nonnuclear consolidation, SRS is also in the process of receiving some of the tritium processing and reservoir surveillance functions previously performed at the Mound Plant in Miamisburg, OH. The current missions at SRS are shown in table 3.2.3-1.

Table 3.2.3-1.-- ***Current Major Missions at Savannah River Site***

Mission	***Description***	***Sponsor***
Tritium Recycling and Reservoir Surveillance	Operate H-Area tritium facilities	Defense Programs (DP)
Stockpile Surveillance	Evaluation of reservoir components returned from stockpile	Defense Programs (DP)
Research and Development	Savannah River Technology Center technical support of Defense Programs, Environmental Management, and Nuclear Energy programs	Defense Programs (DP); Environmental Management (EM); Nuclear Energy (NE)
Stabilize Targets, Spent Nuclear Fuels, and Other Nuclear Materials	Operate F- and H-Canyons	Environmental Management (EM)
Waste Management	Operate waste processing facilities	Environmental Management (EM)
Environmental Monitoring and Restoration	Operate remediation facilities	Environmental Management (EM)
Space Program Support	Provide plutonium-238 for space program missions	Nuclear Energy (NE)

Defense Program Activities. In the past, the SRS complex for the production of nuclear materials consisted of five reactors (the C-, K-, L-, P-, and R-Reactors) in addition to a fuel and target fabrication plant, two target and spent nuclear fuel chemical separation plants, a tritium-target processing facility, a heavy water rework facility, and waste management facilities.

The K-Reactor, the last operational reactor, was put into cold standby status in 1992 with no planned provision for restart. SRS is now conducting tritium-recycling operations in support of stockpile requirements using dismantled weapons as the tritium supply source.

3.2.4 Kansas City Plant

KCP is situated on approximately 57 ha (141 acres) of the 121-ha (300-acre) Bannister Federal Complex, which is located within incorporated city limits 19 km (12 mi) south of the downtown center of Kansas City, MO. The plant shares the Bannister Federal Complex site with other Federal agencies: the General Services Administration, the U.S. Marine Corps, the Federal Aviation Administration, the National Archives, and the Internal Revenue Service, among others.

KCP produces and procures nonnuclear electrical, electronic, electromechanical, mechanical, plastic, and nonfissionable metal components for the nuclear weapons program. Current missions at KCP are shown in table 3.2.4-1.

Table 3.2.4-1.-- ***Current Major Missions at Kansas City Plant***

Mission	Description	Sponsor
Nonnuclear Component Fabrication	Manufacture electrical, electronic, electromechanical, plastic, and metallic components; fuzing and firing systems; and composite structures	Defense Programs (DP)
Telemetry Assembly	Manufacture telemetry assemblies and neutron detectors for flight test assemblies	Defense Programs (DP)
Test Equipment Design and Fabrication	Manufacture test equipment capable of performing electrical and mechanical tests on nonnuclear weapon components	Defense Programs (DP)
Stockpile Surveillance	Evaluation of components and subsystems returned from stockpile	Defense Programs (DP)

Defense Program Activities. KCP is currently the principal nonnuclear fabrication facility within the Complex. As such, KCP produces a variety of nonnuclear components and provides surveillance testing and repair services for these components.

3.2.5 Pantex Plant

Pantex is located about 27 km (17 mi) northeast of Amarillo, TX, on approximately 4,119 ha (10,177 acres) of DOE-owned land. Pantex missions are the fabrication of chemical HE for nuclear weapons, assembly, disassembly, maintenance, and surveillance of nuclear weapons in the stockpile, dismantlement of nuclear weapons being retired from the stockpile, and interim storage of plutonium components from dismantled weapons. Weapons activities involve the handling (but not processing) of uranium, plutonium, and tritium components, as well as a variety of nonradioactive hazardous or toxic chemicals. The current Pantex missions and functions are listed in table 3.2.5-1.

In the near term, weapons dismantlement and plutonium pit storage activities will dominate activities at Pantex. Although analysis in the *Environmental Assessment for Interim Storage of Plutonium Components* (DOE/EA-0812) found that Pantex has a sufficient number of storage magazines to safely accommodate 20,000 pits, Pantex only has authority to provide interim storage for up to 12,000 pits as described in a Finding of No Significant Impact (59 FR 3674) on January 26, 1994. Decisions regarding additional pit storage beyond 12,000 pits are being considered in the *Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (DOE/EIS-0225).

Defense Program Activities. The main mission of Pantex is the A/D of nuclear weapons. Other than HE, virtually all other components of the weapons come from other DOE or DOD sites. Modification, maintenance, and repair activity at Pantex involves the disassembly of nuclear weapons so that one or more of the components can be repaired, replaced, or modified. After replacing components, the weapons are reassembled and returned to the stockpile. Pantex surveillance activities involve weapon disassembly, laboratory testing of various components, and rebuilding weapons for shipment back to the stockpile. Production of HE components includes processing and machining main charge subassemblies and fabrication of mock components for use in weapon test assemblies, manufacturing small HE components, producing a variety of explosive materials from chemical reactants and commercially produced explosives, and evaluating explosive materials and components through a variety of analytical, mechanical, and explosive tests. Retired weapon dismantlement is the predominant current activity at Pantex. Weapons are returned from DOD, disassembled, and components are either destroyed, reclaimed, or returned to the original manufacturer. The exception is plutonium pits, which are stored onsite on an interim basis.

Table 3.2.5-1.-- ***Current Major Missions at Pantex Plant***

Mission	Description	Sponsor
Weapons Assembly/ Disassembly	Assemble and disassemble nuclear weapons as necessary	Defense Programs (DP)

Weapons Dismantlement	Dismantle nuclear weapons no longer required	Defense Programs (DP)
Weapons Maintenance	Retrofit, maintain, and repair stockpile weapons	Defense Programs (DP)
Stockpile Surveillance	Disassembly and inspection	Defense Programs (DP)
High Explosive Components	Manufacture for use in nuclear weapons	Defense Programs (DP)
Plutonium Storage	Provide interim storage of pits	Defense Programs (DP)
Test/training Programs	Assemble nuclear explosive-like assemblies for training or flight test	Defense Programs (DP)
Waste Management	Provide waste management and decontamination and decommissioning activities	Environmental Management (EM)

3.2.6 Los Alamos National Laboratory

LANL was established as a nuclear weapons design laboratory in 1943 and was formerly known as the Los Alamos Scientific Laboratory. Its facilities are located on about 11,300 ha (28,000 acres) about 40 km (25 mi) northwest of Santa Fe, NM.

LANL is a multidisiciplinary research facility engaged in a variety of programs for DOE and other Government agencies. Its primary mission is the nuclear weapons Stockpile Stewardship and Management Program and related emergency response, arms control, and nonproliferation and environmental activities. It conducts R&D activities in the basic sciences, mathematics, and computing with applications to these mission areas and to a broad range of programs including: nonnuclear defense; nuclear and nonnuclear energy; atmospheric, space, and geosciences; bioscience and biotechnology; and the environment. Table 3.2.6-1 illustrates current missions at LANL. A more detailed discussion of the complete spectrum of laboratory activities can be found in the current LANL Institutional Plan, which is unclassified and available to the public.

Table 3.2.6-1.-- ***Current Major Missions at Los Alamos National Laboratory***

Mission	Description	Primary Sponsor
Nuclear Weapons	Stockpile stewardship; production of nonnuclear components; pit surveillance; tritium production R&D	Defense Programs (DP)

Arms Control and Nonproliferation	Intelligence analysis; technology R&D; treaty verification; fissile material control; counterproliferation analysis	Nonproliferation and National Security (NN)
Energy Research, Science and Technology	Neutron science (e.g., at LANSCE); scientific computing; fusion energy; health and environmental research; high energy and nuclear physics; basic energy sciences	Energy Research (ER)
Energy Technology	Fossil; nuclear	Energy Efficiency and Renewable Energy (EE)
Environmental	Environmental restoration; waste management and treatment	Environmental Management (EM)
Work for Others	Conventional weapons; computing, modeling and simulation	DOD and various other agencies

In regard to nuclear weapons, LANL is responsible for the design of the nuclear explosive package in certain U.S. weapons (LLNL has this responsibility for other weapons.) LANL maintains research, design, development, testing (including nuclear testing), surveillance, assessment, and certification capabilities in support of the Stockpile Stewardship and Management Program. In addition, since the end of the Cold War, LANL now conducts the pit surveillance program and some manufacturing of nonnuclear components due to termination of the nuclear weapons mission at the Mound, Pinellas, and Rocky Flats Plants.

3.2.7 Lawrence Livermore National Laboratory

LLNL was established as a nuclear weapons design laboratory in 1952 and was formerly known as the Lawrence Radiation Laboratory. Its facilities are located on about 332 ha (821 acres) in Livermore, CA. A 2,800-ha (7,000-acre) auxiliary testing range known as Site 300 is located about 29 km (18 mi) east of the Livermore Site. Site 300 is used primarily for HE testing and other experimentation, such as particle beam research.

LLNL is a multidisiciplinary research facility engaged in a variety of programs for DOE and other Government agencies. Its primary mission is the nuclear weapons stewardship program and related emergency response, arms control, and nonproliferation activities. It conducts research and development activities in the basic sciences, mathematics, and computing, with applications to these mission areas and to a broad range of programs including: nonnuclear defense; nuclear and nonnuclear energy; atmospheric, space, and geosciences; bioscience and biotechnology; and the environment. Table 3.2.7-1 illustrates current missions at LLNL. A more detailed discussion of the complete spectrum of laboratory activities can be found in the current LLNL Institutional Plan which is unclassified and available to the public. In regard to nuclear weapons, LLNL is responsible for the design of the nuclear explosive package in certain U.S. weapons (LANL has this responsibility for other weapons). LLNL maintains research, design, development, testing (including nuclear testing), surveillance, assessment, and certification capabilities in support of the Stockpile Stewardship and Management Program.

Table 3.2.7-1.-- ***Current Major Missions at Lawrence Livermore National Laboratory***

Mission	Description	Primary Sponsor
Nuclear Weapons	Stockpile stewardship	Defense Programs (DP)
Arms Control and Nonproliferation	Intelligence analysis; treaty verification; fissile material control; counterproliferation analysis	Nonproliferation and National Security (NN)
Energy Research, Science and Technology	Scientific computing; fusion energy; health and environmental research; high energy and nuclear physics; basic energy sciences	Energy Research (ER)
Energy Technology	Nuclear safety; uranium - AVLIS	Nuclear Energy (NE)
Environmental	Environmental restoration; waste management and treatment	Environmental Management (EM)
Radioactive Waste	Repository studies	Radioactive Waste (RW)
Work for Others	Conventional weapons; space	DOD and various other agencies

Note: AVLIS - Atomic Vapor Laser Isotope Separation.

3.2.8 Sandia National Laboratories

SNL was established as a nuclear weapons design laboratory in 1945. Its facilities are in three locations in the continental United States: Albuquerque, NM; Livermore, CA; and Tonopah, NV. The facilities discussed in this document refer only to the main Albuquerque site, which is located on about 1,150 ha (2,842 acres) of DOE property on Kirtland Air Force Base and an additional 6,072 ha (15,003 acres) provided to DOE through ingrant land from Kirtland Air Force Base, the State of New Mexico, and Isleta Pueblo.

SNL is a multidisiciplinary research and engineering facility engaged in a variety of programs for DOE and other Government agencies. Its primary mission is the nuclear weapons Stewardship and Management Program and related emergency, arms control, and nonproliferation activities. In addition, it conducts R&D activities in advanced manufacturing, electronics, information, pulsed power, energy, environment, transportation, and biomedical technologies. Table 3.2.8-1 illustrates current missions at SNL. A more detailed discussion of the complete spectrum of laboratory activities can be found in the current SNL Institutional Plan, which is unclassified and available to the public.

In regard to nuclear weapons, SNL is responsible for the design of nonnuclear components and related system engineering. It maintains research, design, development, testing (including nuclear testing), surveillance, assessment, and certification capabilities in support of the Program. In addition, because of the end of the Cold War, SNL now performs some nonnuclear manufacturing functions due to termination of the nuclear weapons mission at the Mound and Pinellas Plants.

Table 3.2.8-1.-- ***Current Major Missions at Sandia National Laboratories***

Mission	Description	Primary Sponsor
Nuclear Weapons	Stockpile stewardship; nonnuclear component production	Defense Programs (DP)
Arms Control and Nonproliferation	Intelligence support; policy analysis; verification and control	Nonproliferation and National Security (NN)
Energy Research, Science and Technology	Electric, geothermal, solar, wind and photovoltaics; coal, gas and petroleum; fusion; basic energy sciences	Energy Efficiency and Renewable Energy (EE); Fossil Energy (FE); Energy Research (ER)
Environmental	Environmentally conscious manufacturing; environmental restoration; waste management; HazMat transport	Environmental Management (EM)
Work for Others	Satellites; arming, fuzing, and firing systems; probabilistic risk assessment; transport packaging	DOD and various other agencies

3.2.9 Nevada Test Site

NTS occupies approximately 351,000 ha (867,000 acres) in the southeastern part of Nye County in southern Nevada. NTS is located about 104 km (65 mi) northwest of Las Vegas. It is a remote, secure facility that maintains the capability for conducting underground testing of nuclear weapons and evaluating the effects of nuclear weapons on military communications systems, electronics, satellites, sensors, and other materials. The first nuclear test at NTS was conducted in January 1951. Since the signing of the Threshold Test Ban Treaty in 1974, it has been the only U.S. site used for nuclear weapons testing. Approximately one-third of the land (located in the eastern and northwestern portions of the site) has been used for nuclear weapons testing, one-third (located in the western portion of the site) has been reserved for future missions, and one-third has been reserved for R&D and other facility requirements. Facilities include nuclear device assembly, diagnostic canister assembly, hazardous liquid spill, and the radioactive waste management site. In addition, Yucca Mountain, an area on the southwestern boundary of the site, is being evaluated by DOE for siting of a spent nuclear fuel and high-level waste (HLW) repository. While the primary purpose of Yucca Mountain is for commercial HLW, it is also slated to receive some defense HLW.

Activities at NTS are concentrated in several general areas. Most of the onsite work is related to DP activities, although there are DOE Office of Environmental Management (EM), other DOE, and non-DOE activities as well. NTS is a unique facility because it is a large open area into which access is tightly controlled, it has a substantial infrastructure, and it has the capability to handle and run tests with hazardous or radioactive materials. Because of these factors, activities other than nuclear testing, such as mobile missile transporter tests and nuclear rocket tests, have been carried out for other Federal departments and agencies. The current missions and functions of NTS are shown in table 3.2.9-1.

Defense Program Activities. The primary DP mission at NTS is to help ensure the safety and reliability of the Nation's nuclear weapons stockpile. This stewardship program includes maintaining the readiness and capability to conduct underground nuclear weapons tests and conducting such tests if so directed by the President. Other aspects of stockpile stewardship also include conventional HE tests, dynamic experiments, and hydrodynamic testing. The Nuclear Emergency Search Team based at NTS maintains the readiness to respond to any type of nuclear emergency, including search and identification for lost or stolen weapons, and training exercises related to nuclear bomb and radiation dispersal threats.

Table 3.2.9-1.-- ***Current Major Missions at Nevada Test Site***

Mission	Description	Sponsor
Defense Program	Stockpile stewardship activities, including maintenance of readiness to conduct underground nuclear tests, if directed	Defense Programs (DP)
Waste Management	Safe and permanent disposal of waste through disposal on NTS or to offsite commercial waste treatment or disposal facilities	Environmental Management (EM)

Environmental Restoration	Identification and cleanup of contaminated areas	Environmental Management (EM)
Nondefense Research and Development	Original research efforts by DOE, other Federal agencies, and universities	Environmental Management (EM); Energy Research (ER); and others
Work for Others	Provides for the use of NTS areas and facilities by other groups and agencies for activities such as military training exercises	DOD and various other agencies

NTS has also been a key site for past efforts in the areas of nuclear nonproliferation and verification of international treaties. This work was exemplified recently by the Joint Treaty Verification Project, a cooperative effort between the United States and the former Soviet Union.

North Las Vegas Facility . Located on a 32-ha (80-acre) site in the city of North Las Vegas, NV, the North Las Vegas Facility supports the DOE Nevada Operations Office and LLNL, LANL, and SNL weapons test programs and is considered an adjunct to NTS. The facility supports test prestaging activities and fabrication, assembly, and testing of field diagnostic systems that collect data from NTS weapons testing activities. This facility is being considered as an alternative location for NIF and is described more fully in appendix I.

3.3 Stockpile Stewardship Enhanced Experimental Capability

Historically, nuclear testing has provided unambiguous high confidence in the safety and reliability of weapons in the stockpile. Without additional underground nuclear testing, DOE must rely on experimental and computational capabilities, especially in weapons physics, to predict the consequences of the complex problems that are likely to occur in an aging stockpile. Without these enhanced capabilities, DOE will lack the ability to adequately evaluate some safety and reliability issues, which could significantly affect the Nation's confidence in the stockpile. It is also possible that, without these enhanced capabilities, DOE could not certify the acceptability of certain weapons components repaired or modified to address future safety or reliability issues.

The physical principles involved in nuclear weapons call for a range of experimental capabilities to provide data. These capabilities differ in time and energy density (related to temperature and pressure), and they are complementary rather than duplicative, because they serve different needs. These aboveground sources of experimental data can be categorized most easily by time; that is, by the duration of the output pulse of the data. Thermonuclear processes vary in time down to the nanosecond range. [2] For example, powerful lasers do the best job of producing experimental data at the highest temperatures (millions of degrees) in the laboratory, but only for very short time intervals. Multi-nanosecond pulsed-power sources do the best job of producing very energetic pulses of x radiation in that time period, but at moderate temperatures. And microsecond pulsed-power sources and HE do the best job of providing an energetic but controlled hydrodynamic "push" in that time period for simulation and study of complex hydrodynamic phenomena. [3] The three weapons laboratories are also complementary in providing these technologies. The powerful laser capability is centered at LLNL, the nanosecond pulsed-power capability is centered at SNL, and the microsecond pulsed-power capability is centered at LANL.

As discussed in chapter 2, the historical stockpile data indicate that problems are likely to develop in the aging stockpile that will require certified repairs or replacements without nuclear testing. Thus, U. S. national security policy in pursuit of a "zero yield" CTBT calls for the aggressive pursuit of enhanced experimental capabilities to help ensure a safe and reliable stockpile without additional nuclear testing. Therefore, DOE has included the detailed project-specific analyses for the proposed facilities (NIF, CFF, and Atlas) in this PEIS. Enhanced experimental facilities considered in this PEIS are those that either require or may require budget "line item" authorization from Congress. Next generation facilities are discussed in section 3.3.4. Within the next several years, it is expected that the weapons laboratories may request DOE authorization to begin the formal Congressional budget "line item" process for these facilities. NEPA documentation would be completed as a normal part of this process.

The nuclear weapons phenomena involved in enhanced experimental capability can be broadly grouped into three categories: physics of nuclear weapons primaries, physics of nuclear weapons secondaries, and weapons effects. Table 3.3-1 depicts the proposed alternatives and facilities for enhanced experimental capability.

Table 3.3-1.-- ***Stockpile Stewardship Enhanced Experimental Capability Alternatives***

Capability	LANL	LLNL	SNL	NTS
Physics of Nuclear Weapons *Primaries*				
No Action	X	X		X
Contained Firing Facility [4]		X		
Physics of Nuclear Weapons Secondaries [5]				
No Action	X	X		
National Ignition Facility [5]	X	X	X	X
Atlas Facility [5]	X			
Weapons Effects				

No Action [6]			X	

3.3.1 Physics of Nuclear Weapons Primaries

Primary implosion is initiated by detonating a layer of chemical HE that surrounds the plutonium pit. The HE drives the pit material into a compressed mass at the center of the primary assembly, resulting in a fission reaction. With respect to the physics phenomena from the implosion of the primary, the experimental facilities provide physics validation, material behavior information, improved understanding of the implosion, and the ability to assess age-related defects. LANL and LLNL have been conducting basic work in these areas for many years. However, in the absence of additional nuclear testing, new and improved capabilities are needed. Proposed new facilities and site alternatives under consideration, along with the existing facilities which are part of the No Action alternative, are discussed below.

3.3.1.1 *No Action*

The principal diagnostic tools DOE currently uses to study nuclear weapons primaries are hydrodynamic tests and dynamic experiments. Hydrodynamic tests examine interactions among parts of the weapons primary. Dynamic experiments explore broader issues regarding materials science. Under the No Action alternative, DOE would continue to use the hydrodynamic testing facilities currently available at LANL, LLNL, and NTS, and a new facility planned for LANL. The FXR Facility at LLNL Site 300 has been in continuous operation since 1983. The FXR Facility uses linear induction accelerator technology for high-speed radiography. DOE does not perform dynamic experiments with plutonium at LLNL because the necessary infrastructure is not in place at Site 300. The PHERMEX Facility has been in continuous operation at LANL since 1963. The PHERMEX Facility uses a radio-frequency accelerator designed for high-speed radiography at LANL. Because neither the FXR Facility nor the PHERMEX Facility is capable of providing the degree of resolution, intensity, rapid time sequencing, or three-dimensional views that are now needed to provide answers to current questions regarding weapons condition or performance, DOE has decided to construct and operate a new facility (DARHT) at LANL.

The DARHT Facility will consist of a new accelerator building with two accelerator halls to provide two perpendicular lines-of-sight, which will enable two radiographic images to be captured simultaneously or sequentially and will provide a capability to perform three-dimensional diagnostics of a simulated nuclear weapon primary. Most tests and experiments at the DARHT Facility would be conducted inside of modular steel containment vessels. In the future, DOE may perform dynamic experiments with plutonium at the DARHT Facility; these experiments would be conducted in specially designed double-walled containment vessels. DOE has analyzed the environmental impacts of this proposal; the DARHT Facility Final EIS (DOE/EIS-0228) was published in August 1995 and on October 10, 1995, DOE issued its ROD to proceed with the facility. Construction of the facility was enjoined by the U.S. District Court for the District of New Mexico on January 27, 1995, pending completion of the EIS and ROD. Following the ROD, DOE filed motion for dissolution of the injunction. On April 16, 1996, the U.S. District Court concluded that the purpose of the injunction had been satisfied, and therefore lifted the injunction and dismissed the case.

For the purposes of this PEIS, DOE includes DARHT as an existing facility at LANL because DOE has reached an independent decision to construct and operate the facility. Under all alternatives considered in this PEIS, including the No Action alternative, DOE would complete construction and operate both axes of the DARHT Facility. When DARHT becomes operational, DOE would phase out operation of the PHERMEX Facility. Modular steel containment vessels would be used at the DARHT Facility firing site to contain emissions and debris from selected hydrodynamic tests and dynamic experiments; any experiments involving plutonium would always be conducted inside a specially designed double-walled steel vessel.

Besides LANL and LLNL, NTS has some hydrodynamic testing facilities in place. In addition to its past underground nuclear testing program, DOE has conducted underground and aboveground hydrodynamic tests at NTS. For example, BEEF is used to study hydrodynamic motion associated with HE detonations; however, BEEF does not include a high resolution radiographic diagnostic capability.

3.3.1.2 *Proposed Contained Firing Facility*

As discussed previously, both LANL and LLNL are considered necessary for the continued development of the science-based stockpile stewardship program. In this regard both laboratories will continue to utilize and improve radiographic hydrodynamic test capability.

Table 3.3.1.2-1.-- ***Contained Firing Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	64
Peak electrical demand (MWe)	0.1
Concrete (m^3)	3,000
Steel (t)	1,500
Gasoline, diesel, and lube oil (L)	56,800
Industrial gases [7] (m^3)	4,300
Water (L)	3,790,000
Land (ha)	1.2
Employment	
Total employment (worker years)	60
Peak employment (workers)	30
Construction period (years)	2

The proposed CFF would augment and upgrade the existing FXR Facility at LLNL's Site 300. The containment enclosure would provide for containment of hydrodynamic tests and reduce the environmental, safety, and health impacts of current outdoor testing. The enclosure will also improve the quality of diagnostics data derived from testing by better controlling experimental conditions. Tables 3.3.1.2-1 through 3.3.1.2-3 show CFF construction and operating requirements and waste volumes. More detailed information about CFF can be found in appendix section A.2.2 and in the project-specific analysis presented in appendix J.

Table 3.3.1.2-2.-- ***Contained Firing Facility Annual Operation Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	1,600
Peak electrical demand (MWe)	1.2
Liquid fuel (L)	2,650
Natural gas [8] (m^3)	None
Water (L)	2,300,000
Coal (t)	None
Plant Footprint (ha)	0.4
Employment (Workers)	6 [9]

Table 3.3.1.2-3.-- ***Contained Firing Facility Waste Volumes (100 Tests Per Year)***

Category	Average Annual Volume Generated from Construction (m^3)	Annual Volume Generated from Operation (m^3)	Annual Volume Effluent from Operation (m^3)
Low-Level			
Liquid	None	None	None
Solid	None	90 [10]	90 [11]
Mixed Low-Level			
Liquid	None	None	None
Solid	None	10 [12]	10
Hazardous			
Liquid	None	8 [13]	8

Solid	None	4	4
Nonhazardous (Sanitary)			
Liquid	1,420	284 [14]	284
Solid	64	13 [15]	13
Nonhazardous (Other)			
Liquid	None	None	None
Solid	None	None	None

3.3.2 Physics of Nuclear Weapons Secondaries

The energy released by the fission of the nuclear weapons primary activates the secondary assembly, creating a thermonuclear (fusion) explosion. The physics of nuclear weapons secondaries deals with the interaction of many dynamic physics processes, including hydrodynamics, thermodynamics, fission, and fusion. With respect to the phenomena of the physics from the thermonuclear explosion of the secondary, the experimental facilities provide improved understanding of thermonuclear ignition, secondary physics validation, and material behavior information. LANL and LLNL have been conducting basic work in these areas for many years. However, without additional nuclear testing, new and improved capabilities are needed. The proposed new facilities and site alternatives under consideration are discussed below. Some of the facilities may also be useful for investigating physics phenomena related to nuclear weapons primaries and weapons effects. The capabilities that would be provided by the proposed NIF and the Atlas Facility are independent components needed to improve the understanding of the physics of nuclear weapons secondaries. Each proposed facility responds to a different diagnostic need related to nuclear weapons secondaries and is not competing with other alternatives.

3.3.2.1 *No Action*

Few methods are currently available to study the physics of nuclear weapons secondaries. The principal facilities currently available are the Nova Facility at LLNL and the Pegasus II Facility at LANL. The Nova Facility and the Pegasus II Facility do not provide conditions sufficiently close to those in a nuclear weapon secondary to improve our understanding of these important concepts and processes. Without improvements to these capabilities, as proposed by NIF and the Atlas Facility, DOE would lack the ability to evaluate some significant nuclear performance issues, which could adversely affect confidence in the Nation's nuclear deterrent.

3.3.2.2 *Proposed National Ignition Facility*

The proposed NIF would make it possible to study radiation physics in laboratory experiments that would approach certain conditions of a thermonuclear detonation. NIF would achieve higher temperatures and pressures, albeit in a very small volume, than any other existing or proposed stockpile stewardship facility. This facility could be located at either LANL, LLNL,SNL, or NTS.

Tables 3.3.2.2-1 through 3.3.2.2-3 show generic NIF construction, operating requirements, and waste volumes. The data in these three tables reflect nonsite-specific estimates developed prior to site-specific analyses. More detailed and site-specific information about NIF can be found in the project-specific analysis presented in appendix I.

Table 3.3.2.2-1.-- *National Ignition Facility Construction Requirements*

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	24
Concrete (m^3)	60,000
Steel (t)	10,000
Liquid fuel and lube oil (L)	1,500,000
Industrial gases [16] (m^3)	9,000
Water (L)	14,300,000 [17]
Land (ha)	20
Employment	
Total employment (worker years)	1,627
Peak employment (workers)	470
Construction period (years)	5

Table 3.3.2.2-2.--*National Ignition Facility Annual Operation Requirements*

Requirement	Consumption
Resource	
Electrical energy (MWh)	58,000
Peak electrical demand (MWe)	20
Liquid fuel (L)	5,820
Natural gas [18] (m^3)	1,100,000 [19]
Water (L)	152,000,000
Coal (t)	None
Plant Footprint (ha)	20 [20]

Employment (Workers)	267 [21]

Table 3.3.2.2-3.--*National Ignition Facility Conceptual Design Waste Volumes*

Category	Average Annual Volume Generated from Construction (m^3)	Annual Volume Generated from Operation (m^3)	Annual Volume Effluent from Operation (m^3)
Low-Level			
Liquid	None	0.6	None
Solid	None	3	3
Mixed Low-Level			
Liquid	None	2	2
Solid	None	0.3	0.3
Hazardous			
Liquid	None	2.3	2.3
Solid	None	8	8
Nonhazardous (Sanitary)			
Liquid	2,800	17,900 [22]	17,800 [23]
Solid	100	6,000	6,050
Nonhazardous (Other)			
Liquid	180	Included in sanitary	Included in sanitary
Solid	180	Included in sanitary	Included in sanitary

3.3.2.3 Proposed Atlas Facility

The proposed Atlas Facility at LANL would be used for experiments that would contribute to the development of predictive capabilities related to the aging and performance of secondaries. This facility would build on existing special equipment at LANL, SNL, or NTS. Tables 3.3.2.3-1 through 3.3.2.3-3 show Atlas Facility construction and operating requirements and waste volumes. Although principally considered as a stewardship facility for study of the physics of nuclear weapons secondaries, the proposed Atlas Facility at LANL could also be used for hydrodynamic experiments to resolve issues related to material properties, mixing and other physics aspects of weapons primaries. More detailed information about the Atlas Facility can be found in the project-specific analysis presented in appendix K.

Table 3.3.2.3-1.--*Atlas Facility Construction Requirements*

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	520
Peak electrical demand (MWe)	0.1
Concrete (m^3)	100
Steel (t)	10
Liquid fuel and lube oil (L)	1,000
Industrial gases [24] (m^3)	100
Water (L)	10,000
Land (ha)	0.04
Employment	
Total employment (worker years)	53
Peak employment (workers)	35
Construction period (years)	4

Table 3.3.2.3-2.-- *Atlas Facility Annual Operation Requirements*

Requirement	Consumption
Resource	
Electrical energy (MWh)	5,360
Peak electrical demand (MWe)	12
Liquid fuel (L)	None
Natural gas [25] (m^3)	45,710
Water (L)	10,000
Coal (t)	None
Plant Footprint (ha)	0.3
Employment (Workers)	15

Table 3.3.2.3-3.-- *Atlas Facility Waste Volumes*

Category	Average Annual Volume Generated from Construction (m^3)	Annual Volume Generated from Operation (m^3)	Annual Volume Effluent from Operation (m^3)
Low-Level			
Liquid	None	None [26]	None
Solid	None	None[26]	None
Mixed Low-Level			
Liquid	None	None[26]	None
Solid	None	None[26]	None
Hazardous			
Liquid	None	<1 [27]	None
Solid	None	<1b	None
Nonhazardous (Sanitary)			
Liquid	1,120 [28]	710 [29]	708 [30]
Solid	15.3	7	9
Nonhazardous (Other)			
Liquid	None	Included in sanitary	Included in sanitary
Solid	None	Included in sanitary	Included in sanitary

3.3.3 Weapons Effects

One of the reasons for past underground nuclear testing has been to determine the effects of nuclear weapon radiation outputs of x rays, gamma rays, and neutrons on nuclear weapon subsystems and components. Of particular importance is the ability to certify that crucial nuclear weapons components meet military requirements to withstand radiation. Additionally, underground nuclear testing has been used to establish, with high confidence, adherence to military requirements for nonweapons systems such as satellites. Existing facilities at SNL, such as the Saturn Facility or the

PBFA Facility, provide a limited capability to investigate these effects, and would continue to operate under the No Action alternative. No alternatives for new facilities designed principally for weapons effects testing are being proposed in this PEIS.

3.3.4 Next Generation Stockpile Stewardship Facilities

The science-based stockpile stewardship program will build upon existing information and capabilities and the program is expected to continuously evolve as better information becomes available and technological advancements occur. Today, because of limitations on data and technology, only the first steps to a fully capable science-based stockpile stewardship program can be taken. Thus, DOE is only in a position to propose NIF, CFF, and Atlas Facility for decisionmaking analysis in this PEIS. These three facilities are described in detail in appendixes I, J, and K, respectively. The goal is to provide a sufficiently detailed analysis for these three facilities in this PEIS to allow for their construction and operation if the decision is made to do so.

While these three proposed facilities would provide improvements over existing capabilities, and are expected to be important components of science-based stewardship, they do not represent the entire science-based stewardship program that is envisioned for all time. The next generation of potential stockpile stewardship facilities cannot be defined to the degree necessary to perform detailed environmental impact analysis. However, these next generation facilities can be described in general terms such that a consideration of cumulative impacts that might be related to the ultimate science-based stockpile stewardship program can be qualitatively assessed. Next generation facilities anticipated for science-based stockpile stewardship are the Advanced Hydrotest Facility (AHF), the High Explosive Pulsed Power Facility (HEPPF), the Advanced Radiation Source (ARS [X-1]), and the Jupiter Facility. The following sections provide a broad description of what these three facilities might look like. Section 4.11 describes the general impacts of constructing and operating these types of facilities.

3.3.4.1 *Advanced Hydrotest Facility*

AHF would be the next generation hydrodynamic test facility following the DARHT Facility at LANL. AHF would be an improved radiographic facility that would provide for imaging on more than two axes, each with multiple time frames, though the number of axes and time frames is still subject to requirements definition and design evolution. The facility would be used to better reveal the evolution of weapon primary implosion symmetry and boost-cavity shape under normal conditions and in accident scenarios. Due to the nature of the dynamic experiments and hydrodynamic testing to be conducted with the facility, AHF would probably be considered for location at NTS and LANL only.

At this point, the feasibility and definition of an AHF is still insufficiently determined for DOE to propose such a facility. For example: performance requirements and specifications for such a facility (i.e., determination of what capabilities should be required of an AHF for assessment of stockpile aging and related effects, beyond those of the DARHT Facility) have not been fully established. In addition, the type of technology to provide the basis for the facility has not been determined, and concepts for the resultant physical plant would accordingly vary significantly. Three basic technology approaches are currently being examined. These include linear induction accelerators of a type similar to that in the baseline DARHT Facility design (DOE/EIS-0228), an inductive-adder pulsed-power technology based on technology now in use for other purposes at SNL and elsewhere, and high-energy proton accelerators similar to technology in use at LANSCE and a number of facilities in the United States and internationally. The first two are different approaches to accelerating a high-current burst of electrons, which when stopped in a dense target produce x rays for radiography. This is the approach used in the existing PHERMEX (LANL) and FXR (LLNL) Facilities, and which will be used in the DARHT Facility. The third approach would use bursts of very energetic protons, magnetic lenses, and particle detectors to produce the radiographic image. These technologies still require development and validation.

3.3.4.2 *High Explosives Pulsed Power Facility*

This facility would provide experimental capabilities for studying secondary physics at shock pressures and velocities approaching those of actual weapon conditions. Explosive pulsed power is the most economically feasible means of providing aboveground experimental capability at energies above 100 megajoules. While current explosives testing facilities can probably test explosives systems using up to 500 kilograms (kg) (1,100 pounds [lb]) of HE, future systems may require up to 3,000-kg (6,600-lb) explosive charges. Systems so large cannot be tested at current laboratory facilities; therefore, BEEF at NTS is a likely candidate site.

For some years, DOE has pursued both capacitor bank facilities and HE experiments in pulsed power. HE generators offered a means to explore higher energy (higher current) frontiers without major capital investment, albeit at a relatively low data rate, and capacitor banks offered the advantages of repeatable (and indoor) experimental facilities with higher data rates, for broad experimental use. Data from HE experiments, for example, has helped provide validation of technical issues used in the Atlas Facility design concept.

An HE pulsed-power generator, such as Procyon at LANL, is basically an assembly of HE and metal (e.g., copper) and other components which is explosively and destructively detonated a single time, resulting in a brief pulse of high electrical current being delivered to the experimental configuration. High magnetic fields result from the high current pulse and may either be directly used to study materials phenomena or may be used to produce high pressures and implosions of (typically) cylindrical shells. (See the discussion in the Atlas Facility site-specific analysis, appendix sections K.1 and K.2.1.)

As distinct from an explosive generator, a firing site is a facility typically consisting of a firing location, associated hardened bunkers, and related equipment, in an area from which personnel can be excluded. Many different HE experiments (including those in which pulsed electrical power is produced) can be performed at an HE firing site, as long as the explosive blast, and other experiment parameters, do not exceed the designed or permitted capabilities of the firing site. Currently most of the largest-scale HE pulsed-power experiments in the United States, whether for technology development or weapons stockpile stewardship, are conducted at a pulsed-power firing point at TA-

39 at LANL. As noted, this experimental capability has a limit of approximately 500 kg (1,100 lb) of HE. Therefore a potential need for a new HEPPF was postulated to support generators using much larger explosive charges, which though not yet demonstrated could produce higher pressures in larger masses and volumes than can be accessed at the LANL site. Existing laboratory sites cannot readily support experiments with much larger charges.

3.3.4.3 *Advanced Radiation Source (X-1) and Jupiter Facility*

The ARS (X-1) and Jupiter Facilities would have advanced pulsed-power x-ray sources to provide enhanced experimental capabilities in the areas of weapons physics and weapon effects.

Conceptually, the ARS(X-1) Facility would be a new facility containing a pulsed-power accelerator capable of producing intense bursts of x rays and high temperature and density plasmas. ARS (X-1) would be a technological advance over the current PBFA II Facility and would provide about 8 megajoules of x-ray energy in contrast to 2 megajoules expected from PBFA II in the near term. ARS (X-1) would be an interim step to the conceptual Jupiter Facility, which limits the risk involved in developing a new facility that requires a much larger investment. Conceptually, the Jupiter Facility would provide about 32 megajoules of x-ray energy.

ARS (X-1) would be used to study the physics of radiation flow, opacities, high energy densities, the effects of radiation on weapons, and potentially, inertial confinement fusion relevant physics. Section 3.3 describes the complementary nature of experimental facilities required to perform weapon assessment and certification functions in the absence of nuclear testing. ARS (X-1) would provide greatly improved capability over the current Saturn and PBFA II Facilities with regard to higher temperatures, higher densities, and longer pulse widths in the multi-nanosecond range. ARS (X-1) would thereby add to the complement of fast pulsed power, slow pulsed power, and laser facilities needed to begin addressing the full spectrum of weapons physics and weapon-effects science in the absence of nuclear testing.

Although other stewardship sites would be considered, if ARS (X-1) were constructed at SNL, the conceptual design would use some of the pulsed-power facility infrastructure existing in Technical Area IV. Various accelerator architecture concepts are being explored which present different performance, cost, and risk options. The ARS (X-1) accelerator is conceived of as a 24-module machine which would store approximately 56 megajoules of electrical energy in capacitors. This electrical energy would be released and compressed to produce an output pulse on the order of 100 nanoseconds long. This pulse may be used to generate an intense burst of x rays and high temperature and density plasmas. Supporting facilities for the accelerator, such as storage and circulation systems for insulating oil and de-ionized water, would also be required to supplement the already present capacity used by the other major facilities collocated in Technical Area IV. About 4,645 m^2 (50,000 ft^2) of space available in Technical Area IV would be needed to construct the facility which would be operated and maintained by a staff of about 20 people.

1 Capability based capacity - the facility capacity (up to 50 per year) inherent with the facilities and equipment required to manufacture one component for any stockpile system.

Source: DOE 1996j.

2 Nanoseconds are billionths of a second; microseconds are millionths of a second.

3 Under extreme temperatures and pressures, the dynamics (motion) of solids, such as metals, behave more like fluids, thus the term hydrodynamic.

4 Proposed facilities. The Stockpile Stewardship and Management PEIS includes both a programmatic assessment and a project-specific analysis of these potential experimental facilities.

5 Facilities used to investigate the physics of nuclear weapons secondaries may also be used to investigate some physics phenomena related to nuclear weapons primaries and weapons effects.

6 No new facilities solely to investigate weapons effects phenomena are being proposed at this time.

7 Cubic meters at standard temperature and pressure.

LLNL 1995i:3; appendix J.

8 Cubic meters at standard temperature and pressure.

9 In addition to current B801/FXR Facility staff of approximately 20.

LLNL 1995i:3; appendix J.

10 Assumes density of 500 kg/m3.

11 Solid low-level waste is not compactible.

12 Assumes 0.l m *3* (3.7 ft *3*) per test although none is expected.

13 Assumes density of 1,000 kg/m3. Liquid is mostly film processing solutions.

14 Based on 50 gal/day per person and 250 days/yr for six employees.

15 Based on 0.3 ft^3/day per person and 250 days/yr for six employees.

LLNL 1995i:3; LLNL 1996i:2; appendix J.

16 Cubic meters at standard temperature and pressure.

17 11,400 L per day for a 5-year construction period, assuming 250 days of construction per year.

Note: This table provides nonsite-specific requirements. See appendix I for site-specific information.

Source: LLNL 1995m; appendix I.

18 Cubic meters at standard temperature and pressure.

19 Energy requirement is 40,900,000 megajoules. Conversion assumes 1,000 British thermal units per cubic foot and 1,055 joules per British thermal unit.

20 Maximum size could be smaller depending on site conditions.

21 Technicians for baseline operations. Does not include 60 scientists required. For enhanced operations, employment would increase by 50 technicians and 10 scientists.

Note: This table provides nonsite-specific requirements. See appendix I for site-specific information.

Source: ANL 1995a:1; LLNL 1995m; appendix I.

22 Assumes 365 days of operation.

23 Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary waste.

Note: This table provides nonsite-specific requirements. See appendix I for site-specific information.

Source: LLNL 1995m; appendix I.

24 Cubic meters at standard temperature and pressure.

LANL 1995b:4; LANL 1996e:1; appendix K.

25 Cubic meters at standard temperature and pressure.

LANL 1995b:4; LANL 1996e:1; appendix K.

26 Anticipated experiments do not utilize radioactive materials.

27 For purposes of this analysis, occasional use of hazardous material is anticipated.

28 Assumes 25 gal/day per construction worker for 250 days/yr and 35 construction workers. Also includes 290 m3 (76,610 gal) from washdown.

29 Assumes 50 gal/day/worker, 250 days/year of operation, and 15 employees.

30 Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary wastes.

LANL 1996e:1; appendix K.

3.4 Stockpile Management

Stockpile management activities include dismantlement, maintenance, surveillance, and repair or replacement of weapons and weapons components in the existing stockpile. In the past, a large Complex provided the capability and capacity to rapidly fix any problems found in the stockpile. One of the primary goals of stockpile management is to rightsize functions to provide an effective and efficient manufacturing capability for the smaller stockpile. The individual stockpile management functions can be grouped into five major categories: weapons A/D, nonnuclear components fabrication, pit fabrication, secondary and case fabrication, and HE fabrication. Both intrusive and nonintrusive modification pit reuse are considered inherent capabilities of pit fabrication and nonintrusive modification pit reuse is always considered to be collocated with A/D. Specific alternatives that would enable DOE to maintain its stockpile management responsibilities are shown in table 3.4-1and are discussed below.

Table 3.4-1.--*Stockpile Management Alternatives*

Capability[1]	**Y-12**	**SRS**	**KCP**	**Pantex**	**LANL**	**LLNL**	**SNL**	**NTS**
Weapons Assembly/Disassembly[2]								
No Action				X				
Downsize existing capability				X				
Relocate capability								X
Nonnuclear Fabrication								
No Action			X		X		X	
Downsize existing capability			X					
Relocate capability					X[3]	X[3]	X[3]	
Pit Fabrication and Intrusive Modification Pit Reuse [4]								
No Action [5]					X	X		
Reestablish capability		X			X			
Secondary and Case Fabrication[4]								
No Action	X[6]							

Downsize existing capability	X[6]							
Relocate capability					X	X		
High Explosives Fabrication								
No Action				X				
Downsize existing capability				X				
Relocate capability					X	X		

3.4.1 Weapons Assembly/Disassembly Alternatives

Weapons A/D provides the capability to dismantle retired weapons, assemble nuclear and nonnuclear components into nuclear weapons, perform weapons surveillance, store strategic reserves of nuclear components (pits and secondaries), and recertify and requalify pits. In addition, nonintrusive modification pit reuse capabilities would be collocated with the weapons A/D Facility.

To maintain confidence in the safety and reliability of the stockpile, DOE conducts surveillance operations on a statistically significant number of weapons annually. Surveillance operations consist primarily of disassembly and inspection of stockpile weapons returned to DOE from DOD. Most of these weapons are rebuilt and returned to the stockpile during what is called the "protected period." Extra components are built at the end of the production run to replace components attrited by surveillance testing for a specified protected period established by DOD. When the replacement components are exhausted, the weapon is not rebuilt and the stockpile is reduced.

The nonintrusive modification pit reuse alternative would provide a capability to perform nonintrusive modification of pits for reuse in the stockpile. Nonintrusive modification is modification to the external surfaces and features of a pit. For example, to add safety features such as fire resistant cladding, there is little risk of contamination, and the generation of radioactive waste is very low.

Operation. The weapons A/D process consists of five main functions and nonintrusive modification pit reuse, which are described below.

Weapons Assembly. Weapons assembly is performed to produce a new weapon, rebuild a weapon that has been disassembled for surveillance, repair a weapon, or modify or replace components. The assembly steps for a rebuild are the same as for a new weapon, except that the starting point varies depending on the extent of disassembly.

Complete weapons assembly is accomplished in three stages: nuclear explosive package assembly, mechanical assembly, and final package assembly. Nuclear explosive package assembly entails bonding or mating HE main charge subassemblies to a pit and then enclosing this subassembly in a case along with other components such as the secondary. Mechanical weapons assembly entails placing the nuclear explosive package in a warhead or bomb case, then installing the arming, fusing and firing system;

neutron generator; and gas transfer system components. Numerous quality control inspections and tests of electrical and mechanical systems are performed throughout the process. Final package assembly involves installing some additional components and packaging the weapons for shipment.

Weapons Disassembly. Weapons disassembly is similar to the reverse of the assembly process and is performed to dismantle, modify, repair, or evaluate a weapon. The operations conducted for each type of disassembly are similar, but the extent of the disassembly and the procedures used vary. Many of the facilities used for various disassembly and testing operations are the same as facilities used for weapons assembly.

Joint Test Assembly and Post-Mortem . As part of the ongoing stockpile surveillance program, weapons are randomly selected from the stockpile or from new production for conversion into a joint test assembly. The nuclear explosive package is removed and replaced with a mock assembly that includes telemetry components. After flight tests by DOD, joint test assemblies are often recovered and returned to the A/D Facility for post-mortem disassembly and evaluation.

Test Bed Assembly and Disassembly. A test bed is an apparatus used for bench testing weapons systems, subsystems, and components. Testing is generally conducted at Pantex in the Weapons Evaluation Test Laboratory operated by SNL. Test beds are disassembled at the A/D Facility after testing.

Optional Storage of Plutonium and Highly Enriched Uranium Strategic Reserve. Storage of the plutonium strategic reserve could occur at the weapons A/D Facility. If Y-12 is selected as the site for the secondary and case fabrication mission, HEU strategic reserve storage would remain at ORR. If Y-12 is not selected, then the HEU strategic reserve could also be stored at the weapons A/D Facility. The strategic reserve provides pits and secondaries which could be used for replacement in the enduring stockpile or as feedstock for nuclear fabrication. The quantities associated with strategic reserve storage are classified. If the decision is made that strategic reserves will be stored with nonstrategic reserves, then consolidated storage could occur at one of the five sites being considered in the Storage and Disposition of Weapons Usable Fissile Materials Programmatic Environmental Impact Statement, rather than at the weapons A/D Facility.

Nonintrusive Modification Pit Reuse . This alternative supports three major operations: pit recertification, pit requalification, and nonintrusive modification. Nonintrusive modification pit reuse includes the operations, inspections, and evaluations that are required to change design features by the addition of shells or other nonnuclear components for the incorporation of fire safety or security improvements. Pits received from strategic reserve storage or weapon disassembly for surveillance or maintenance may be used as feed stock for nonintrusive modification.

The alternatives for A/D are to continue in current facilities at Pantex with only those changes that are currently scheduled and budgeted (No Action), to downsize and consolidate facilities and operations at Pantex, or to relocate operations to NTS.

3.4.1.1 *No Action*

The No Action alternative for these activities, except nonintrusive modification pit reuse, is presently located at Pantex. Pantex dismantles retired weapons, assembles nuclear and nonnuclear components into nuclear weapons, repairs and modifies weapons, evaluates weapons, and performs nonnuclear testing of nuclear weapons. Current plutonium R&D facilities at LANL and LLNL have limited capability and capacity to perform nonintrusive modification pit reuse.

3.4.1.2 *Downsize at Pantex Plant*

This alternative would downsize and consolidate facilities and operations including strategic reserve storage at Pantex primarily into Zone 12 (figure 3.4.1.2-1), using existing modern structures. This alternative is described in more detail in appendix section A.3.1.1.

Downsizing of the A/D operation at Pantex would consist of an in-place decrease in facility footprints and relocation into modern, existing facilities, mostly within Zone 12. The facilities primarily used are cells and bays that were specifically designed and constructed for A/D operations. The consolidation of the site would not require modification of these structures, but would require relocation and installation of equipment within them. Support functions would remain within the currently established facilities, some of which are outside Zone 12. No new construction would be required at Pantex; however, relocation and reinstallation of equipment would be required.

The capabilities for nonintrusive modification pit reuse would be established in existing facilities within Zone 12. This would require modification of some of the bays to install glove boxes; redesign of the heating, ventilation, and air conditioning; and improvement of the fire detection and suppression systems. These facilities would also have the capability to support pit recertification and requalification operations.

Construction. There would be no new construction anticipated at Pantex for this alternative. The A/D mission would be consolidated primarily into Zone 12 with some supporting operations in Zones 13, 15, and 16. Figure 3.4.1.2-2 shows the weapons A/D site plan for Zone 12 and the facilities included in the proposed downsized and consolidated A/D mission at Pantex. Strategic reserve storage would be in Zone 12 for both plutonium and HEU. The nonintrusive modification pit reuse alternative would require modification of four bays in Building 12-104. The capability to perform recertification, requalification, and nonintrusive modification pit reuse activities currently exists at Pantex except for processes that are needed for pit tube replacement, welding on the pit, and inspection of internal pit surfaces. The existing capabilities would be upgraded and relocated within Building 12-116.

Building 12-116 is a new building that was constructed in accordance with the requirements for a safety class (Category 2) vault-type nuclear facility. This facility would support consolidation of the activities that involve processing of components that contain special nuclear material. Recertification, requalification, and reuse activities would use almost the entire facility.

Building 12-104 is a new building that was also constructed in accordance with the requirements for a safety class (Category 2) nuclear explosives A/D Facility. To fulfill the pit reuse mission, one module (four bays) of the building would be modified to meet nonreactor nuclear facility requirements. These requirements include improvements to the fire detection and suppression system; a capture system for fire water runoff; the addition of control, change out, and decontamination areas; security improvements to provide facility control; and complete redesign of the heating, ventilation, and air conditioning system to provide the progressive negative pressure scenario required for containment of radionuclide contamination. Three of the four bays would be fitted with pit reuse process equipment to provide the minimum capability required to support recertification, requalification, and nonintrusive modification activities. The fourth bay would be available for installation of additional equipment if workload requirements increase. The pit reuse facility would have the capability to support all recertification, requalification, and nonintrusive modification pit reuse activities. Table 3.4.1.2-1 shows building modification construction requirements for downsizing and consolidating into existing facilities.

Table 3.4.1.2-1.-- ***Pantex Plant Weapons Assembly/Disassembly Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	609
Peak electrical demand (MWe)	4
Concrete (m^3)	840
Steel (t)	15
Gasoline, diesel, and lube oil (L)	28,800
Industrial gases [7] (m^3)	600
Water (L)	1,400,000
Land (ha)	NA [8]
Employment	
Total employment (worker years)	99
Peak employment (workers)	67
Construction period (years)	3

Table 3.4.1.2-2.-- ***Pantex Plant Weapons Assembly/Disassembly Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	43,000
Peak electrical demand (MWe)	10
Liquid fuel (L)	740,000
Natural gas [9] (m^3)	7,150,000
Water (L)	196,000,000
Plant Footprint (ha)	NA [10]

Employment (Workers)	1,890 [11]

Operation. Operation requirements for surge operation of the downsized/consolidated weapons A/D facilities are shown in table 3.4.1.2-2.

Process Support Systems. Process support systems include systems, equipment, and procedures that support the weapons A/D processes. The process support systems are described in more detail in appendix section A.3.1.1.

Waste Management. Pantex's existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, radioactive, and mixed wastes generated at Pantex facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workloads would not require significant modification of the existing Pantex waste management infrastructure. Waste generation for construction and operation of the Pantex A/D alternative is shown in table 3.4.1.2-3.

Table 3.4.1.2-3.-- Pantex Plant Weapons Assembly/Disassembly Facility Waste Volumes

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	0.06	None
Solid	None	21 [12]	10 [13]
Mixed Low-Level			
Liquid	None	0.06	0.06
Solid	None	Minimal	Minimal
Hazardous			
Liquid	None	2	2
Solid	0.25	0.05	0.05
Nonhazardous (Sanitary)			
Liquid	315	141,000	141,000
Solid	5 [14]	340	170 [15]
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary

Solid	Included in sanitary	Included in sanitary	Included in sanitary

3.4.1.3 *Relocate to Nevada Test Site*

This alternative is based on the use of the current Device Assembly Facility and balance of plant infrastructure available and required to maintain the capability for underground nuclear testing. The alternative is discussed in more detail in appendix section A.3.1.2. Additional new construction would be required and would be designed and sized to meet the specific needs of the reduced program and enhanced safety and environmental objectives.

Construction. This alternative would require modification of existing facilities and new construction. Nonintrusive modification pit reuse would require construction of a new pit reuse facility as an adjunct to the existing Device Assembly Facility. Equipment for the facility would be purchased or transferred from existing Complex facilities. The new facility would be classified as a nonreactor nuclear facility. Though new construction would be required, the existing NTS infrastructure would be sufficient to support the facility.

The facility would be placed in the backfill area north of the Device Assembly Facility, with a specific location to be developed in conjunction with the A/D effort. The current Device Assembly Facility would be used for a secure shipping and receiving station with no additional construction requirements.

A site map of the proposed A/D plant is shown in figure 3.4.1.3-1. This map shows the overall plant, including associated support facilities, the plant protected area, and limited area. A site plan of the material access area is shown in figure 3.4.1.3-2. The size, number, and arrangement of the plant building and support areas are conceptual and can change as design progresses. The site plans are included to convey general layout information only.

The existing Device Assembly Facility would form the cornerstone of the A/D plant, but additional facilities to handle the workload, pit reuse, and strategic storage (if appropriate) would have to be added. All plant facilities located within the material access area either occupy existing buildings inside the Device Assembly Facility or are located in hardened new construction connected to the Device Assembly Facility. All plant facilities located within the limited area, at the plant site (adjacent to the Device Assembly Facility), would require new construction. Approximately 11 percent of this construction is needed to support the option of storing strategic reserves of nuclear components (pits and secondaries). Table 3.4.1.3-1 shows construction requirements for the NTS weapons A/D alternative.

Table 3.4.1.3-1.-- ***Nevada Test Site Weapons Assembly/Disassembly Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	38,000
Peak electrical demand (MWe)	5

Concrete (m^3)	75,000
Steel (t)	16,300
Gasoline, diesel, and lube oil (L)	3,030,000
Industrial gases [16] (m^3)	65,100
Water (L)	98,400,000
Land (ha)	3.2 [17]
Employment	
Total employment (worker years)	2,768
Peak employment (workers)	662
Construction period (years)	6

Table 3.4.1.3-2.- ***Nevada Test Site Weapons Assembly/Disassembly Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	45,000
Peak electrical demand (MWe)	7
Gasoline and diesel fuel (L)	432,000
Natural gas[18](m^3)	3,680,000
Water (L)	98,400,000
Plant Footprint	4.3[19]
Employment (Workers)	1,093[20]

Operation. Operating requirements for surge operation of the NTS weapons A/D Facility are shown in table 3.4.1.3-2. The water usage at NTS is somewhat lower than at Pantex since Pantex has a larger plant population and uses more water for supporting operations such as steam heat.

Waste Management. NTS's existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, radioactive, and mixed wastes generated at NTS facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workloads would not require significant modification of the existing NTS waste management infrastructure. Waste generation for construction and operation of the NTS A/D alternative is shown in table 3.4.1.3-3.

Table 3.4.1.3-3.-Nevada Test Site Weapons Assembly/Disassembly Facility Waste Volumes

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent From Surge Operations (m^3)
Low-Level			
Liquid	None	0.06	None
Solid	None	30 [21]	15 [22]
Mixed Low-Level			
Liquid	None	None	None
Solid	None	2	2
Hazardous			
Liquid	None	6	6
Solid	5	0.05	0.05
Nonhazardous (Sanitary)			
Liquid	6,670	53,000	53,000
Solid	260 [23]	100	50 [24]
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary

3.4.2 Nonnuclear Fabrication Alternatives

Nonnuclear fabrication consists of the following general functions:

- Fabrication of electrical, electronic, electromechanical and mechanical componenets (plastics, metals, and composites), and assembly of arming, fuzing, and firing systems.
- Surveillance inspection and testing of nonnuclear components

The nonnuclear components alternatives provide for the nonnuclear fabrication missions currently residing at KCP. Production requirements for nonuclear components, in terms of factory and field retrofits to weapons, are shown in table 3.1.1.2-1

The alternatives considered for nonnuclear fabrication included downsizing and consolidating existing facilities at KCP, or closing KCP and sharing nonnuclear fabrication functions among SNL, LANL, and/or LLNL. These alternatives are discussed below.

3.4.2.1 *No Action*

The No Action alternative facilities for these activities are presently located at KCP, SNL, and LANL. KCP manufactures nonnuclear weapons components and conducts surveillance testing on, and makes repairs to, nonnuclear weapons components. SNL conducts system engineering of nuclear weapons, designs and develops nonnuclear components, conducts field and laboratory nonnuclear testing, manufactures some nonnuclear weapons components, and provides safety and reliability assessments of the stockpile. LANL also manufactures a few nonnuclear weapons components and conducts surveillance on certain nonnuclear weapons components.

Downsize at Kansas City Plant

The downsized nonnuclear fabrication alternative consists of three major factories designed around electronic, mechanical, and engineered materilas product lines; procuring some components from outside sources; and reducing the KCP footprint fo DP activities to 167,000 square meters (m^2) (1.8 million square feet [ft^2]) from the current 297,000 m^2 (3.2 million ft^2). This alternative is discussed in more detail in appendix section A.3.6.1.

Construction. This alternative consists of downsizing and consolidating existing facilities and would require facility modification but no new construction. Currently, KCP occupies approximately 297,000 m^2 (3.2 million ft^2) contained in three buildings: the Main Manufacturing Building, the Manufacturing Support Building, and the Technology Transfer Center (figure 3.4.2.2-1). The downsized and consolidated KCP would reduce the size of the plant to approximately 167,000 m^2 (1.8 million ft^2) for DP activities. The Technology Transfer Center and Manufacturing Support Building facilities would be totally vacated of DP activities. All operations and support functions required for the nonnuclear fabrication mission would be accomplished within the reduced floor space of the Main Manufacturing Building. Vacated floor space would be returned to the General Services Administration or retained for Work for Others use, if appropriate. The downsized KCP facility would consist of the following major factories and product-oriented departments: Electronics Factory, Mechanical Factory, Engineered Materials Factory, Joint Test Assembly and Special Electronic Assembly Department, Reservoir Fabrication and Assembly Department, and Transportation Safeguards Department.

Facilities modification to establish the downsized and consolidated KCP configuration would take approximately 4 years. During this time, major interior building modification would occur. Table 3.4.2.2-1 shows construction requirements for the KCP nonnuclear fabrication alternative.

Table 3.4.2.2-1.-- ***Kansas City Plant Nonnuclear Fabrication Facility Construction Requirements***

Requirement	Consumption

Material/Resource	
Electrical energy (MWh)	Minimal
Peak electrical demand (MWe)	Minimal
Concrete (m^3)	286
Steel (t)	220
Gasoline, diesel, and lube oil (L)	Minimal
Industrial gases [25] (m^3)	Minimal
Water (L)	Minimal
Land (ha)	NA [26]
Employment	
Total employment (worker years)	459
Peak employment (workers)	187
Construction period (years)	4

Operation. The operation of the downsized and consolidated KCP is based on current KCP facilities and missions, downsized and reorganized for efficiency into several modules and product departments.

Electronics Factory. Existing separate departments for electronics products would be combined into the electronics factory and would be designed around three common process modules: microelectronics, interconnects, and final assembly.

Mechanical Factory. KCP has already implemented a process-based approach for most mechanical technologies. The alternative would achieve substantial downsizing in processing areas to maximize efficiency and cost savings. The mechanical factory would be organized around three process modules: mechanical assembly, mechanical welding, and sheet metal and special processing.

Engineered Materials Factory. This factory would manufacture products that depend on special materials (foams, polymers, and composites) for unique performance or functional characteristics. These products include cushions, desiccants, getters, and composite cases. The engineered materials factory would consist of four generic processing modules (machining, pressing, molding, and compounding), one assembly module, and the Polymer Production Facility. The processing and assembly areas would be consolidated, but the Polymer Production Facility would remain unchanged. The facility is a stand-alone facility that produces materials not available from commercial industry. The consolidation of facilities for the engineered materials factory would reduce floor space requirements for these operations by approximately 50 percent.

Joint Test Assembly and Special Electronics Assembly. Even though these products are electronic assemblies similar to the products fabricated in the electronics factory, they would be built in separate areas because of their unique production and security requirements. These production operations would be combined into one organizational unit. This would provide savings in indirect support, yet allow the unique operations practices and security considerations to be maintained.

Reservoir Fabrication and Assembly. Reservoir production, a relatively new responsibility at KCP, was transferred from the Rocky Flats Plant through the previously authorized nonnuclear consolidation program. The new reservoir production area is correctly sized to support the ongoing workload associated with limited-life component exchanges and would not be changed for this alternative.

Transportation Safeguards. Trailer production and escort vehicle modification would continue to be managed and operated as a separate unit. Floor space requirements would be reduced by relocation of the escort vehicle modification operations so they would be contiguous with the trailer operations.

Table 3.4.2.2-2 shows the KCP Nonnuclear Fabrication Facility annual surge operating requirements.

Table 3.4.2.2-2.-- *Kansas City Plant Nonnuclear Fabrication Facility Surge Operation Annual Requirements*

Requirement	Consumption
Resource	
Electrical energy (MWh)	225,000
Peak electrical demand (MWe)	30
Liquid fuel (L)	None
Natural gas [27] (m^3)	18,900,000
Water (L)	1,340,000,000
Plant Footprint (ha)	NA [28]
Employment (Workers)	2,928 [29]

Waste Management. The KCP waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All wastes generated at KCP facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workload would not require significant modification of the existing KCP waste management infrastructure. Waste generation for construction and operation of the KCP nonnuclear fabrication alternative is shown in table 3.4.2.2-3.

Table 3.4.2.2-3.-*Kansas City Plant Nonnuclear Fabrication Facility Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent From Surge Operations (m^3)
Low-Level[30]			
Liquid	None	None	None

Solid	None	None	None
Mixed Low-Level[30]			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	60	60
Solid	786	61	61
Nonhazardous (Sanitary)			
Liquid	None	570,000	570,000
Solid	745	310	310
Nonhazardous (Other)			
Liquid	None	223,900	223,900
Solid	None	11,500	11,500

3.4.2.3 *Relocate to Los Alamos National Laboratory*

Historically, LANL has maintained a prototyping capability in support of R&D for nearly all of the components in nuclear weapons that are designed at LANL. The basis for this alternative would be to use the existing infrastructure at LANL to provide for production requirements of the Complex. Figures 3.4.2.3-1 through *(graphic not available)* 3.4.2.3-5 show the technical areas (TAs) involved and the detailed facility layout for key project TAs. Nonnuclear fabrication missions considered for transfer to LANL fall into the following categories: plastics, detonator inert components, and pilot plant; and reservoirs and valves. The LANL nonnuclear fabrication alternative is discussed in more detail in appendix section A.3.6.2.

[Figure 3.4.2.3-2] [Figure 3.4.2.3-3] [Figure 3.4.2.3-4]

Construction

Plastics, Detonator Inert Components, and Pilot Plant. In the areas of plastics production and high energy detonator inert components, existing facilities contain nearly all required processing equipment and facilities to provide for the production mission. LANL facilities currently used for plastics processing and polymer synthesis activities include the Weapons Plastics and Adhesives Facility at TA-16, the Detonator Production Facility at TA-22, Reservoir and Valve Production at TA-3, and a Polymer Synthesis, Processing, and Characterization Facility at TA-35. Additional floor space is available at TA-16 for production and two bays are available in the DX-16 Pilot Processing Facility for large-scale pilot processes. The following facilities, with the specified installations/upgrades, would be used for nonnuclear production activities at LANL: plastics production would be located in TA-16, Buildings 302, 303, 304, 305, 306, and 307; detonator inert components would be manufactured in TA-22, Building 91; and large-scale pilot plant polymer synthesis would occur in TA-16, Building 340. Electrical system upgrades and the installation of new and/or transferred equipment would be required in most of these facilities. Small-scale pilot plant polymer synthesis operations and mold storage, which require no installations or upgrades, would be located in TA-35, Building 213, and TA-16, Building 332, respectively.

Reservoirs and Valves. The basis for the reservoir alternative is to construct a Boost System Production Facility and establish a nuclear-grade material mission. The alternative would dedicate 2,300 m^2 (25,000 ft^2) in TA-3, Building SM-39 (Main Shops) for boost system production and the nuclear grade materials mission. Building modification activities would include removal of existing machine tools and replacement with new or transferred machine tools. No other upgrades would be necessary. The proposed installations and modifications would occur over a 2-year period.

Table 3.4.2.3-1 shows construction requirements to install 50 pieces of equipment and to upgrade electrical systems for the LANL nonnuclear fabrication alternative.

Operation

Plastics, Detonator Inert Components, and Pilot Plant. LANL currently has process equipment and capabilities in place to support much of this mission. Additional processing capability would be transferred from KCP in the areas of polyurethane foam dispensing, intensive mixing, extruding and leaching of cellular silicone, flame spraying, and parylene coating. The proposed plastics production activities would use equipment such as mixers, extruders, roll mills, presses, coaters, screeners, testing equipment, and quality assurance equipment. For pilot plant operations, additional processing capability would be required for large-scale processing of up to 379 liters (L) (100 gallons [gal]). The proposed pilot plant production activities would use reactor vessels, mixer heaters, pulverizers, and solvent recovery equipment during operation. All detonator flat cable processing capability is currently available; however, upgraded equipment would be used to better meet production requirements. Detonator inert component manufacture and assembly operations would use several types of equipment including drills, cleaners, etchers, strippers, developers, scanners, laminators, presses, lasers, and welders.

Table 3.4.2.3-1.-- Los Alamos National Laboratory Nonnuclear Fabrication Facility Construction Requirements

Requirement	Consumption
Material/Resource	
Electrical energy (kWh)	105
Peak electrical demand (kWe)	3.8
Concrete (m^3)	None
Steel (t)	None
Gasoline, diesel, and lube oil (L)	None

Industrial gases [31] (m^3)	None
Water (L)	9,500
Land (ha)	NA [32]
Employment	
Total employment (worker years)	12
Peak employment (workers)	6
Construction period (years)	2

Reservoirs and Valves. Process equipment and capabilities exist at LANL to support small-scale reservoir and valve production. Operation activities would consist of metal machining, inspection, packaging, and storage functions. Typical production equipment would include lathes, mills, drills, grinders, welders, and inspections/testing equipment. Table 3.4.2.3-2 shows the LANL Nonnuclear Fabrication Facility surge operating requirements.

Waste Management. The LANL existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous and nonhazardous wastes generated at LANL facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workload would not require significant modification of the existing LANL waste management infrastructure. Waste generation for construction and operation of the LANL nonuclear fabrication alternative is shown in table 3.4.2.3-3.

Table 3.4.2.3-2- ***Los Alamos National Laboratory Nonnuclear Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	525
Peak electrical demand (MWe)	0.23
Liquid fuel (L)	None
Natural gas[33](m^3)	340
Water (L)	48,300,00
Plant Footprint	NA [34]
Employment (Workers)	315 [35]

Table 3.4.2.3-3.-- ***Los Alamos National Laboratory Nonnuclear Fabrication Facility Waste Volumes***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations [36] (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Hazardous			
Liquid	None	11	11
Solid	None	0.11	0.11
Nonhazardous (Sanitary)			
Liquid	None	568	566 [37]
Solid	None	10	6 [38]
Nonhazardous (Other)			
Liquid	5 [39]	25 [40]	None
Solid	0.04	3 [41]	None

3.4.2.4 *Relocate to Lawrence Livermore National Laboratory*

This alternative calls for LLNL to provide support for nuclear system plastic components. The LLNL Nonnuclear Fabrication Facility would provide the plastic components and polymers currently produced at KCP. These products include filled and unfilled molded parts; syntactic, rigid, and flexible foam parts; composite structures and specialty polymers currently produced at the KCP pilot plant. All processes would be identical to those currently used at KCP, except for the scaling down of the cellular silicone process and one polymer synthesis process.

This alternative would build on LLNL's established plastics fabrication mission. Over half of the equipment to be used is currently operational at LLNL. The laboratory has used this equipment to provide components for prototypes, underground test devices, and hydrotest devices to the weapons program, and numerous other components to other DOE programs. As a result of this established mission, LLNL has developed a site infrastructure that would support this alternative at the Livermore Site (figure 3.4.2.4-1). All facilities meet the current Federal and state environment, safety, and health requirements. The LLNL nonnuclear fabrication alternative is discussed in more detail in appendix section A.3.6.3.

Construction. The LLNL Nonnuclear Fabrication Facility would consist of 15 departments with facilities located primarily in Building B231 and 4 other buildings nearby. No new facility construction is required. Modification efforts would essentially consist of a small to moderate expansion within existing facilities. The fabrication, including polymer synthesis, would be confined to a consolidated area consisting of five adjacent buildings as shown in figure 3.4.2.4-2. Table 3.4.2.4-1 shows construction requirements for the LLNL Nonnuclear Fabrication Facility.

Table 3.4.2.4-1.-- ***Lawrence Livermore National Laboratory Nonnuclear Fabrication Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	21
Peak electrical demand (MWe)	0.05
Concrete (m^3)	7.6
Steel (t)	7.3
Gasoline, diesel, and lube oil (L)	19,900
Industrial gases [42] (m^3)	7.5
Water (L)	79,500
Land (ha)	NA [43]
Employment	
Total employment (worker years)	19
Peak employment (workers)	6
Construction period (years)	5

Operation. The operation of the LLNL nonnuclear fabrication mission includes production or procurement of plastic components, polymers, and composite parts. The processes and products included in the LLNL nonnuclear fabrication alternative are transfer molded parts, compression molded parts, injection molded parts, machined plastic parts, silicone cushions (all types), syntactic components, filled polymers, and polymer synthesis. Table 3.4.2.4-2 shows the surge operating requirement for the LLNL Nonnuclear Fabrication Facility.

Table 3.4.2.4-2.-- ***Lawrence Livermore National Laboratory Nonnuclear Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	108
Peak electrical demand (MWe)	0.095
Gasoline and diesel fuel (L)	None
Natural gas [44] (m^3)	28,900
Water (L)	3,790,000
Plant Footprint (ha)	NA [45]
Employment (Workers)	114 [46]

Waste Management. LLNL's existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous and nonhazardous wastes generated at LLNL facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workloads would not require significant modification of the existing LLNL waste management infrastructure. Waste generation for construction and operation of the LLNL nonnuclear fabrication alternative is shown in table 3.4.2.4-3.

Table 3.4.2.4-3.-- ***Lawrence Livermore National Laboratory Nonnuclear Fabrication Facility Waste Volumes***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations [47] (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Hazardous			
Liquid	0.08	7 [48]	3 [49]
Solid	0.15	None	0.2
Nonhazardous (Sanitary)			
Liquid	36	5,770 [50]	5,770 [51]
Solid	0.9	127 [52]	64 [53]
Nonhazardous (Other)			
Liquid	76	Included in sanitary	Included in sanitary
Solid	10	Included in sanitary	Included in sanitary

3.4.2.5 *Relocate to Sandia National Laboratories*

This alternative would transfer the majority of current KCP missions to the Albuquerque, NM facility of SNL, except for nuclear system plastic components that would go to either LANL or LLNL, and high energy detonator inert components that would go to LANL. In addition, there is the option of moving the reservoir mission to either SNL or LANL.

Only major assemblies or those components requiring special security considerations would be planned for in-house fabrication. SNL production would consist primarily of assembly of procured piece parts. The technologies that have been traditionally retained in-house at KCP, but under this alternative would be produced commercially, include the following: printed wiring boards, interconnect/junction boxes, lasers and electro-optics, interconnect cables, and molded plastic parts. Additionally, SNL would outsource metal machining, hybrid microcircuit substrates, and sheet metal forming. A more detailed discussion of this alternative is provided in appendix section A.3.6.4.

Construction. This alternative would require construction of a new stand-alone production site at SNL, directly east of Technical Area I (figure 3.4.2.5-1). The alternative includes six new buildings and renovation or minor modifications to some existing buildings. The site would have four new production facilities, an office structure, and a central utilities building, all surrounded by a security fence with guards. The facility plot plan is shown in figure 3.4.2.5-2.

The new site would be independent of the existing Technical Area I, but would be connected to the area's utility network. The new construction would total approximately 58,060 m^2(625,000 ft^2), which would be located on 9 ha (22 acres) of available land. In addition to renovation projects, some existing buildings would undergo minor modifications to accept the new workload. These minor modifications would yield an additional 5,110 m^2(55,000 ft^2) of work space.

The new or modified facilities are Office Facility; Distribution Center Facility, Electronic Assembly Facility, Mechanical Assembly Facility, Special Products Facility, Central Utility Building, and modifications to existing buildings (820, 860, 894, 905, 913, and others). Table 3.4.2.5-1 shows construction requirements for the SNL Nonnuclear Fabrication Facility.

Operation. The nonnuclear fabrication alternative at SNL would operate processes and manufacturing functions similar to those of KCP. Manufacturing activities would be designed to fabricate the numerous electrical and mechanical components of nuclear weapons not proposed to be secured commercially. Fabrication activities would involve a precision machine shop with forges, presses, ovens, other metal-forming and metal-treating equipment, mechanical assembly areas, and clean rooms. Table 3.4.2.5-2 shows the surge operating requirements for the SNL Nonnuclear Fabrication Facility.

Table 3.4.2.5-1.-- ***Sandia National Laboratories Nonnuclear Fabrication Facility Construction Requirements***

Requirement	**Consumption**
Material/Resource	
Electrical energy (MWh)	46.8
Peak electrical demand (MWe)	2.5
Concrete (m^3)	12,800
Steel (t)	5,440
Gasoline, diesel, and lube oil (L)	2,600,000
Industrial gases [54] (m^3)	NA
Water (L)	2,200,000
Land (ha)	9
Employment	
Total employment (worker years)	781
Peak employment (workers)	379
Construction period (years)	3

Table 3.4.2.5-2.-- ***Sandia National Laboratories Nonnuclear Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	39,700
Peak electrical demand (MWe)	6.2
Gasoline and diesel fuel (L)	None
Natural gas [55] (m ^{3})	3,270,000
Water (L)	893,000,000
Plant Footprint (ha)	9
Employment (Workers)	1,160

Waste Management. The SNL existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous and nonhazardous wastes generated and any radioactive or mixed wastes generated under upset conditions at SNL facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workload would not require significant modification of the existing SNL waste management infrastructure. Waste generation for construction and operation of the SNL Nonnuclear Fabrication Facility is shown in table 3.4.2.5-3.

Table 3.4.2.5-3.-- ***Sandia National Laboratories Nonnuclear Fabrication Facility Waste Volumes***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations [56] (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level [57]			
Liquid	None	None	None
Solid	None	None	None
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	0.11	15	15
Solid	23	17	17
Nonhazardous (Sanitary)			

Liquid	6,160 [58]	291,470	291,470 [59]
Solid	236	7,880	3,940 [60]
Nonhazardous (Other)			
Liquid	383 [61]	Included in sanitary	Included in sanitary
Solid	5	Included in sanitary	Included in sanitary

3.4.3 Pit Fabrication and Intrusive Modification Pit Reuse Alternatives

This capability, hereafter referred to as pit fabrication, includes all activities necessary to fabricate new pits, to modify the internal features of existing pits (intrusive modification), and to recertify or requalify pits. Processes for fabrication of replacement pits and modification of existing pits may involve handling, storing, and shipping HEU components. It is assumed that HEU components for assembly into replacement pits will be fabricated at Y-12 and shipped to LANL. Uranium components removed from pits that are to be replaced would be processed to remove residual plutonium, packaged, and shipped to Y-12.

For the base case analysis, workload requirements are assumed to be at a level necessary to maintain competence and to replace components destroyed during surveillance testing. This base case production rate is approximately 20 pits per year. In order to ensure that DOE is able to support the national security mission, equipment would be installed to provide the capability to fabricate one each of every pit type in the post-2005 stockpile. This concept is called capability-based capacity. Operating this array of equipment 5 days per week, on a single shift, provides an annual capacity of approximately 50 pits of, at most, 2 different types.

There are two alternative sites for pit fabrication: SRS and LANL. Nonintrusive modification pit reuse, which is an inherent capability of the pit fabrication facility, includes the processes and systems necessary to make modifications to the external features of a pit, if necessary, and to recertify the pit for reuse in a weapon.

3.4.3.1 *No Action*

Under the No Action alternative, DOE would continue to use existing R&D capabilities at LANL and LLNL. LANL maintains a limited capability to fabricate plutonium components using its Plutonium Research and Development Facility and performs surveillance operations on plutonium components returned from the stockpile. In addition, less extensive capabilities would continue at LLNL to support material and process technology development. Under No Action, DOE would not have the capability to perform pit fabrication to meet the requirements described in section 3.1 for the base case.

3.4.3.2 *Reestablish at Los Alamos National Laboratory*

This alternative would reconfigure the Plutonium Facility at LANL to fulfill the pit fabrication mission and the intrusive modification pit reuse mission. Pit manufacturing would consist of the following functions: pit fabrication, plutonium processing, waste processing, analytical chemistry, physical vapor deposition coatings, and storage. A more detailed discussion of this alternative is provided in appendix section A.3.3.1.

Construction. This alternative would locate pit manufacturing in existing facilities within five technical areas (TAs -55, -3, -8, -50, and -54). *(graphic not available)* Figure 3.4.3.2-1 shows the LANL TAs. The pit fabrication/modification and plutonium processing activities would be located in the existing Plutonium Facility (PF-4), which is situated within the controlled access area of TA-55. The 300 Area of PF-4 would be used to fabricate plutonium components and to assemble those components into pits. Existing equipment would be retained as much as possible, but some equipment would be upgraded to production quality. Other TAs would provide waste processing, analytical chemistry, and other support functions. Figure 3.4.3.2-2 shows the plot plan for the pit fabrication/modification and plutonium processing facilities in TA-55. Table 3.4.3.2-1 shows construction requirements for the LANL Pit Fabrication Facility.

Table 3.4.3.2-1.-- ***Los Alamos National Laboratory Pit Fabrication Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	Minimal
Peak electrical demand (MWe)	Minimal
Concrete (m^3)	Minimal
Steel (t)	Minimal
Gasoline, diesel, and lube oil (L)	Minimal
Industrial gases [62] (m^3)	Minimal
Water (L)	Minimal
Land (ha)	NA [63]
Employment	
Total employment (worker years)	216
Peak employment (workers)	138
Construction period (years)	3

Operation. This alternative would consolidate the pit fabrication and modification processes, receiving pits from offsite and shipping new or rebuilt pits to the Weapons Assembly Facility. The pits received from offsite would be routed to a disassembly area. The plutonium metal from disassembled pits would be purified before transfer to the fabrication area. Residues generated in the disassembly/metal purification areas would primarily consist of chloride salts, crucibles, and chloride-contaminated scrap. The bulk of the residual plutonium would be purified and converted to plutonium metal in the chloride recovery area. Recovered plutonium metal would also be sent to the fabrication area. During fabrication, plutonium metal would be cast into the desired near-net shape and machined to the final shape with desired tolerances. The finished components would be assembled with other nonplutonium materials into the new pit component. These new pits would be sent to the Weapons Assembly Facility. During the casting and machining operations, a number of residues would be generated that require processing and would subsequently undergo nitrate aqueous recovery operations. In nitrate aqueous recovery, the residues are purified and converted to oxide for return to the reduction operations. Solid and liquid wastes from processing areas would be routed to waste management facilities for processing into a disposable waste form. Analytical laboratories provide chemical analyses of plutonium metal, oxides, solutions, and wastes. Table 3.4.3.2-2 shows the surge operating requirements for the LANL Pit Fabrication and Intrusive Modification Pit Reuse Facility.

Table 3.4.3.2-2.-- ***Los Alamos National Laboratory Pit Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	5,480
Peak electrical demand (MWe)	0.7
Liquid fuel (L)	None
Natural gas [64] (m^3)	30,900
Water (L)	30,200,000
Plant Footprint (ha)	NA [65]
Employment (Workers)	628 [66]

Waste Management. The existing LANL waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, radioactive, and mixed waste generated at LANL facilities would be managed in accordance with all applicable Federal and state regulation. The wastes anticipated from the estimated workloads would not require significant modifications of the existing LANL waste management infrastructure. Waste generation for construction and operation of the LANL Pit Fabrication Facility is shown in table 3.4.3.2-3.

Table 3.4.3.2-3.-- ***Los Alamos National Laboratory Pit Fabrication Facility Waste Volumes (80 Pits Per Year)***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operation (m^3)	Annual Volume Effluent from Surge Operation (m^3)
Transuranic			
Liquid	None	5	None
Solid	6 [67]	43	60
Mixed Transuranic			
Liquid	None	None	None

Solid	None	2	2
Low-Level			
Liquid	None	15	None
Solid	12 [68]	386	393
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	0.06	2	2
Solid	51	None	None
Nonhazardous (Sanitary)			
Liquid	None	12,300 [69]	12,300
Solid	None	552 [70]	552
Nonhazardous (Other)			
Liquid	None	Included in sanitary	Included in sanitary
Solid	26 [71]	Included in sanitary	Included in sanitary

3.4.3.3 *Reestablish at Savannah River Site*

This alternative would establish a pit fabrication and reuse facility at SRS within existing hardened facilities, but with new equipment and systems. The facility would fulfill the replacement pit fabrication mission and the intrusive and nonintrusive modification pit reuse missions. This alternative would consolidate all pit fabrication and modification processes, receiving pits from offsite and shipping new or rebuilt pits off site to the Weapons Assembly Facility. Nonnuclear pit components would be manufactured at other DOE sites and shipped to SRS for assembly into pits. The receiving, handling, and disposition of surplus plutonium could also be consolidated with the plutonium processing facilities. A more detailed discussion of this alternative is provided in appendix section A.3.3.2.

Construction. Facilities are available at the SRS separation areas, F-Area, and H-Area, which could house, in hardened structures, all the process functions required for the manufacture of plutonium pits (figure 3.4.3.3-1). Pit fabrication would be located in Building 232-H, and plutonium processing would be located in the F-Canyon facilities.

Building 232-H is primarily a hardened facility that is used for tritium processing and handling operations that are being relocated to the Replacement Tritium Facility. Adequate space would be available for the Pit Fabrication Facility following removal of some existing equipment and piping systems. New equipment and systems would be required for the Pit Fabrication Facility.

F-Canyon facilities have adequate noncontaminated hardened areas to house the plutonium processing functions. The Plutonium Storage Facility and the New Special Recovery Facility, which have never been started up, would be used in addition to a third level F-Canyon building production space that has been decontaminated. Many of the unused glove boxes in these facilities could be used as is or with minor modifications. Table 3.4.3.3-1 shows construction requirements, and figure 3.4.3.3-2 provides a site plan for the SRS Pit Fabrication and Intrusive Modification Pit Reuse Facility.

Table 3.4.3.3-1.-- ***Savannah River Site Pit Fabrication Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	15
Peak electrical demand (MWe)	0.37
Concrete (m^3)	1,600
Steel (t)	249
Gasoline, diesel, and lube oil (L)	175,000
Industrial gases [72] (m^3)	3,780
Water (L)	30,000,000
Land (ha)	NA [73]
Employment	
Total employment (worker years)	801
Peak employment (workers)	288
Construction period (years)	5

Operation. Table 3.4.3.3-2 shows the surge operating requirements for the SRS Pit Fabrication and Intrusive Modification Pit Reuse Facility. Specific processes required for pit fabrication are discussed in appendix section A.3.3.2.

Table 3.4.3.3-2.-- ***Savannah River Site Pit Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	9,700
Peak electrical demand (MWe)	1.6
Liquid fuel (L)	28,400
Natural gas [74] (m^3)	None
Water (L)	46,200,000
Coal (t)	1,090
Plant Footprint (m^3)	NA [75]

Employment (Workers)	813

Pit disassembly, plutonium purification, and residue processing would be performed in existing hardened facilities in the F-Area. These facilities include New Special Recovery, which is equipped to dissolve and purify plutonium, a new reduction (metal preparation) facility in Building 221-F, and the Plutonium Storage Facility. Existing facilities in the F-Area are sized for a large yearly throughput (2 to 5 metric tons [t] [2.2 to 5.5 short tons {tons}]), if required. Also available onsite is the Defense Waste Processing Facility, which would be used for disposal of americium that is a byproduct of plutonium purification. Analytical laboratories in the F-Canyon Area are available to support process control requirements. These facilities in F-Area are operated by the DOE Environmental Management Program.

The plutonium fabrication process in Building 232-H would be an abbreviated version of the process used by the Rocky Flats Plant. Though there are several pit types, the process for each pit type is basically the same. The process consists of casting parts to the near-net shape, machining the surfaces of the casting to achieve the final shape, and performing tests on the completed parts to ensure suitability. After this inspection, the plutonium components are cleaned and assembled with the nonnuclear components to be built into the pit and then welded together into one unit. With the plutonium encapsulated, it may then be safely removed from the glove box, certified, and stored or shipped offsite, as needed.

Nonnuclear components used in the new pits would be received from offsite. After inspection, these parts would be stored in Building 704-55H until needed for either newly fabricated or reused pits.

For the nonintrusive modification pit reuse function, the pit is not disassembled. The entire pit is received through the weapons retirement/disassembly process. The pit is then cleaned, inspected and, if necessary, the exterior of the pit is modified. No plutonium is exposed in the nonintrusive modification pit reuse function.

Waste Management. The existing SRS waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, radioactive, and mixed waste generated at SRS facilities would be managed in accordance with all applicable Federal and state regulations. The wastes anticipated from the estimated workloads would not require significant modifications of the existing SRS waste management infrastructure. The plutonium recovery process would generate a liquid transuranic (TRU) waste that SRS would manage as a high-specific activity waste. This waste would be managed in accordance with the SRS HLW management plan and would result in HLW glass logs and LLW saltstone. Radiographic inspection would generate a low-specific activity waste stream that would include development chemicals such as silver. This stream would be treated as mixed LLW. Waste generation for construction and operation of the SRS Pit Fabrication Facility is shown in table 3.4.3.3-3.

Table 3.4.3.3-3.-- ***Savannah River Site Pit Fabrication Waste Volumes (120 Pits Per Year)***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Transuranic			
Liquid	None	28 [76]	None
Solid	None	129 [77]	129b
Mixed Transuranic			
Liquid	None	None	None
Solid	None	11	11
Low-Level			
Liquid	None	80 [78]	None
Solid	None	88 [79]	34
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	<0.01	<1	None
Solid	8 [80]	None	<0.01 [81]
Nonhazardous (Sanitary)			
Liquid	3,020	46,160	46,140 [82]
Solid	23	1,450	1,580
Nonhazardous (Other)			
Liquid	None	None	None
Solid	500 [83]	1,450 [84]	None

3.4.4 Secondary and Case Fabrication Alternatives

The secondary and case fabrication mission includes all activities to support fabrication, surveillance, inspection, and testing of secondaries and components. Functional capabilities for these services include operations to physically and chemically process, machine, inspect, assemble, and disassemble secondary and case materials. Materials include depleted uranium, enriched uranium, uranium alloys, isotopically enriched lithium hydride and lithium deuteride, and other materials. The concept of capability-based capacity discussed in section 3.4.3 applies to this section. Alternative sites considered for stockpile management secondary activities are ORR, LANL, and LLNL.

When comparing data between site alternatives, it is important to note that there are differences in the facility designs. The Y-12 alternative includes all the necessary support facilities to conduct the missions, not just the production and storage facilities. The LANL and LLNL alternatives only consider the incremental changes for operating the production facilities. The actual production footprint size of each alternative is almost identical; however, the production capacities vary between site alternatives. For example, base case, multiple-shift capacities at Y-12 and LANL are about 150 units, whereas at LLNL the equivalent production capability would be about 50 units. This creates significant differences in some of the data.

3.4.4.1 *No Action*

Under No Action, ORR would continue secondary and case fabrication. Y-12 maintains the capability to produce and assemble uranium and lithium components, to recover uranium and lithium materials from the component fabrication process and disassembled weapons, and to produce secondaries, cases, and related nonnuclear weapons components.

3.4.4.2 *Downsize at Oak Ridge Reservation*

This alternative would be based on downsizing the existing secondary and case fabrication facilities at Y-12 (figure 3.4.4.2-1) consistent with future requirements. The downsized facilities would only require approximately 14 percent of the existing Y-12 floor space for the DP mission, while EM missions would assume the majority of the remaining area. The Y-12 secondary and case fabrication facilities would be divided into the following four factories:

- Enriched uranium factory for processing enriched uranium
- Depleted uranium factory for processing depleted uranium and uranium alloys
- Special materials factory for processing lithium compounds and other materials
- Nonnuclear factory for processing nonnuclear secondary and case parts and materials

This alternative is discussed in more detail in appendix section A.3.2.1.

Construction . This alternative consists of five principal production buildings, one shared production facility, and a number of office, utility, and changehouse facilities. Buildings 9204-2 and 9201-5W would be placed in cold standby for potential activation should unforeseen capacity needs arise. Re-activation of these buildings would require separate NEPA evaluation. Figure 3.4.4.2-2 shows the location of the Y-12 secondary and case fabrication facilities. There would be no new facility construction at Y-12 to support the secondary and case fabrication mission. Modifications to the existing buildings would be required for implementation of the alternate secondary and case fabrication mission and to upgrade the buildings to meet natural phenomena requirements. The modifications would be as follows:

- Building 9996: Connections between the building and the A-2 Wing of Building 9212 complex would be strengthened.
- Building 9212: Modifications would be made to numerous columns, knee braces, and cross braces to provide proper stiffness and load distribution.
- Buildings 9215: The M-Wing area of this building would be converted primarily for enriched uranium storage. The high case would require some machine tools to be in cold standby. The F-Wing area would house the can shop, to be relocated from Building 9201-1. The roof deck would be tack welded to existing purlins, additional corner supports would be added to this area of the roof, and four new scuppers would be added.
- Building 9998: This building houses the depleted uranium/binary foundry area. The installation of a 3,175-t (3,500-ton) press would be required in F-Area. Enriched uranium machining and the associated dimensional inspection would be relocated to the H2-Area. Other additions include the plasma-spray coating and ceramic machining operations to be located in the G3-Area. Some new equipment for special materials processing would also be installed in the G3-Area. Four steel columns and two steel girders would be strengthened by adding additional steel. Roof bracing would be added and additional tack welding of the roof support steel would be done.
- Building 9201-5N: Tack weld roof deck to roof, provide additional roof corner support, and install scuppers.
- Building 9204-2E: The first floor of this building would have a lithium pro (MWh)

Table 3.4.4.2-1 - ***Y-12 Plant Secondary and Case Fabrication Facility Construction Requirements***

Requirement	**Consumption**
Material/Resource	
Electrical energy (MWh)	2.7
Peak electrical demand (MWe)	0.2
Concrete (m^3)	100
Steel (t)	20
Gasoline, diesel, and lube oil (L)	10,000
Industrial gases(m^3)[85]	300
Water (L)	2,000,000
Land (ha)	NA[86]
Employment[87]	
Total employment (worker years)	72
Peak employment (workers)	14
Construction period (years)	6

Operation. Table 3.4.4.2-2 shows the surge operating requirements for the Y-12 Secondary and Case

Fabrication Facility.

Table 3.4.4.2-2.-- ***Y-12 Plant Secondary and Case Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	118,000
Peak electrical demand (MWe)	19
Liquid fuel (L)	250,000
Natural gas [88] (m^3)	17,000,000
Water (L)	1,510,000,000
Coal (t)	500
Plant Footprint (ha)	NA [89]
Employment (Workers)	4,508 [90]

Waste Management. The ORR existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, radioactive, and mixed wastes generated at Y-12 facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workloads would not require significant modification of the existing ORR waste management infrastructure. Waste generation for construction and operation of the Y-12 secondary and case fabrication alternative is shown in table 3.4.4.2-3.

Table 3.4.4.2-3.-- ***Y-12 Plant Secondary and Case Fabrication Facility Waste Volumes***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	320	None
Solid	8	1,120 [91]	570 [92]
Mixed Low-Level			
Liquid	None	3,400	3,400
Solid	1	92 [93]	92

Hazardous			
Liquid	None	Included in mixed	Included in mixed
Solid	2	Included in mixed	Included in mixed
Nonhazardous (Sanitary)			
Liquid	27	320,000	319,400 [94]
Solid	30 [95]	13,500 [96]	7,670 [97]
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	2	10,000 [98]	Included in sanitary

3.4.4.3 Relocate to Los Alamos National Laboratory

This alternative would establish a secondary and case fabrication capability using the processes proven at Y-12 and would use facilities in 11 existing buildings. The LANL Secondary and Case Fabrication Facility operations would fall into the following four categories:

- Enriched uranium operations
- Depleted uranium and uranium alloy operations
- Special materials fabrication for lithium compounds and other materials
- Nonnuclear fabrication and processing for nonnuclear secondary and case parts and materials

This alternative is discussed in more detail in appendix section A.3.2.2.

Construction. Secondary and case fabrication at LANL would utilize existing facilities within the boundaries of TAs -3, -8, -50, -55, and -54. Facilities within each of these TAs include the TA-3 Sigma complex (Buildings SM-35, SM-66, and SM-141), the TA-3 Chemistry and Metallurgy Research Building (Building SM-29), the TA-3 Main Machine Shop (Buildings SM-39 and SM-102), the TA-8 Nondestructive Evaluation Facility (Buildings 22 and 23), the TA-55 Nuclear Material Storage Facility for overflow capacity, the TA-50 Liquid Radioactive Waste Management Facility, and the TA-54 Solid Radioactive Waste Management Area. These areas are shown in figure 3.4.4.3-1.

Figure 3.4.4.3-2 shows the major structures located in TA-3. The buildings shown on this plot plan for use in stockpile stewardship and management operations are SM-29, SM-35, SM-39, SM-66, SM-102, and SM-141. Modifications would be required for the following facilities:

- Renovations to Wings 2, 4, and 9 of the Chemistry and Metallurgy Research Building

- Main machine shop change room and ventilation upgrades
- Sigma complex lithium forming, machining, and inspection
- Sigma complex lithium purification and storage

Modification to the LANL facilities to perform the stockpile management secondary and case fabrication mission would require approximately 7 years for design, construction, mission transfer, and operational startup. Table 3.4.4.3-1 shows construction requirements for the LANL Secondary and Case Fabrication Facility.

Table 3.4.4.3-1.-- ***Los Alamos National Laboratory Secondary and Case Fabrication Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	4,130
Peak electrical demand (MWe)	0.75
Concrete (m^3)	245
Steel (t)	54
Gasoline, diesel, and lube oil (L)	22,700
Industrial gases [99] (m^3)	11,500
Water (L)	4,160,000
Land (ha)	NA [100]
Employment	
Total employment (worker years)	205
Peak employment (workers)	55
Construction period (years)	4

Operation. Table 3.4.4.2-2 shows the surge operating requirements for the LANL Secondary and Case Fabrication Facility.

Table 3.4.4.3-2.-- Los Alamos National Laboratory Secondary and Case Fabrication Facility Surge Operation Annual Requirements

Requirement	Consumption
Resource	
Electrical energy (MWh)	36,000
Peak electrical demand (MWe)	5
Liquid fuel (L)	100,000
Natural gas [101] (m^3)	None

Water (L)	55,000,000
Plant Footprint (ha)	NA [102]
Employment (Workers)	523 [103]

Table 3.4.4.3-3.-- ***Los Alamos National Laboratory Secondary and Case Fabrication Facility Waste Volumes***

Category	**Annual Average Volume Generated from Construction (m^3)**	**Annual Volume Generated from Surge Operations (m^3)**	**Annual Volume Effluent from Surge Operations (m^3)**
Low-Level			
Liquid	None	192	None
Solid	134	690	349 [104]
Mixed Low-Level			
Liquid	None	30	**30**
Solid	10	108	**108**
Hazardous			
Liquid	None	60	60
Solid	37	216	216
Nonhazardous (Sanitary)			
Liquid	890	20,240	20,370
Solid	120	1,160	639 [105]
Nonhazardous (Other)			
Liquid	Included in sanitary	None	None
Solid	10 [106]	3,000	3,000

Waste Management. The LANL existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, radioactive, and mixed wastes generated at LANL facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workloads would not require significant modification of the existing LANL waste management infrastructure. Waste generation for construction and operation of the LANL secondary and case fabrication alternative is shown in table 3.4.4.3-3.

3.4.4.4 Relocate to Lawrence Livermore National Laboratory

This alternative would establish a secondary and case fabrication capability using the processes proven at Y-12, and would use facilities in existing buildings. The LLNL Secondary and Case Fabrication Facility operations are the same as those described in section 3.4.4.3. This alternative is discussed in more detail in appendix section A.3.2.3.

Construction. Manufacturing and assembly of the secondaries and cases would take place at the Livermore Site (figure 3.4.4.4-1) in the buildings shown on the LLNL site plan, figure 3.4.4.4-2. The secondary and case fabrication facilities at LLNL would principally involve the following buildings with minor modifications:

- Building 175 for E-beam melt facility for uranium alloy billets
- Building 231 for uranium foundry and metal working for uranium alloys
- Building 241 for special material fabrication (lithium and other special materials)
- Building 321 for machining of depleted uranium and uranium alloys and fabrication of nonnuclear components
- Building 332 as the Main Enriched Uranium Piece Part Fabrication Facility and the Main A/D Quality Evaluation Facility
- Building 334 as an extension to Building 332

In addition, the secondary and case fabrication functions would share facilities in several buildings with other LLNL programs for sample test activities. While this alternative would not require new building construction, it would require some modifications and building renovations, and the construction of a 167 m *2* (1,800 ft^{2}) steel frame covered space within the Superblock protected area to house the enriched uranium inventory. Table 3.4.4.4-1 shows construction requirements for the LLNL Secondary and Case Fabrication Facility.

Table 3.4.4.4-1.-- ***Lawrence Livermore National Laboratory Secondary and Case Fabrication Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	3,500
Peak electrical demand (MWe)	0.4
Concrete (m^{3})	612
Steel (t)	73
Gasoline, diesel, and lube oil (L)	908,000
Industrial gases [107] (m^{3})	142
Water (L)	8,710,000
Land (ha)	NA [108]
Employment	
Total employment (worker years)	330

Peak employment (workers)	130
Construction period (years)	3

Operation. Table 3.4.4.4-2 shows the surge operating requirements for the LLNL Secondary and Case Fabrication Facility.

Table 3.4.4.4-2.- ***Lawrence Livermore National Laboratory Secondary and Case Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	15,000
Peak electrical demand (MWe)	2.0
Liquid fuel (L)	85,200
Natural gas [109] (m^3)	566,000
Water (L)	194,000,000
Plant Footprint (ha)	NA [110]
Employment (Workers)	760 [111]

Waste Management. The LLNL existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, radioactive, and mixed wastes generated at LLNL facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workload would not require significant modifications to the existing LLNL waste management infrastructure. Waste generation for construction and operation of the LLNL secondary and case fabrication alternative is shown in table 3.4.4.4-3.

Table 3.4.4.4-3.-- ***Lawrence Livermore National Laboratory Secondary and Case Fabrication Facility Waste Volumes***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	105	None
Solid	5	370	304
Mixed Low-Level			
Liquid	None	550	550
Solid	None	12	12

Hazardous			
Liquid	11	540	540
Solid	41	18	18
Nonhazardous (Sanitary)			
Liquid	5,050	102,000	102,000
Solid	2,820	4,320	4,320
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	255	3,200 [112]	None

3.4.5 High Explosives Fabrication Alternatives

The HE fabrication mission is described in two functional areas: HE main charge fabrication and small HE component fabrication. Capabilities required include manufacturing process development, formulation, synthesis, main charge manufacturing (pressing, machining, subassembly, receiving/storage, quality assurance, and disposition), and energetic component manufacture. The HE fabrication mission supports the production aspect of stockpile management and also supports HE surveillance and some stockpile stewardship activities.

3.4.5.1 No Action

Under No Action, Pantex would continue, in its current configuration, the fabrication and surveillance of HE components for nuclear weapons. LANL and LLNL would continue to perform weapons HE R&D, surveillance, and HE safety studies.

3.4.5.2 Downsize at Pantex Plant

The Pantex HE fabrication alternative would downsize and consolidate current HE operations and facilities. This alternative would be considered only in conjunction with maintaining the weapons A/D mission at Pantex. Although there is no requirement for collocation of weapons A/D and HE fabrication, it would not be practical to maintain Pantex operations solely for HE fabrication. This alternative is discussed in more detail in appendix section A.3.5.1.

Construction. Figures 3.4.5.2-1, 3.4.5.2-2, and 3.4.5.2-3 show Zones 11 and 12 and the existing facilities within these zones that are part of the HE fabrication proposal. Only minor modifications to existing facilities within Zones 11 and 12 would be required. The Pantex HE fabrication alternative would use existing buildings and facilities within Zones 4, 11, 12, FS-11, FS-22, FS-24, and the Burning Ground. Table 3.4.5.2-1 shows construction requirements for the Pantex HE Fabrication Facility.

Operation. The HE fabrication process comprises HE main charge fabrication, small HE component fabrication, HE formulation and synthesis, and HE testing and characterization. Processes used include isostatic pressing, machining, mechanical punch and die pressing, laser welding, explosive-extrusion, mechanical assembly, dimensional checking, and a variety of testing methodologies. There would be no change in processes or operations for HE fabrication from existing Pantex operations. Table 3.4.5.2-2 shows the annual Pantex HE Fabrication Facility surge operating requirements.

Table 3.4.5.2-1.-- ***Pantex Plant High Explosives Fabrication Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	257
Peak electrical demand (MWe)	2
Concrete (m^3)	356
Steel (t)	6
Gasoline, diesel, and lube oil (L)	12,200
Industrial gases [113] (m^3)	258
Water (L)	644,000
Land (ha)	NA [114]
Employment	
Total employment (worker years)	46
Peak employment (workers)	29
Construction period (years)	3

Table 3.4.5.2-2.-- ***Pantex Plant High Explosives Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	3,250
Peak electrical demand (MWe)	1
Liquid fuel (L)	55,600
Natural gas [115] (m^3)	500,000
Water (L)	12,500,000
Plant Footprint (ha)	NA [116]
Employment (Workers]	37 [117]

Waste Management. The existing Pantex waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, nonhazardous, and a minimal quantity of radioactive waste generated at Pantex facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workloads would not require significant modification of the existing Pantex waste management infrastructure. Waste generation for construction and operation of the Pantex HE fabrication alternative is shown in table 3.4.5.2-3.

Table 3.4.5.2-3.-- ***Pantex Plant High Explosives Fabrication Facility Waste Volumes***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	0.23	0.23
Solid	0.06	30	30
Nonhazardous (Sanitary)			
Liquid	146	7,120	7,120
Solid	None	17	8 [118]
Nonhazardous (Other)			
Liquid	Included in sanitary	None	None
Solid	2 [119]	Included in sanitary	Included in sanitary

3.4.5.3 Relocate to Los Alamos National Laboratory

This alternative would transfer HE operations to LANL from Pantex during a 2-year transition period, during which Pantex would continue to support the stockpile. This alternative would use existing LANL R&D facilities, which have sufficient capacity to accommodate the required workload. This alternative is discussed in more detail in appendix section A.3.5.2. The option to share the HE mission with LLNL is bounded by this analysis and is not discussed further.

Construction. LANL HE fabrication process capability is already established. HE fabrication and storage functions would be supported in existing facilities at LANL TAs -9, -16, and -37 (figure 3.4.5.3-1). Since LANL HE plant facilities already exist and have sufficient capacity for stockpile management requirements, no new building construction and no significant modifications would be required. As indicated in table 3.4.5.3-1, there would be minimal resource requirements other than personnel for modification and transition, and no waste would be generated. Figure 3.4.5.3-2 shows the existing major HE fabrication facilities at TA-16. Additional TAs would provide production support and testing functions.

Operation. The HE fabrication alternative at LANL would operate in the same manner as current HE fabrication processes and operations. HE processing facilities at LANL were designed and built for production-scale operations and were operated as production facilities for many years. The current baseline production technologies in use at Pantex would be used at LANL. HE processing at LANL includes HE storage; HE synthesis; HE formulations, pressing, machining, assembly, and subassembly of HE devices; quality assurance activities; and HE disposal. Operations would also continue to provide environmental, safety, and performance testing of HE and HE assemblies. Table 3.4.5.3-2 shows the annual LANL HE Fabrication Facility surge operating requirements.

Table 3.4.5.3-1.-- ***Los Alamos National Laboratory High Explosives Fabrication Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	Minimal
Peak electrical demand (MWe)	Minimal
Concrete (m^3)	Minimal
Steel (t)	Minimal
Gasoline, diesel, and lube oil (L)	Minimal
Industrial gases[120] (m^3)	Minimal
Water (L)	Minimal
Land (ha)	NA[121]
Employment	
Total employment (worker years)	77
Peak employment (workers)	46
Construction period (years)	2

Table 3.4.5.3-2.-- ***Los Alamos National Laboratory High Explosives Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption

Resource	
Electrical energy (MWh)	5,600
Peak electrical demand (MWe)	1
Liquid fuel (L)	94,600
Natural gas [122] (m^3)	3,650,000
Water (L)	13,000,000
Plant Footprint (ha)	NA [123]
Employment (Workers)	200 [124]

Waste Management . The existing LANL waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, nonhazardous, and a minimal quantity of radioactive waste generated at LANL facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workloads would not require significant modification of the existing LANL waste management infrastructure. Waste generation for construction and operation of the LANL HE fabrication alternative is shown in table 3.4.5.3-3.

Table 3.4.5.3-3.-- ***Los Alamos National Laboratory High Explosives Fabrication Facility Waste Volumes***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	4 [125]	4
Solid	None	13	13
Nonhazardous (Sanitary)			
Liquid	None	5,900	5,880 [126]
Solid	None	Included in liquid	17
Nonhazardous (Other)			

Liquid	None	6,930 [127]	6,930
Solid	None	28	28

3.4.5.4 Relocate to Lawrence Livermore National Laboratory

The LLNL HE fabrication alternative would transfer HE fabrication activities from Pantex over a 2-year transition period, during which Pantex would continue to support the stockpile. The LLNL HE Fabrication Facility would consist of the HE technology functional area with four main functions: HE main charge fabrication, small HE component fabrication, HE formulation and synthesis, and HE testing and characterization. This alternative would use existing R&D facilities, with some minor enhancements and modifications. The LLNL HE fabrication alternative is discussed in more detail in appendix section A.3.5.3. The option to share the HE mission with LANL is bounded by this analysis and is not discussed further.

Construction. The LLNL HE fabrication alternative would require construction of 1 new facility and would use 23 existing buildings, 66 existing magazines, and various utilities and services at Site 300 (figure 3.4.5.4-1). The one new facility would be for storage of HE. This building would have 11,350 kg (25,000 lb) of conventional HE bulk and parts storage for a 116 m^2 (1,250 ft^2) staging capacity. Table 3.4.5.4-1 shows construction requirements for the LLNL HE Fabrication Facility.

Table 3.4.5.4-1.-- ***Lawrence Livermore National Laboratory High Explosives Fabrication Facility Construction Requirements***

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	15
Peak electrical demand (MWe)	0.2
Concrete (m^3)	190
Steel (t)	15
Gasoline, diesel, and lube oil (L)	9,500
Industrial gases [128] (m^3)	3
Water (L)	1,230,000
Land (ha)	0.8
Employment	
Total employment (worker years)	19
Peak employment (workers)	19
Construction period (years)	1

Operation. The LLNL HE fabrication alternative activities would continue using the same facilities, processes, and operations as the existing HE manufacturing conducted at the site. The current baseline technologies in use at Pantex would be used at LLNL. The production and fabrication of the HE components and materials mission would be accommodated by an incremental increase in the workload currently supported by the HE technology at LLNL. The HE processing at LLNL includes storage, synthesis, formulation, pressing, machining, assembly, and subassembly of HE devices; quality assurance activities; and HE disposal. LLNL operations would also continue to provide environmental, safety, and performance testing of HE and HE assemblies. Table 3.4.5.4-2 shows the annual LLNL HE Fabrication Facility surge operating requirements.

Table 3.4.5.4-2.-- ***Lawrence Livermore National Laboratory High Explosives Fabrication Facility Surge Operation Annual Requirements***

Requirement	Consumption
Resource	
Electrical energy (MWh)	4,300
Peak electrical demand (MWe)	1
Liquid fuel (L)	53,100
Natural gas [129] (m ^{3})	None
Water (L)	58,200,000
Plant Footprint (ha)	0.8 [130]
Employment (Workers)	232[131]

Waste Management. The LLNL existing waste management infrastructure can be applied to manage and treat all anticipated waste streams from this alternative. All hazardous, nonhazardous, and a minimal quantity of radioactive waste generated at LLNL facilities would be managed in accordance with all applicable Federal and state waste regulations. The wastes anticipated from the estimated workloads would not require significant modification of the existing LLNL waste management infrastructure. Waste generation for construction and operation of the LLNL HE fabrication alternative is shown in table 3.4.5.4-3.

Table 3.4.5.4-3.-- ***Lawrence Livermore National Laboratory High Explosives Fabrication Facility Waste Volumes***

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			

Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	1	3	3
Solid	2	54	54
Nonhazardous (Sanitary)			
Liquid	454	7,270	7,250 [132]
Solid	11	69	55 [133]
Nonhazardous (Other)			
Liquid	946	568	566
Solid	8 [134]	36	20

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1 Surveillance is included in all capabilities.

2 Includes nonintrusive modification pit reuse and the option of strategic reserve storage of plutonium and HEU.

3 KCP functions would be distributed among two or three of the laboratories.

4 Staging and storage of working inventories of nuclear materials and components are included.

5 Research and development capability only.

6 Includes strategic storage of HEU reserve.

7 Cubic meters at standard temperature and pressure.

8 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. PX MH 1995a.

9 Cubic meters at standard temperature and pressure.

10 Contained within existing facilities.

11 Includes 22 workers for nonintrusive modification pit reuse and 624 Work for Others employees.

NA - not applicable. PX 1995a:6; PX 1996e:1; PX DOE 1995k;

PX MH 1995a.

12 Includes 9.2 m^3 generated from A/D operations and 11.3 m^3 generated from pit reuse operations.

13 Assumes two-thirds of solid LLW is compactible by a factor of 4:1 and the liquid LLW is solidified by a factor of 2:1.

14 Includes 4.6 m^3 of concrete and 0.6 t (0.7 tons) of steel. Volume estimate made by using 0.127 m^3/t for density of steel.

15 Assumes two-thirds of solid is compactible by a factor of 4:1.

PX 1995a:6; PX DOE 1995k; PX MH 1995a.

16 Cubic meters at standard temperature and pressure.

17 Does not include 4.3 ha of new facility footprint.

NT DOE 1995b.

18 Cubic meters at standard temperature and pressure.

19 New facility footprint. Total including existing facilities is 10.5 ha.

20 Includes 22 workers for nonintrusive modification pit reuse.

NT DOE 1995b; NT DOE 1995f; NTS 1995a:3.

21 Includes 18.3 m^3 generated from A/D operations and 11.3 m^3 generated from pit reuse operations.

22 Assumes two-thirds of solid LLW is compactible by a factor of 4:1 and the liquid LLW is solidified by a factor of 2:1.

23 Includes 255 m^3 of concrete and 39 t (43 tons) of steel. Volume estimate made by using 0.127 m^3/t for density of steel.

24 Assumes two-thirds of solid is compactible by a factor of 4:1.

NT DOE 1995b; NT DOE 1995f; NTS 1995a:2; NTS 1995a:3; PX DOE 1995k.

25 Cubic meters at standard temperature and pressure.

26 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. KC ASI 1995a.

27 Cubic meters at standard temperature and pressure.

28 Contained within existing facilities.

29 Includes 671 workers performing work for others.

NA - not applicable. KC ASI 1995a; KCP 1995a:2; KCP 1995a:3.

30 LLW or mixed LLW would not be generated during normal operation. However, upset conditions may result in the generation of minimal quantities of LLW or mixed LLW.

KC ASI 1995a; KCP 1995a:2; KCP 1995a:3.

31 Cubic meters at standard temperature and pressure.

32 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. LANL 1995c.

33 Cubic meters at standard temperature and pressure.

34 Contained within existing facilities.

35 Total surge employment. Increase to current employment would be 194.

NA - not applicable. LANL 1995b:3; LANL 1995b:4; LANL 1995c.

36 Data for multiple shifts were not provided. Single-shift values were multiplied by 3.

37 Assumes a 350:1 wastewater to sludge ratio in the treatment of liquid sanitary wastes.

38 Assumes that two-thirds of the solid waste is compactible by a factor of 4:1.

39 2,500 gal of cleanup/washdown water, converted to cubic meters and divided by 2 for the 2-year construction period.

40 Industrial liquid wastes, which include cleaners, liquids, lube oils, and developers, are recycled.

41 Metal machining wastes, wire, scrap, and molds are recycled.

LANL 1995c.

42 Cubic meters at standard temperature and pressure.

43 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. LLNL 1995f.

44 Cubic meters at standard temperature and pressure.

45 Contained within existing facilities.

46 Total surge employment. Increase to current employment would be 60.

NA - not applicable. LLNL 1995f; LLNL 1995i:2.

47 With the exception of sanitary wastes, the data for a multiple shift were determined by multiplying the single-shift values by 2.5.

48 Data were provided as 2,500 lb of acetone, 3,500 lb of toluene/methanol, 250 lb of toluene, and 270 lb of dimethyl formamide. Assuming a density of 1,000 kg/cubic meter, these were converted to cubic meters.

49 Assumes toluene/methanol wastewaters would be recycled by a distillation process. Five percent of the toluene/methanol volume is assumed for the distillation bottoms, which appear as a solid waste effluent.

50 No data provided for liquid sanitary wastes such as sewage. Assumed 50 gal/day per person, 250 days/yr operation. Number of employees used is 60. The urea waste stream was multiplied by 2.5. for three shifts.

51 LLNL does not treat sanitary wastewater. It goes to the municipal sanitary sewer system; thus, the effluent is the same as generated.

52 No data provided for solid sanitary wastes such as housekeeping trash. Assumed 0.3 ft3/day per person, 250 days/yr operation. Number of employees used is 60.

53 Assumes that two-thirds of the solid waste is compactible by a factor of 4:1.

LLNL 1995f; LLNL 1995i:2.

54 Cubic meters at standard temperature and pressure.

NA - not applicable. SNL 1995b:5; SNL 1995e.

55 Cubic meters at standard temperature and pressure.

SNL 1995b:4; SNL 1995b:5; SNL 1995e.

56 The data for a multiple shift were determined by multiplying single-shift data by 2.

57 LLW or mixed LLW would not be generated during normal operation. However, upset conditions may result in the generation of minimal quantities of LLW or mixed LLW.

58 No data provided. Assumes 25 gal/day per construction worker for 250 days/yr and 260 construction workers. Construction toilets are trucked offsite for servicing.

59 SNL sanitary wastewater goes to the city of Albuquerque sanitary sewer system; thus the effluent is the same as generated.

60 Assumes that two-thirds of the solid waste is compactible by a factor of 4:1.

61 Includes washing from flushing mechanical systems, dust control water, and blockwork, cementitious coatings.

SNL 1995b:5; SNL 1995e.

62 Cubic meters at standard temperature and pressure.

63 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. LANL 1995g.

64 Cubic meters at standard temperature and pressure.

65 Contained within existing facilities.

66 Total surge employment. Increase to current employment would be 260.

NA - not applicable. LANL 1995b:4; LANL 1995g.

67 Over 3-year construction period a total of 27 t (30 tons) of associated piping and ventilation ductwork from glove boxes would be generated. For volume conversion 1500 kg/m3 was assumed.

68 Over 3-year construction period a total of 41 t (45 tons) of glove boxes and 14 t (15 tons) of associated piping ventilation and ductwork, would be generated. For volume conversion, 1500 kg/m3 was assumed.

69 Assumes 50 gal/day/person/shift with the parameters of 250 days/yr and 260 total additional employees for three shifts.

70 Assumes 0.3 ft3/day/person/shift with the parameters of 250 days/yr and 260 total additional employees for three shifts.

71 Includes 0.15 t (0.17 tons) of steel assuming density of 0.127 m^3/t.

LANL 1995g; LANL 1996e:1.

72 Cubic meters at standard temperature and pressure.

73 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. *WSRC 1995c* .

74 Cubic meters at standard temperature and pressure.

75 Contained within existing facilities.

NA - not applicable. WSRC 1995c.

76 At SRS, this would be managed as high-specific activity liquid waste, which would be combined with HLW at the Tank Farm and then processed in accordance with the High-Level Waste Management Plan as described in appendix section H.2.2. The resultant waste forms include 0.61 glass logs composed of comingled TRU waste from pit fabrication and legacy HLW, and LLW saltstone. Based on aqueous alternative process for Complex 21; denitrated water=49.3 L/kg plutonium metal processed and discarded filtrates=6.9 L/kg plutonium metal. Neutralized with 0.2 L of 50-percent caustic per kilogram of waste.

77 One-half of this volume is considered intermediate-level waste at SRS and would be disposed of in the intermediate-level waste vaults in E-Area. It is managed as TRU waste because it contains beta or gamma emitters that produce a dose equal to or greater than 200 millirem/hr at 5 cm (2 in) from an unshielded container.

78 Based on aqueous alternative process for Complex 21; 166 L of recycle water per kilogram of plutonium metal processed. Assume "recycle" water sent to Effluent Treatment Facility; recovered acid recycled.

79 Incinerable=58 m3, nonincinerable=30 m3.

80 Includes 7.6 m3 (9.9 yd3) of D&D wastes such as wall material contaminated with asbestos.

81 Treatment of liquid hazardous wastes results in solid hazardous ash. Volume reduction is 200:1.

82 Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary waste.

83 Includes 1.5 m3 (2 yd3) of concrete and 0.18 t (0.2 tons) of steel. Includes 498 m3 (651 yd3) of D&D wastes such as ductwork, concrete, electrical wiring, and equipment.

84 Recyclable wastes.

SRS 1996a:2; WSRC 1995c.

85 Cubic meters at standard temperature and pressure.

86 Laydown area for construction within existing facilities or previously disturbed areas.

87 Does not include employment requirements for D&D of vacated buildings.

NA - not applicable. OR MMES 1996j; ORR 1995a:3; ORR 1995a:4.

88 Cubic meters at standard temperature and pressure.

89 Contained within existing facilities.

90 Includes 1,152 D&D workers, 1,980 work for others.

NA - not applicable. OR MMES 1996j; ORR 1995a:3; ORR 1995a:4.

91 Includes 10 m *3* of classified waste, 40 drums depleted uranium ash from chip oxidation (one 55-gal drum=0.2 m *3*), and 1,100 m *3* of unclassified waste.

92 Assumes 100:1 wastewater to sludge ratio for the treatment of liquid LLW followed by 2:1 for solidification. Assumes two-thirds of LLW is compactible by a factor of 4:1. LLW in drums is not compactible.

93 Includes 2 m *3* of classified waste and 90 m *3* of unclassified waste.

94 Y-12 only pretreats industrial wastewater prior to discharge to the city of Oak Ridge municipal sanitary sewer system.

95 Includes 3.4 m *3* of concrete and 4.1 t of steel.

96 Includes 5 m *3* of classified waste.

97 Assumes two-thirds of solid is compactible by a factor of 4:1.

98 Recyclable wastes.

OR MMES 1996j; ORR 1995a:4.

99 Cubic meters at standard temperature and pressure.

100 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. LANL 1995b:4; LANL 1995e.

101 Cubic meters at standard temperature and pressure.

102 Contained within existing facilities.

103 Total surge employment. Increment to current employment would be 321.

NA - not applicable. LANL 1995b:4; LANL 1995e.

104 Assumes two-thirds of the solid LLW is compactible by a factor of 4:1. The wastewater to sludge ratio for liquid LLW treatment is 100:1 followed by 2:1 solidification ratio.

105 Assumes two-thirds of the solid waste is compactible by a factor of 4:1. The wastewater to sludge ratio for liquid sanitary treatment is 350:1.

106 Includes 300 t of recyclable steel and 18 t of recyclable copper.

LANL 1995b:4; LANL 1995e.

107 Cubic meters at standard temperature and pressure.

108 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. LLNL 1995e.

109 Cubic meters at standard temperature and pressure.

110 Contained within existing facilities.

111 Total surge employment. Increase to current employment would be 290.

NA - not applicable. LLNL 1995e; LLNL 1995i:3; LLNL 1996i:2.

112 Recyclable wastes.

LLNL 1995e; LLNL 1995i:3.

113 Cubic meters at standard temperature and pressure.

114 Laydown area for construction within existing facilities or previously disturbed areas.

NA - not applicable. PX DOE 1995e.

115 Cubic meters at standard temperature and pressure.

116 Contained within existing facilities.

117 No overhead workers are attributable to the HE mission.

NA - not applicable. PX 1995a:5; PX 1995a:6; PX 1996e:1;
PX DOE 1995e.

118 Assumes two-thirds of solid sanitary waste is compactible by a factor of 4:1.

119 Includes 2 m3 of concrete and 0.25 t (0.28 tons) of steel that is recycled. Density of steel was assumed to be 0.127 m3/t for volume conversion.

PX 1995a:5; PX 1995a:6; PX DOE 1995e.

120 Cubic meters at standard temperature and pressure.

121 Laydown area for construction within existing facilities or previously disturbed areas.

Note: NA - not applicable. Source: LANL 1995d.

122 Cubic meters at standard temperature and pressure.

123 Contained within existing facilities.

124 Total surge employment. Increase to current employment would be 67.

NA - not applicable. LANL 1995b:4; LANL 1995d.

125 Includes high explosives process solvents and contaminated oils.

126 Assumes 350:1 wastewater to sludge ratio in treatment of liquid sanitary waste.

127 Treated process water to NPDES-permitted outfalls.

LANL 1995b:3; LANL 1995b:4; LANL 1995d.

128 Cubic meters at standard temperature and pressure.

LLNL 1995i:3; LLNL 1995j.

129 Cubic meters at standard temperature and pressure.

130 Existing facilities occupy 2,830 ha.

131 Total surge employment. Increase to current employment would be 100.

LLNL 1995i:3; LLNL 1995j.

132 Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary waste.

133 Two-thirds of solid is compactible by a factor of 4:1.

134 Includes 7.6 m3 (9.9 yd^3) of concrete and 3 t (3.3 tons) of steel that is recycled.

LLNL 1995i:3; LLNL 1995j.

3.5 Emerging Technologies

DOE is planning to maintain the weapons stockpile using technologies that are in many cases more cost effective with less environmental impact than those used in the past. In addition to these proven baseline technologies planned for the downsized weapons complex, there are newer technologies under consideration that have the potential to offer even greater cost and environmental advantages. However, these technologies have not matured sufficiently to be included with confidence within the current baseline design. In most cases, new technologies that reduce waste and scrap generation and raw material usage concurrently reduce processing steps and operating costs. However, installing new technology requires capital construction and in nuclear facilities may require substantial additional cost to decontaminate and remove old equipment. These construction and decontamination operations also generate waste. Nevertheless, it is foreseeable that the future Complex could include some of these emerging technologies. This section discusses the major emerging technologies under consideration and their potential to further reduce future environmental impacts.

In the design of the Complex, there is a common waste management approach that emphasizes four areas of concern: the reduction of environmental impacts by avoiding environmentally offensive substances; process improvements that minimize waste generation; recycling, in order to minimize waste and raw material use; and the treatment of generated wastes. For some of the major processes, the following sections identify the significant benefits from emerging technologies that could reduce plant effluent, emissions, wastes, worker exposures, and operating cost.

3.5.1 Plutonium Fabrication and Processing

The plutonium facility includes a fabrication area where the plutonium is shaped into usable geometric shapes called pits and a processing area where the supporting chemical operations are performed. Plutonium from dismantled weapons may also be recovered. An amount of plutonium sufficient for carrying out fabrication and processing operations would be stored at the facility. The facility would be supported by activities such as analytical laboratories and waste management operations.

The emerging technologies for plutonium fabrication and processing are directed at minimizing waste at the source, reducing the amount of emissions, reducing the exposure of personnel to radiation, reducing the operational cost of the facility, improving recovery efficiencies, and improving safety. The following specific emerging technologies could affect the characteristics of the Plutonium Fabrication and Processing Facility and further reduce its environmental impact on the public and the safety and health of its workers.

For fabrication of plutonium parts, a near-net shape casting process is part of the baseline design. The casting undergoes additional machining, cleaning, and certification steps. This fabrication process is vastly superior to fabrication processes used in the past because the amount of scrap, waste, residue, and worker radiation dose are greatly reduced. Near-net shape casting technology development is continuing toward a goal of producing precision castings that require no additional machining and associated handling and material recycling. Even if the final goal is not met, any additional progress toward the goal allows for reduced machining, which results in reduced scrap, waste, residue, and worker radiation exposure.

An important fabrication step is a density measurement of the plutonium part. The baseline design measurement process requires that the part be immersed in a brominated hydrocarbon fluid. Hazardous residue is left in the fluid and from the cleaning step that follows. An emerging technology would use a nonreactive gas as the density measurement medium. If this technology is able to provide the required precision, then no residue would be left from the measurement and no follow-up cleaning step would be required.

3.5.2 Uranium Fabrication and Processing

The production of nuclear weapons requires parts fabrication and supporting chemical operations for enriched uranium, depleted uranium, and depleted uranium alloys. Uranium from dismantled weapons may also be processed. An amount of uranium in its various forms would be stored at the facility sufficient for carrying out uranium fabrication and processing operations. The facility would be supported by activities such as analytical laboratories and waste management operations.

The emerging technologies for uranium fabrication and processing are directed at minimizing waste at the source, reducing the amount of emissions, reducing the operational cost of the facility, improving recovery efficiencies, improving safety, and reducing the exposure of personnel to radiation. Radiation exposure is not as big an issue for uranium operations as for plutonium operations, but there will always be an operational goal to reduce exposures consistent with an as-low-as-reasonably-achievable philosophy. The following specific emerging technologies could affect the characteristics of the Uranium Fabrication and Processing Facility and further reduce its environmental impact on the public and the impact to the safety and health of its workers.

The baseline technology for enriched uranium parts fabrication largely continues to rely on the same technologies that have been in use for many years. Some enriched uranium parts are produced by a wrought process that includes casting, rolling, forming, and machining. This process produces a substantial amount of scrap that must be recycled. Other parts are produced directly from a casting to a near-net shape, but these require a substantial amount of final machining. Advances in technology should improve the near-net shape casting process so that final machining is greatly reduced. The improved near-net shape casting process has fewer steps and generates far less scrap that must be recycled. The full implementation of this process would reduce cost, worker radiation exposure, and waste and residue production.

Baseline technology for depleted uranium and uranium alloy parts involves casting, rolling, forming, and machining operations in which the finished part is much smaller than the starting material. An emerging technology is spin forming of some or all of these parts. Although conceptually simple, it is very difficult to spin form to the proper specifications because of the metallurgical properties of uranium. After spin forming, a machining step would still be required, but the final part would have a substantial portion of the metal contained in the starting blank. Spin forming has far fewer process steps than the current process and generates far less scrap that must be processed. The full implementation of this process would reduce cost, worker radiation exposure, and waste and residue.

All uranium and uranium alloy products, whether using the baseline technology or emerging technologies, require a casting step. Currently, the crucibles and molds for casting are made of graphite. In some cases, the graphite is coated with rare earth oxides to extend its life and to reduce carbon contamination of the parts. Graphite molds and crucibles are expensive, have a short life even when coated, and become contaminated with uranium. There is ongoing development to improve coatings, to extend the life of molds and crucibles, and to reduce carbon contamination of parts and uranium contamination of the molds and crucibles. There is also development in alternative materials for molds and crucibles. If improved coating or metal molds and crucibles prove to be feasible, their use in a production environment could reduce cost, and reduce or eliminate substantial quantities of contaminated graphite that must be processed.

Advanced uranium chemical processing technologies are currently under development. These technologies allow high-efficiency recovery and waste and residue processing with reduced worker and environmental radiation exposure. The chemicals used for processing, and the resulting emissions and effluents, are largely benign. These emerging processing technologies have been successfully tested in the laboratory, but have not been scaled up to the pilot plant level. This technology, if successful, could result in reductions in plant emissions and effluents as well as improvements in worker and public health and safety.

3.5.3 Lithium Hydride Fabrication and Processing

The basic steps of producing lithium hydride parts are hydriding lithium metal, grinding hydrided lithium into powder, pressing the powder into blanks, and machining the blanks into the final part. Near-net shape pressing technology has the potential to produce blanks that require less machining and therefore generate less material that must be recycled or stored. This process, if successful, could reduce the cost of operations. Environmental and waste impacts from current operations are very small.

Scrap and parts from old weapons are converted to a hydroxide, then to lithium chloride. The lithium chloride is converted to lithium metal in an electrolytic cell. This process poses hazards for workers and is an environmental emission hazard. The next step is to hydride the metal so it can serve as the feed material for the fabrication process. An emerging technology proven on a laboratory scale uses a bi-polar electrolytic cell to convert lithium hydroxide directly to lithium metal. This avoids the lithium chloride step and its associated emission and worker safety hazards.

3.5.4 High Explosives

The HE processes formulate, press, machine, and inspect main charges required for nuclear weapons and related research, development, and testing programs. Also included are explosive material recycling and disposition of explosives from disassembled weapons. Currently, excess explosive materials are disposed of by open burning or detonation. Alternative disposal technologies are being reviewed or developed for possible application. These alternative technologies include biodegradation, base hydrolysis, and reaction in a molten salt solution. Each of these technologies, if proved feasible, would be capable of reducing explosive materials to environmentally benign gases and chemicals.

3.6 Next Generation Stockpile Management Facilities

Stockpile management facilities have been sized in this analysis based on the planned and expected workload to support a START II-sized nuclear weapons stockpile. In addition, stockpile sizes larger and smaller than the START II protocol stockpile have been analyzed to assess the sensitivity of the analysis and the ultimate decision to pursue alternative stockpile sizes.

For all parts of nuclear weapons, except the plutonium pits, an existing large manufacturing capacity exists. Alternatives are considered for downsizing this large capacity at the manufacturing site or transferring the mission to a laboratory or test site where a smaller development and test capability could be expanded to accommodate the production mission. The pit manufacturing capability and capacity was located at the DOE Rocky Flats Plant, which is no longer available for this mission. Therefore, only alternatives that build on an R&D plutonium infrastructure or, in the case of SRS, build on a plutonium infrastructure established for a different purpose, are considered in this analysis.

In sizing pit fabrication for the foreseeable future, consideration was given to establishing a larger fabrication capacity in line with the capacity planned for other portions of the Complex. However, after review of historical pit surveillance data, larger capacity was rejected because of the expected small demand for the fabrication of new replacement pits for the foreseeable future covered in this PEIS.

Construction and operation of a larger pit production capacity at this time would be expensive and would not have sufficient workload requirements for the foreseeable future to justify its maintenance and operation. DOE believes that significant advances are possible in facility design, construction, and operation which would significantly affect new plutonium facility size, cost, and environmental impact. DOE further believes that development and demonstration work should be performed on alternative facility concepts prior to making large financial and programmatic commitments, particularly in light of the expected small near-term requirement for pit production. DOE will perform development and demonstration work at its operating plutonium facilities over the next 5 years to study alternative modular facility concepts that could be utilized in the future in the construction of a larger fabrication capacity. Should a larger pit production capacity be required in the future, appropriate environmental and siting analyses would be performed at that time.

3.7 Comparison of Alternatives

To aid the reader in understanding the differences in environmental impacts among the various PEIS alternatives, this section presents comparisons of the alternatives, concentrating on the major resources assessed in this PEIS. In section 3.7.1, alternatives for each stockpile management mission (e.g., A/D, pit fabrication, secondary and case fabrication, nonnuclear fabrication, and HE fabrication) are compared with one another and the No Action alternative. Tables 3.7.1-1 through 3.7.1-4 contain the quantitative data to support these comparisons. Section 3.7.1 also contains a top-level comparison of the entire stockpile management program. That comparison assesses the major differences in environmental impacts between a Complex that is downsized/rightsized in-place (the preferred alternative) and a Complex that is consolidated to the maximum extent practicable.

In section 3.7.2, the three proposed stockpile stewardship facilities are compared with the No Action alternative. The quantitative data to support the comparisons for the proposed stockpile stewardship facilities are in the project-specific analyses found in appendixes I, J, and K.

3.7.1 Stockpile Management

To aid the reader in understanding the differences in environmental impacts among the various PEIS alternatives, this section presents comparisons of the alternatives, concentrating on the major resources assessed in this PEIS.

Assembly/Disassembly. In addition to the No Action alternative, two alternatives are being considered that would meet the needs of the Program: (1) downsizing the existing A/D facilities at Pantex and (2) transferring the A/D mission to NTS by expanding the Device Assembly Facility. Under No Action, the A/D mission would remain at Pantex. No downsizing or modification of facilities would occur, and there would be no construction impacts. Downsizing existing facilities at Pantex would involve internal modifications to the existing facility. Transferring the A/D mission to NTS would entail upgrading and expanding the Device Assembly Facility.

Socioeconomic Impacts. Because of the reduced workload associated with completing the weapon dismantlement backlog, significant employment reductions will occur at Pantex for all alternatives. There would be a decrease from the current total of 3,437 workers to about 1,644 workers. Of the current workforce, 3,002 are associated with A/D operations. Under No Action only 915 A/D workers would be required. The downsized Pantex facility would be optimally configured for the reduced future workload, and would operate more efficiently than the No Action Pantex facility. The downsized Pantex facility would require 800 workers for single-shift operation. To perform operations in the downsized Pantex facility in a three-shift mode, 1,266 workers would be required.

If the A/D mission were transferred to NTS, 1,093 direct jobs (based on three-shift operation) would be created at that site, along with 1,160 indirect jobs. The 2,253 total new jobs would cause the regional economic area unemployment rate to decrease by approximately 0.1 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. If the A/D mission were transferred to NTS, there would be socioeconomic impacts associated with phasing out the A/D mission at Pantex. The phaseout would result in 1,644 direct jobs lost at the Pantex site, and another 1,905 indirect jobs would be lost in the regional economic area. The loss of 3,549 total jobs would cause the regional economic area unemployment rate to increase from 4.8 to 6.2 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent.

Socioeconomic impacts at NTS associated with a peak construction workforce of 662 would produce small positive economic benefits. The 662 direct workers would also generate 622 indirect jobs. The 1,284 total new jobs during peak construction would cause no change in the regional economic area unemployment rate. Housing rental vacancies and public finance expenditures/revenues would change by less than 1 percent.

Resource Impacts. Due to the reduced workload expected in the future at Pantex, impacts from operations are expected to be less than current impacts. Air quality would remain within regulatory limits, and water requirements would be met without increased aquifer drawdowns. In addition, downsizing existing facilities at Pantex would involve internal modifications to the existing facility. No land would be disturbed.

Transferring the A/D mission to NTS would entail upgrading and expanding the Device Assembly Facility, with associated increases in land disturbance. An estimated 7.5 ha (18.5 acres) of additional land would be disturbed, which is less than 1 percent of the land available at NTS for development. This land disturbance would increase the potential to impact cultural and biotic resources; however, the impact to cultural resources is not expected to be significant because the proposed A/D site has been previously disturbed during construction activities associated with the Device Assembly Facility. Impacts to biotic resources are expected to be minor; however, the presence of the desert tortoise at NTS would require a site survey to determine any impacts. With mitigation measures already in place at NTS to minimize impacts to the Federal-listed desert tortoise, significant impacts due to the proposed project are not expected.

Because both alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, both alternatives would produce similar operational environmental impacts for most resource areas. Impacts to air quality were modeled, and results indicate minimal impacts for both alternatives. Water use for the NTS alternative is projected to be less than for the Pantex alternative because continued operations at Pantex would rely on existing, older, site-wide infrastructure. At both sites, water requirements could be adequately met without substantial aquifer drawdown. At Pantex, downsizing would reduce groundwater withdrawals by 21 percent compared to No Action. At NTS, water requirements to support the A/D mission would be approximately 4 percent more than projected usage. Groundwater withdrawals at NTS would be less than the recharge rates for the aquifer.

Radiation and Waste Management Impacts. The average radiological dose to workers at Pantex would not be expected to change, although the total worker dose would change due to the reduced number of workers associated with a reduction in workload. Worker exposure to radiation is expected to be about equal (approximately 10 mrem/year) for both alternatives and well within regulatory limits. Because of the small difference in the workforce for this mission at the two sites, this would result in a total worker dose of 3.0 person-rem/year at Pantex and 2.6 person-rem/year at NTS. The added risk to the workforce due to these levels of radiation exposure is extremely small.

Radiation exposure to the public from normal operation would be well within regulatory limits at both sites. At Pantex, the incremental dose to the population within 80 km (50 mi) would be 4.0x10-4 person-rem/year. At NTS, the incremental dose to the public within 80 km (50 mi) resulting from operation of the A/D Facility would be 3.1x10-6 person-rem/year. The added risk to the public due to these levels of radiation exposure is extremely small.

Both sites have adequate waste management facilities to treat, store, and/or dispose of wastes from the A/D mission, although LLW at Pantex would continue to be shipped offsite to NTS. The impacts of transporting LLW are similar to the impacts of transporting nonradiological materials, which are small. Transferring the A/D mission to NTS would eliminate the need to ship LLW from Pantex to NTS. Transferring the A/D mission to NTS by expanding the Device Assembly Facility would also increase the overall amount of eventual D&D activities and wastes.

Accident Impacts. Potential impacts from accidents would not be expected to change significantly due to reduced workload. Accident impacts were determined using computer modeling. For the composite accident, less than one fatal cancer would be expected for the surrounding 80-km (50-mi) population at either Pantex or NTS. Based on a weighted averaging of the postulated accidents, at Pantex there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 43,000 years from accidents. At NTS, there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 500,000 years from accidents.

Other. The A/D mission also includes an option to store strategic reserves of plutonium and/or uranium. At Pantex, which presently stores both strategic reserves and surplus quantities of plutonium, no additional facilities would be needed, and no significant new environmental impacts or risks would result. Storing the strategic reserve would not produce any additional air emissions, require any additional water withdrawals, generate any wastes, or require additional workers. At NTS, however, the Device Assembly Facility would be further expanded to accomplish the strategic reserve storage. The additional construction would have smaller impacts (less than 10 percent) than the construction associated with the Device Assembly Facility upgrade for the A/D mission. Radiation exposure to the public in the event of an accident would be significantly less than for the A/D mission for either alternative.

Pit Fabrication. For pit fabrication, a capability that no longer exists due to the closure of the Rocky Flats Plant, two alternatives are being considered that would reestablish this mission and meet the needs of the Program: (1) upgrading the existing plutonium R&D fabrication capability at LANL and (2) upgrading existing H-Area and F-Canyon facilities at SRS. Both alternatives involve relatively minor (though costly) upgrades to existing facilities. Under the No Action alternative, DOE would not reestablish this mission, but would rely on the existing R&D capabilities at LANL and LLNL.

Socioeconomic Impacts. During operation, both alternatives would have small positive socioeconomic impacts. Based on the socioeconomic modeling, impacts would be higher at SRS because of the indirect jobs that would be created due to this mission. Modeling results indicate no indirect jobs for this mission at LANL. At SRS, up to 813 direct jobs would be created for surge operations, along with 1,594 indirect jobs. These 2,407 total new jobs would cause the regional economic area unemployment rate to decrease from 6.7 to 6.0 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. At LANL, up to 260 new direct jobs would be created for surge operations, but no indirect jobs would be created. The 260 total new jobs would cause the regional economic area unemployment rate to decrease from 6.2 to 6.0 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. Because the SRS alternative has less of an infrastructure in place for plutonium fabrication, the SRS alternative would require more direct workers (288 versus 138) during construction. At both sites, however, the socioeconomic impacts during construction would not cause any socioeconomic indicator to change by more than 1 percent.

Resource Impacts. Construction activities would involve internal modifications to existing facilities, no land would be disturbed, and thus, no impacts to cultural and biotic resources would result. Because both alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, both alternatives would result in similar operational environmental impacts for most resource areas. Impacts to air quality were modeled, and results indicate minimal impacts to air quality for both alternatives. Water requirements at SRS would be provided from surface water, which is plentiful, and no adverse impacts would be expected. At LANL, groundwater would be used. Water requirements for this mission, which would be less than 1 percent of projected No Action uses, could be adequately met without exceeding the groundwater allotment at LANL.

Radiation and Waste Management Impacts. Worker exposure to radiation is expected to be about equal for both alternatives and well within regulatory limits. At either SRS or LANL, the average workforce dose from this mission would be approximately 380 mrem/year. Because of a difference in workforce for this mission at the two sites, this would result in a total worker dose of 156 person-rem/year at SRS and 55 person-rem/year at LANL. Statistically, this would equate to one fatal cancer every 16 years at SRS, and every 45 years at LANL, from operation of the Pit Fabrication Facility. Radiation exposure to the public from normal operation would be well within regulatory limits at both sites. At SRS and LANL, the incremental dose to the public within 80 km (50 mi) would be 5.9x10-4 person-rem/year and 8.6x10-5 person-rem/year, respectively. The added risk to the public due to these levels of radiation exposure is extremely small. Both site alternatives have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by this mission.

Accident Impacts. Potential impacts from accidents were determined using computer modeling. For the composite accident, less than one fatal cancer would be expected for the surrounding 80-km (50-mi) population at both SRS and LANL. Based on a weighted averaging of the postulated accidents, at SRS there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 360,000 years from accidents. At LANL, there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 160,000 years from accidents.

Secondary and Case Fabrication. In addition to the No Action alternative, three alternatives being considered would meet the needs of the Program: (1) downsizing facilities that presently perform this mission at ORR, (2) transferring the secondary and case fabrication mission to LANL by upgrading the existing R&D secondary and case fabrication capabilities of LANL, and (3) transferring the secondary and case fabrication mission to LLNL by upgrading the existing R&D secondary and case fabrication capabilities of LLNL. Under No Action, the secondary and case fabrication mission would remain at Y-12 at ORR, and no downsizing or modification of facilities would occur.

Socioeconomic Impacts. Under No Action, there would be a decrease in the number of workers at Y-12 from the current total of 5,152 workers to 4,721 workers. Of the 5,152 workers, 3,126 are currently associated with the core stockpile management mission. Under No Action, only 2,741 core stockpile management workers would be required. The downsized Y-12 would be optimally configured for the reduced future workload, operate more efficiently, and require 784 workers for single-shift operation, a reduction of 1,957 workers. To perform operations in the downsized Y-12 in a three-shift mode, 1,376 core stockpile management workers would be required, a reduction of 1,365 workers. A reduction of 1,365 direct jobs represents approximately 9 percent of the projected No Action workforce at the entire ORR site, and less than 1 percent of the regional economic area. Another 3,490 indirect jobs would also be lost.

Mitigating the workforce reductions would be the fact that downsizing would require 1,152 new jobs associated with landlord activities in preparation for D&D activities. Another 1,600 indirect jobs would be created by these

D&D jobs. The net effect for the three-shift mode of operation would be a loss of a total of 213 direct jobs at Y-12, which would represent less than 1 percent of the projected No Action workforce at ORR.

Transferring the secondary and case fabrication mission to either LANL or LLNL would have small positive socioeconomic impacts at those sites, and negative socioeconomic impacts at ORR due to the phaseout of this mission. At LANL, 321 direct jobs (based on three-shift operation) would be created, but no indirect jobs would be created for this industry. The 321 new jobs would cause the regional economic area unemployment rate to decrease from 6.2 to 6.0 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. At LLNL, 290 new direct jobs (based on three-shift operation) would be created, along with 722 indirect jobs. The 1,012 new jobs would cause the regional economic area unemployment rate to decrease by less than 1 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent.

Transferring the secondary and case fabrication mission from ORR to either LANL or LLNL would result in the loss of 3,336 direct jobs projected for this mission under No Action at Y-12, and the closure and D&D of the Y-12 facilities previously involved in this mission. Another 10,134 indirect jobs could also be lost. It is expected that 1,385 new jobs would be created by a direct transfer of responsibilities from DP to EM. Additionally, because the D&D of facilities at ORR would be a relatively long-term process, any initial negative socioeconomic impacts resulting from the transfer of the secondary and case fabrication mission to LANL or LLNL would be minimized by the additional workforce associated with D&D activities at ORR. These 1,385 new D&D jobs would also create 1,937 new indirect jobs. The net effect would be a loss of a total of 13,470 total jobs (direct plus indirect) in the ORR regional economic area. This would cause the regional economic area unemployment rate to increase from 4.9 to 7.4 percent. Housing/rental vacancies and public finance expenditures/ revenues would change by less than 1 percent.

During construction activities, socioeconomic impacts would result, but would be small. The number of peak workers would be 14 at ORR, 55 at LANL, and 130 at LLNL, which has the least extensive existing infrastructure for secondary and case fabrication. At all three sites, the socioeconomic impacts during construction would not cause any socioeconomic indicator to change by more than 1 percent.

Resource Impacts. Impacts from continued operation at Y-12 are expected to be similar to current impacts. Air quality would remain within regulatory limits and water requirements would be adequately met by surface water withdrawals. For the three "action" alternatives, no previously undisturbed land would be disturbed, and thus, no impacts to biotic resources would result. Minimal impacts to cultural resources may result from building modifications to facilities eligible for the National Register of Historic Places. Because each of the alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, each of the alternatives would produce similar operational environmental impacts for most resource areas. Impacts to air quality were modeled for each alternative and results indicate minimal impacts to air quality for each of the alternatives. Water requirements at ORR would be met from surface water, which is plentiful, and no adverse impacts would be expected. At LANL, groundwater would be used. Groundwater withdrawals would increase by less than 1 percent over projected No Action water requirements, and LANL's groundwater allotment would not be exceeded. At LLNL, public water supply would be used, and usage would be approximately 20-percent higher than projected No Action water requirements. No adverse impacts to water resources are expected.

Radiation and Waste Management Impacts. Radiation worker exposure to radiation is expected to be about equal for all three alternatives and well within regulatory limits. At each of the three sites, the average workforce dose from this mission would be approximately 2.2 mrem/year. Because of differences in projected workforces, this would result in a total worker dose of 0.38 person-rem/year at ORR, 0.33 person-rem/year at LANL, and 0.55 person-rem/year at LLNL. The added risk to the workforce due to these levels of radiation exposure is extremely small. Radiation exposure to the public from normal operation would be well within regulatory limits at these sites. At ORR, the incremental dose to the population within 80 km (50 mi) would be 0.6 person rem/year. The probability of a member of the public dying from cancer would be 3x10-4/year. At LANL, the incremental dose to the population within 80 km (50 mi) would be 0.5 person-rem/year. The probability of a member of the public dying from cancer would be 2.5x10-4/year. At LLNL, the incremental dose to the population within 80 km (50 mi) would be 0.84 person-rem/year. The probability of a member of the public dying from cancer would be 4.2x10-4/year. The added risk to the public due to these levels of radiation exposure is extremely small. All three site alternatives have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by this mission.

Accident Impacts. Potential impacts from accidents were determined using computer modeling. For all postulated accidents, less than one fatal cancer would be expected for the surrounding 80-km (50-mi) population at each of the sites. Based on a weighted averaging of the postulated accidents, at ORR and LANL there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 830,000 years from accidents. At LLNL, there would be a statistical risk that one fatal cancer to a member of the public would result approximately every 260,000 years from accidents.

Other. If the secondary and case fabrication mission were transferred from ORR, storage of the strategic reserves of HEU would be transferred to the A/D Facility (or a consolidated storage facility being assessed in the Storage and Disposition PEIS). The potential impacts associated with the one-time transfer of the strategic reserves of HEU to the A/D Facility are expected to be minor, even in the event of an accident, due to the robust shipping containers.

High Explosives Fabrication. In addition to the No Action alternative, three alternatives are being considered that would meet the needs of the Program: (1) downsizing facilities that presently perform this mission at Pantex, (2) transferring the HE fabrication mission to LANL by upgrading the existing R&D HE fabrication capabilities of LANL, and/or (3) transferring the HE fabrication mission to LLNL by upgrading the existing R&D HE fabrication capabilities of LLNL. Transferring the HE fabrication from Pantex to LANL and/or LLNL would result in the closure and D&D of Pantex facilities previously involved in this activity. Under No Action, the HE fabrication mission would remain at Pantex. No downsizing or modification of facilities would occur.

Socioeconomic Impacts. Downsizing the HE fabrication mission at Pantex would reduce the number of direct workers associated with this mission to 37, compared to 105 for No Action. Transferring the HE fabrication mission to either LANL or LLNL would create small positive socioeconomic impacts at either of those sites, and small negative socioeconomic impacts at Pantex, due to the phaseout of this mission. For surge operations at LANL, 67 new direct jobs would be created, but no indirect jobs would be created by this industry. The 67 new jobs would cause the regional economic area unemployment rate to decrease from 6.2 to 6.1 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. For surge operations at LLNL, 100 new direct jobs would be created, along with 155 indirect jobs. The 255 total new jobs would cause the regional economic area unemployment rate to decrease by less than 1 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. Phasing out the HE fabrication mission at Pantex would cause the loss of 105 direct jobs, which would be approximately 3 percent of the projected No Action workforce at Pantex. The direct plus indirect jobs lost would cause no observable change to the Pantex regional economic area unemployment rate, housing/rental vacancies, and public finance expenditures/revenues.

During construction activities, socioeconomic impacts would result, but they would be small. The number of peak workers would be 29 at Pantex, 46 at LANL, and 19 at LLNL. At all three sites, the socioeconomic impacts during construction would not cause any socioeconomic indicator to change by more than 1 percent.

Resource Impacts. For the three "action" alternatives, construction impacts are expected to be minor and would involve internal modifications to existing facilities. No land would be disturbed at Pantex or LANL, and thus, no impacts to cultural or biotic resources would result. At LLNL, a small area of land (less than 1 ha) would be disturbed to construct an HE and parts storage building, but impacts to biotic and cultural resources are not expected.

Because each of the alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, each of the alternatives would result in similar operational environmental impacts for most resource areas. Impacts to air quality were modeled for each alternative, and results indicate minimal impacts to air quality for each of the alternatives. At all sites, water requirements would be met from groundwater. At Pantex, this alternative applies only in conjunction with the downsize A/D alternative at Pantex discussed earlier. Downsizing both missions would reduce groundwater withdrawals by 16 percent compared to No Action. At LANL, groundwater withdrawals would increase by less than 1 percent over projected No Action water requirements, and LANL's groundwater allotment would not be exceeded. At LLNL, groundwater and/or the public water supply could be used to support the HE fabrication mission. If public water were used, it would require approximately 21 percent of the design capacity of the public water tap line. If groundwater were used, withdrawals would increase by approximately 65 percent from No Action, but they would not have any adverse impacts to aquifer levels.

Radiation and Waste Management Impacts. There are no radiological risks to workers or the public associated with the HE fabrication mission and no adverse impacts associated with normal operation. All three site alternatives have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by this mission.

Accident Impacts. Potential impacts from chemical accidents or explosions were determined using modeling. Impacts from these types of accidents could include death or bodily damage. Due to proximity, workers would be most susceptible to any potential impacts. For all postulated accidents, impacts to the public were much less than to workers. In the event of an accident involving HE fabrication, due to the higher population surrounding LLNL, public impacts could be higher at LLNL compared to LANL and Pantex. Lastly, transferring the HE fabrication mission from Pantex to LANL and/or LLNL would require HE components to be shipped from the fabrication site to the A/D Facility. HE is a nonradioactive, hazardous material. There are no impacts associated with the incident-free transportation of HE. In the event of an accident, HE transportation impacts would be no greater than those encountered by the public from industry's transportation of similar explosives. Potential accidents could include both explosive and nonexplosive roadway accidents, with potential impacts of death, lesser bodily injury, and property damage.

Nonnuclear Fabrication. In addition to the No Action alternative, two alternatives are being considered that would meet the needs of the Program: (1) downsizing the facilities that presently perform this mission at KCP and (2) transferring the KCP nonnuclear fabrication mission to LANL, LLNL, and SNL by upgrading existing nonnuclear fabrication capabilities at LANL and LLNL and constructing new nonnuclear fabrication facilities at SNL. Under No Action, the nonnuclear fabrication mission would remain at current locations; primarily at KCP, with small workloads at SNL and LANL.

Socioeconomic Impacts. At KCP, workforce downsizing consistent with a reduced workload has already taken place; therefore, the projected No Action workforce (3,179 workers) is equal to the current workforce. Of these 3,179 workers, 2,508 workers perform core stockpile management missions. The downsized KCP facility would be optimally configured for the reduced future workload, would operate more efficiently, and would require 1,669 core stockpile management workers for single-shift operation. To perform operations in the downsized

KCP facility in a three-shift mode, 2,257 workers would be required. This is 251 workers less than the No Action single-shift number of workers. Another 443 indirect jobs would also be lost. The loss of a total of 694 jobs (direct plus indirect jobs) would not cause the regional economic area unemployment rate to change.

Transferring the nonnuclear fabrication mission to the laboratories would create small positive socioeconomic impacts at both LANL and LLNL, with increases of 240 and 131 total (direct plus indirect) jobs, respectively. At each of these sites, socioeconomic indicators would change by less than 1 percent. At SNL, 1,160 direct jobs would be created, along with 1,350 indirect jobs. The 2,510 new jobs would cause the regional economic area unemployment rate to decrease from 5.7 to 5.2 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. Phasing out the nonnuclear fabrication mission from KCP would cause the loss of 3,179 direct jobs and the loss of 5,609 indirect jobs in the regional economic area. The loss of 8,788 total jobs from KCP would cause the regional economic area unemployment rate to increase from 4.9 to 5.6 percent. Housing/rental vacancies and public finance expenditures/revenues would change by less than 1 percent. Some socioeconomic impacts could be mitigated by employing personnel for D&D of the KCP facility, although that is not expected to last more than 5 years.

During construction activities, socioeconomic impacts would result, but would be small. At KCP, 187 direct jobs would be created during downsizing activities, plus another 262 indirect jobs. The 449 total jobs created during construction at KCP would represent less than a 1 percent increase in the regional economic area, and would cause no observable change to the regional economic area unemployment rate, housing/rental vacancies, and public finance expenditures/revenues. If the nonnuclear fabrication mission is transferred to the three laboratories, no observable socioeconomic impacts would occur at LANL or LLNL. At SNL, 379 direct jobs would be created during construction activities, plus another 421 indirect jobs. The 800 total jobs created during construction at SNL would represent less than a 1 percent increase in employment in the regional economic area, and would not cause any socioeconomic indicator to change by more than 1 percent.

Resource Impacts. Due to the reduced workload expected in the future, impacts from operations are expected to be less than current impacts. Air quality would remain within regulatory limits at each of the sites, and water requirements would be adequately met.

For the alternative that would downsize KCP, the construction activities would involve internal modifications to the existing facility. No land would be disturbed. For the alternative that would transfer the KCP mission to the laboratories, construction impacts would involve internal facility modifications at LANL and LLNL. At SNL, approximately 9 ha (22 acres) of land would be disturbed to construct a new facility. This represents approximately 6 percent of the undisturbed land at SNL. Potential impacts to cultural and biotic resources would exist, but they would be mitigated to the extent practicable during follow-on, site-specific studies.

Because each of the alternatives would utilize similar facilities, procedures, resources, and numbers of workers during operation, each of the alternatives would result in similar operational environmental impacts for most resource areas. Impacts to air quality were modeled for each alternative. Modeling results indicate minimal impacts to air quality for each of the alternatives. Water requirements for nonnuclear fabrication are relatively minor at each of the sites. At KCP, water requirements, which are publicly provided, would be reduced by approximately 31 percent compared to No Action. At LANL, groundwater withdrawals would increase by less than 1 percent over projected No Action water requirements, and LANL's groundwater allotment would not be exceeded. At LLNL, there would also be a less than 1 percent increase in water requirements to support nonnuclear fabrication. At SNL, groundwater would be used. Groundwater withdrawals would increase by approximately 64 percent over projected No Action withdrawals, but would still represent only 29 percent of the Kirtland Air Force Base groundwater rights. Thus, no adverse impacts are expected.

Radiation, Waste Management, and Accident Impacts. There are no radiological risks to workers or the public associated with the nonnuclear fabrication mission, and there are no adverse impacts associated with normal operation. Accident profiles at the sites would not change as a result of downsizing KCP or transferring the nonnuclear fabrication mission to the laboratories. Phaseout of the nonnuclear mission from KCP would eliminate any potential accidents at that site. Lastly, all three site alternatives have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by this mission.

Stockpile Management Top-Level Comparison. Based upon the reasonable alternatives for the five major missions that make up the stockpile management program, one could construct a matrix with a large number of discrete alternatives for the entire Complex. Analyzing such a large number of alternatives is neither practical nor useful. What is useful, however, is to look at the two extreme configurations for the entire Complex in order to compare environmental impacts for a bounding case analysis. Based on the alternatives that are reasonable for the individual missions, the bounding configurations and environmental impacts for the Complex are a relatively unconsolidated Complex that is downsized/rightsized in place or a relatively consolidated Complex that is rightsized by upsizing the laboratories and NTS.

For the first configuration (referred to as Downsize/Rightsize-in-Place), the Complex would consist of A/D at Pantex, HE fabrication at Pantex, pit fabrication at LANL (or SRS), secondary and case fabrication at ORR, and nonnuclear fabrication at KCP. This is essentially the preferred alternative for stockpile management. For the second configuration (referred to as Maximum Consolidation), the Complex would consist of A/D at NTS, HE fabrication at LANL (or LLNL), pit fabrication at LANL, secondary and case fabrication at LANL (or LLNL), and nonnuclear fabrication at SNL, LANL, and LLNL. Major differences in environmental impacts between these two configurations are presented below.

Socioeconomic Impacts. It is worthy to note that some of the reductions in workforce at the various stockpile management facilities are associated with reduced workloads expected in the future, while additional reductions in workforce could occur due to the physical downsizing of facilities. For the A/D and HE missions at Pantex, under No Action, the core stockpile management workforce would be reduced from the current level of 3,107 workers (3,002 for A/D and 105 for HE) to 1,020 workers (9l5 for A/D and 105 for HE) for single-shift operation. The physical downsizing of the facility would also improve efficiency such that the workforce could be reduced even further, to 831 workers for single-shift operation (800 for A/D and 31 for HE). Three-shift operation of the downsized Pantex facility would require 1,303 core stockpile management workers (1266 for A/D and 37 for HE).

For the secondary and case fabrication mission at ORR, under No Action, the workforce would be reduced from the current level of 3,126 core stockpile management workers to 2,741 workers for single-shift operation. The physical downsizing of Y-12 (essentially an 86-percent reduction in facility size) would also improve efficiency such that the core stockpile management workforce could be reduced even further, to 784 workers for single-shift operation. Three-shift operation of the downsized Y-12 facility would require 1,376 core stockpile management workers. The adverse socioeconomic impacts associated with the Y-12 downsizing would be mitigated by the creation of 1,152 new jobs associated with landlord activities in preparation for the D&D of the facilities no longer needed.

At KCP, workforce reductions consistent with a reduced workload have already taken place; therefore, the projected No Action workforce (2,508 core stockpile management workers) is equal to the current workforce. Downsizing the KCP facility would improve efficiency such that the workforce could be reduced to 1,669 workers for single-shift operation. Three-shift operation of the downsized KCP facility would require 2,257 workers.

Overall, socioeconomic impacts from construction for the Maximum Consolidation configuration would be minimal, except at NTS and SNL. Socioeconomic impacts from construction for the Downsize/Rightsize-in-Place configuration would also be minimal.

Resource Impacts. Construction impacts associated with the Downsize/Rightsize-in-Place configuration would be minimal. All construction activities would be modifications to existing facilities, with no new construction. Consequently, no significant land disturbance at any sites would result, and no potential impacts to biota or cultural resources would occur.

Construction impacts associated with the Maximum Consolidation configuration would be small overall; only the Device Assembly Facility upgrade at NTS and the Nonnuclear Facility at SNL involve any land disturbance greater than 1 ha (2.47 acres). Most construction activities would be modifications to existing facilities, with no significant land disturbance, and no potential impacts to biota or cultural resources.

During operation, because each of the two configurations would utilize similar facilities, procedures, resources, and numbers of workers, each would result in similar operational environmental impacts for most resource areas. For the Maximum Consolidation configuration, the greatest potential for any significant environmental impacts would occur at LANL, which would be the site for pit fabrication, secondary and case fabrication, HE fabrication, and a portion of nonnuclear fabrication. For each of the resources evaluated in this PEIS, no significant impacts are expected from such consolidation. Modeling results for air quality indicate minimal impacts to air quality. Water requirements would increase at LANL by 2.5 percent, but would still be less than the LANL allotment.

Radiation, Waste Management, and Accident Impacts. Cumulative doses to the population from normal operation would be less than regulatory limits. Impacts from accidents are independent of other missions (e.g., accident risks are additive, not multiplicative). Thus, the potential accident would be the sum of the risks from each mission. For maximum consolidation at LANL, there would be a statistical risk that one fatal cancer to a member of the public would result aproximately every 135,000 years from accidents. LANL would have adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by these missions.

A difference in the operation of the Downsize/Rightsize-in-Place configuration and the Maximum Consolidation configuration would involve the transportation of nuclear and hazardous materials. The Downsize/Rightsize-in-Place configuration would result in transporting plutonium components between LANL (or SRS) and Pantex, and transporting secondary and case components between ORR and Pantex. Incident-free impacts associated with this transportation are small, while accident impacts are minor. The Maximum Consolidation configuration would also result in transporting plutonium components and secondary and case components. Transportation would occur between LANL and NTS. Relative to the Downsize/Rightsize-in-Place configuration, any transportation impacts would be less due to shorter distances and less populated roadways. The Maximum Consolidation configuration would also result in transporting HE components between LANL and NTS, but no significant impacts are expected.

3.7.2 Stockpile Stewardship

Proposed National Ignition Facility. The following comparisons have been summarized from the more-detailed comparisons for the NIF alternatives found in appendix section I.3.5.

The NIF project-specific analysis addresses the impacts of constructing and operating NIF at four alternative sites: LLNL (preferred), LANL, SNL, and NTS (including NLVF). A No Action alternative is also assessed.

Under No Action, DOE would rely on existing aboveground experimental facilities, predominantly the Nova Facility at LLNL, to study the physics of nuclear weapons secondaries. No construction impacts are associated with the No Action alternative and the operational impacts of the Nova Facility have been accounted for in the overall environmental baseline presented for LLNL.

For the action alternative, the analysis indicates that there would be few significant differences in environmental impacts at the candidate sites. The maximum 24-hour concentration of particulate matter 10 microns or smaller (PM_{10}) in the air during site clearing would exceed applicable standards at LLNL and NLVF. However, the ambient air quality impacts would be localized and of short duration. Uncommitted land requirements would be greatest at NTS (18.2odyText"> At each NIF alternative site, beneficial socioeconomic impacts associated with construction and operation would occur. During construction, 270 to 470 direct new jobs would be created in the peak year of activity. These direct jobs would create indirect jobs such that the total jobs during the peak year would be: 2,870 at LLNL; 1,130 at LANL; 1,640 at NTS; and 1,770 at SNL. Once operations begin, NIF would employ 330 direct workers. The total number of jobs (direct plus indirect) during operation would be 890 at LLNL, 600 at LANL, 620 at NTS, and 670 at SNL.

Over the 30-year operational life of NIF, the public would be exposed to a very small dose of radiation. No cancer fatalities would be expected to occur from exposures associated with routine NIF operations under either the Conceptual Design or Enhanced options. A radiological accident at NIF would not cause any cancer fatalities to the public except possibly at NLVF and SNL. Under postulated accident conditions, radiological impacts to the public and workers would be minor. The highest calculated radiation dose is 4,900 person-rem. At most, two cancer fatalities could occur if an accidental release occurred. Because of the extremely low accidental release frequency ($2x10^{-8}$ /yr), the risk of radiation-caused cancer fatalities from the postulated accident at any site is essentially zero. The cancer fatality risk associated with radiological exposure from an accident involving the transport of NIF tritium targets would range from 1x10-*8* to 8x10-*10/yr*; whereas the nonradiological fatality risks associated with vehicular emissions and accidents would be in the range of 10-3 to 10-4/yr.

Although each candidate site would implement waste minimization practices, the generation of additional wastes would be unavoidable. All candidate sites have current or planned capacity to handle wastes associated with construction and operation of NIF; however, this would entail offsite shipment of some of the wastes for all sites but LANL.

NIF would comply with all applicable Federal, state, and local environmental regulatory requirements, including the *California Environmental Quality Act* if NIF is sited in the State of California. Such compliance functions as a general form of mitigation. The candidate sites have also established several mitigative measures for construction actions that would also be applicable to NIF construction. While each of these mitigative measures may be minor, in combination they could significantly reduce impacts to the environmental resources of the selected site.

With regard to unavoidable impacts, land clearing and construction activities for NIF would eliminate habitat and destroy or displace wildlife. Construction of new facilities could result in short-term disturbances of previously undisturbed biological habitats. These disturbances could cause long-term reductions in the biological productivity of an area. Construction of NIF would replace natural habitat with areas of pavement and buildings. Depending upon the candidate site selected, this conversion could extend the influence of urbanized/industrial habitats into natural areas, increase fragmentation of natural habitat, and cause minor loss of habitat used by rare species. However, no critical habitat for federally threatened or endangered species would be affected.

Radiological doses to the general public from NIF operation would be no more than 20e addition of the incremental effects of the construction and operation of NIF to the effects of other past, present, and reasonably foreseeable future actions at the selected site. Fugitive dust emissions from construction of NIF would be an incremental addition to the already existing environmental impact of dust emissions to the atmosphere. Minor changes in stormwater runoff are expected due to removal of grass cover during NIF construction and increased runoff from pavement during facility operation.

Proposed Contained Firing Facility. The following comparisons have been summarized from the more-detailed information for CFF found in appendix J.

Under No Action, DOE would rely on existing aboveground experimental facilities, predominantly the existing hydrotest facilities at LLNL, LANL, and NTS to study the physics of nuclear weapons primaries. No construction impacts are associated with those existing facilities, and the operational impacts of those facilities have been accounted for in the overall environmental baseline presented for LLNL, LANL, and NTS.

Because the proposal for CFF involves modification to the existing FXR Facility, construction impacts are expected to be small. Very little land would be disturbed and the construction activities would largely involve internal modifications to the existing facility. Wastes and socioeconomic impacts from construction would be negligible.

Impacts associated with operations would also be negligible. CFF would not utilize any significant quantities of resources, would not cause any significant socioeconomic changes at LLNL, and would not generate large quantities of hazardous or low-level wastes. LLNL has adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by CFF. Impacts to human health from CFF operations are expected to be extremely small and within regulatory limits.

Proposed Atlas Facility. The following comparisons have been summarized from the more-detailed information for the Atlas Facility found in appendix K.

Under No Action, DOE would rely on existing aboveground experimental facilities, predominantly the Pegasus Facility at TA-35 at LANL, to study the physics of nuclear weapon secondaries. No construction impacts are associated with that facility, and the operational impacts from Pegasus have been accounted for in the overall environmental baseline presented for LANL.

Because the proposal for the Atlas Facility involves modification to the existing facilities within TA-35, construction impacts are expected to be small. Very little land would be disturbed and the construction activities would largely involve internal modifications to the existing facility. Wastes and socioeconomic impacts from modification activities would be negligible.

Impacts associated with operations would also be negligible. The Atlas Facility would not utilize any significant quantities of resources, would not cause any significant socioeconomic changes at LANL, and would not generate large quantities of hazardous or low-level wastes. LANL has adequate existing waste management facilities to treat, store, and/or dispose of wastes that would be generated by the Atlas Facility. Impacts to human health from Atlas Facility operations are expected to be small and within regulatory limits.

3.8 Preferred Alternative

CEQ regulations require an agency to identify its preferred alternative(s) in the Final Environmental Impact

Statement (40 CFR 1502.14[e]). The preferred alternative is the alternative which the agency believes would best fulfill its statutory mission, considering environmental, economic, technical, and other factors. This PEIS provides information on the environmental impacts. Cost, schedule, and technical analyses have also been prepared, and are presented in the *Analysis of Stockpile Management Alternatives* report (DOE 1996j) and the *Stockpile Management Preferred Alternatives* Report (DOE 1996k), which are available in the appropriate DOE Public Reading Rooms for public review.

DOE has identified the following preferred alternatives for the Stockpile Stewardship and Management Program:

Stockpile Stewardship:

- Construct and operate NIF at LLNL
- Construct and operate CFF at LLNL
- Construct and operate the Atlas Facility at LANL

Stockpile Management:

- Secondary and Case Component Fabrication--downsize the Y-12 Plant at ORR
- Pit Component Fabrication--reestablish capability and appropriate capacity at LANL
- Assembly/Disassembly--downsize at Pantex
- High Explosives Fabrication--downsize at Pantex
- Nonnuclear Component Fabrication--downsize at KCP
- Based on the analyses performed to support this PEIS, the preferred alternatives for strategic reserve storage are as follows: (1) HEU strategic reserve storage at Y-12 and (2) plutonium pit strategic reserve storage in Zone 12 at Pantex. The preferred alternatives for strategic reserve storage could change based upon decisions to be made in regard to the Storage and Disposition PEIS. Decisions on strategic reserve storage will not be made in the upcoming ROD for the Stockpile Stewardship and Management Program. Storage decisions are not expected to be made until both the Stockpile Stewardship and Management PEIS and the Storage and Disposition PEIS are completed.

The preferred alternative for plutonium-242 oxide at SRS is to transport the material to LANL for storage.

The preferred PEIS alternatives do not represent decisions by DOE. Rather, they reflect DOE's preferences based on existing information. The ROD, when issued, will describe DOE's decisions for the Stockpile Stewardship and Management PEIS proposed actions.

Table 3.7.1-1.--*Summary Comparison of Impacts for Assembly/Disassembly and High Explosives Fabrication Missions*

	Retain both at Pantex		**Retain A/D[1] at Pantex, Relocate HE**			**Phaseout Pantex, Relocate A/D and HE**			
	No Action	Downsize A/D and HE at Pantex	Downsize A/D at Pantex and Relocate HE	Relocate HE to LANL[2]	Relocate HE to LLNL[2] (Site 300)	Phaseout A/D and HE at Pantex	Relocate A/D to NTS	Relocate HE to LANL[2]	Relocate HE to LLNL[2] (Site 300)
Construction/Modification									

Land									
Disturbed land (ha)	0	0	0	0	0.8	0	7.5	0	0.8
Percent of available land	0	0	0	0	<1	0	<1	0	<1
Threatened and Endangered Species									
Potentially affected	None	None	None	None	None	None	Desert tortoise	None	None
Socioeconomics									
Peak workers (direct)	0	96	67	46	19	0	662	46	19
Total jobs (direct and indirect)	0	173	121	76	47	0	1,284	76	47
Operation[3]									
Water									
Use (MLY)	249	209	196	5,773	148	0	2,498	5,773	148
Percent change from current use	-70	-75	-77	4.6	64.7	-100	4.1	4.6	64.7
Percent change from No Action use	NA	-16	-21	0.2	64.7	-100	4.1	0.2	64.7
Percent of groundwater allotment[4]	NA	NA	NA	85	NA	NA	NA	85	NA
Discharge (MLY)	141	148	141	706	12.2	0	53	706	12.2
Percent change from current discharge	-71	-69	-71	2	154	-100	NA	2	154
Percent change from No Action discharge	NA	5	0	2	177	-100	NA	2	177
Percent of discharge capacity	NA	NA	NA	NA	102	NA	NA	NA	102
Total site workforce (all missions)	1,644	1,927	1,890	6,613	8,289	0	9,112	6,613	8,289
A/D workforce	915	1,266[5]	1,266[5]	0	0	0	1,093	0	0

HE workforce	105	37[6]	0	200[7]	232[8]	0	0	200[6]	232[7]
A/D and HE workforce	1,020	1,303	1,266	200	232	0	1,093	200	232
Change from No Action in Total Jobs (direct and indirect)	NA	611 [9]	531 [10]	67	255	-3,549	2,253	67	255
Human Health									
Normal Operations									
Annual population dose (person-rem) (incremental except No Action)	1.4x10-4	4.0x10-4	4.0x10-4	NA	NA	-1.4x10-4	3.1x10-6	NA	NA
25-year fatal cancers (incremental except No Action)	1.8x10-6	5.0x10-6	5.0x10-6	NA	NA	-1.8x10-6	3.9x10-8	NA	NA
Annual worker dose (mrem/yr) (total)	10	10	10	NA	NA	0	10	NA	NA
25-year fatal cancer risk (total)	1.0x10-4	1.0x10-4	1.0x10-4	NA	NA	0	1.0x10-4	NA	NA
Accidents									
Composite Set (EBAs and BEBAs) [11]									
Expected consequences (fatalities)[12]		5.2x10-4	5.2x10-4	NA	NA	0	4.4x10-5	NA	NA
Expected Risk (fatalities per year)l		1.5x10-5	1.5x10-5	NA	NA	0	1.2x10-6	NA	NA

Waste Management	LLW, mixed LLW, hazardous, and nonhazardous wastes would continue to be generated.	Existing facilities adequate; 1 additional shipment every 2 years of LLW to NTS	Same as Downsize A/D & HE during operation. HE fabrication D&D would require 579 shipments of LLW to NTS during HE phaseout period. Additional treatment capacity at Pantex would be needed for liquid LLW and Mixed LLW generated from D&D activities.	Existing facilities adequate	Existing facilities adequate	Eliminates future shipments of Pantex LLW to NTS. D&D would require 1,006 shipments of LLW to NTS during phaseout period. Additional treatment capacity at Pantex would be needed for liquid LLW and Mixed LLW.	Existing facilities adequate	Existing facilities adequate	Existing facilities adequate

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Table 3.7.1-2.-- *Summary Comparison of Impacts for the Nonnuclear Fabrication Mission*

			Relocate Nonnuclear and Phaseout KCP[13]			
	No Action	**Downsize KCP**	**LANL**	**LLNL**	**SNL**	**Phaseout KCP**
Construction/Modification						
Land						
Disturbed land (ha)	0	0	0	0	9	0
Percent of available land	0	0	0	0	6	0
Threatened and Endangered Species						
Potentially affected	None	None	None	None	None	None
Socioeconomics						

Peak workers (direct)	0	187	6	6	379	0
Total jobs (direct and indirect)	0	449	10	15	800	0
Operation[14]						
Water						
Use (MLY)	1,930	1,340	5,808	971	2,283	0
Percent of groundwater allotment	NA	NA	85	NA	29[15]	NA
Percent change from current use	-<1	-31	5.2	<1	135	-100
Percent change from No Action use	NA	-31	<1	<1	64	-100
Discharge (MLY)	702	794	694	462	1,048	0
Percent change from current discharge	-21	-10	<1	16	39	-100
Percent change from No Action Discharge	NA	13	<1	1.3	39	-100
Socioeconomics						
Total site workforce (all missions)	3,179	2,928[16]	6,740	8,249	8,501	0
Nonnuclear workforce	2,508	2,257 [16]	315[17]	114 [17]	1,160	0
Change from No Action in total jobs (direct and indirect)	NA	-694 [19]	240	131	2,510	-8,788
Waste Management	Small quantities of LLW would continue to be generated. Mixed waste would no longer be generated.	Existing facilities adequate; the generation of LLW and hazardous waste would be reduced.	Waste generation volumes would increase slightly. LANL has adequate existing waste management facilities.	Waste generation volumes would increase slightly. LLNL has adequate existing waste management facilities.	Waste generation volumes would increase slightly. SNL has adequate existing waste management facilities.	Hazardous wastes from operations would no longer be generated, but D&D activities during phaseout would generate some hazardous wastes.

Table 3.7.1-3.--*Summary Comparison of Impacts for the Pit Fabrication Mission*

	No Action	**Reestablish at LANL**	**Reestablish at SRS**
Construction/Modification			
Land			
Disturbed land (ha)	0	0	0
Percent of available land	0	0	0
Threatened and Endangered Species			
Potentially affected	None	None	None
Socioeconomics			
Peak worker (direct)	0	138	288
Total jobs (direct and indirect)	0	228	516
Operation[18]			
Water			
Use (MLY)	0	5,790	13,295
Percent of groundwater allotment[19]	0	85	NA
Percent change from current use	0	4.9	6
Percent change from No Action use	NA	0.5	0.3
Discharge (MLY)	0	705	746
Percent change from current discharge	0	1.8	6
Percent change from No Action discharge	0	1.8	7
Socioeconomics			
Total site workforce (all missions)	0	6,806	20,101
Pit fabrication workforce	0	628[20]	813
Change from No Action in total jobs (direct and indirect)	0	260	2,407
Human Health			
Normal Operations			
Annual population dose (person-rem) (Incremental except for No Action)	0	8.6x10-5	5.9x10-4
25-year fatal cancers (Incremental except for No Action)	0	1.1x10-6	7.4x10-6
Annual worker dose (mrem/yr) (total)	0	380	380
25-year fatal cancer risk (total)	0	3.8x10 *-3*	3.8x10 *-3*

Accidents			
Complete Set (EBAs and BEBAs)[21]			
Expected consequences (fatalities)	NA	1.2x10-4	5.4x10-5
Expected risk (fatalities per year)	NA	6.2x10-6	2.8x10-6
Waste Management	NA	TRU, LLW, and hazardous waste generation would increase slightly. Existing waste management facilities are adequate.	TRU, LLW, and hazardous waste generation would increase slightly. Existing waste management facilities are adequate.

Table 3.7.1-4.--*Summary Comparison of Impacts for the Secondary and Case Fabrication Mission*

	No Action	**Downsize ORR**	**Transfer to LANL** [22]	**Transfer to LLNL** [22]	**Phaseout at Y-12**
Construction/Modification					
Land					
Disturbed land (ha)	0	0	0	0	0
Percent of available land	0	0	0	0	0
Threatened & Endangered Species					
Potentially affected	None	None	None	None	None
Socioeconomics					
Peak worker (direct)	0	14	55	130	0
Total jobs (direct and indirect)	0	29	91	324	0
Operation [23]					
Water					
Use (MLY)	14,760	13,820	5,815	1,161	12,310
Percent of groundwater allotment[24]	NA	NA	86	NA	NA
Percent change from current use	4	-3	5.4	20	-13
Percent change from No Action use	NA	-6	1.0	20	-17
Discharge (MLY)	2,277	2,147	713	558	1,827
Percent change from current discharge	71	62	2.9	40	38

Percent change from No Action discharge	NA	-5.7	2.9	22	-20
Socioeconomics					
Total site workforce (all missions)[25]	4,721	4,508	6,867	8,479	1,385
Secondary and case workforce	2,741	1,376[26]	523[27]	760 [28]	0
Change from No Action in total jobs (direct & indirect)	NA	-2103 [29]	321	1,012	-13,470
Human Health					
Normal Operations					
Annual population dose (person-rem) (Incremental except for No Action)	40.2	0.6	0.5	0.84	-0.2
25-year fatal cancers (Incremental except for No Action)	0.51	7.5x10 *-3*	6.3x10 *-3*	1.1x10 *-2*	*-2.5x10-3*
Annual worker dose (mrem/yr) (total)	2.2	2.2	2.2	2.2	0
25-year fatal cancer risk (total)	2.2x10-5	2.2x10 *-5*	2.2x10 *-5*	2.2x10 *-5*	*0*
Complete Set (EBAs and BEBAs) [30]					
Expected consequences (fatalities)	[31]	0.02	0.02	0.063	NA
Expected risk (fatalities per year)	[31]	1.2x10-6	1.2x10-6	3.8x10-6	NA
Waste Management	Spent nuclear fuel, TRU, LLW, mixed waste, hazardous waste, and nonhazardous waste would continue to be generated.	All waste generation would decrease. Existing and planned waste management facilities would be adequate.	Waste generation volumes would increase slightly. Existing waste management facilities are adequate.	Waste generation volumes would increase slightly. Existing waste management facilities are adequate.	Wastes generated by operation of the mission would be eliminated. Existing and planned waste treatment facilities are adequate.

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1 A/D mission includes impacts from strategic reserve storage.

2 Data shown is for transfer of entire HE fabrication mission to LANL or LLNL. HE fabrication could be shared at LANL and LLNL.

3 All data for operations are based on three shift except for No Action, which is based on one shift.

4 Percent groundwater allotment only applies to LANL.

5 Three-shift operation; single-shift operation would be 800 A/D direct workers and 624 support workers.

6 Three-shift operation; single-shift operation would be 31 HE direct workers.

7 At LANL, 67 of the 200 jobs would be new jobs.

8 At LLNL, 100 of the 232 jobs would be new jobs.

9 Three-shift operation; single-shift operation would result in a loss of 408 (189 direct and 219 indirect) jobs.

10 Three-shift operation; single-shift operation would result in a loss of 475 (220 direct and 255 indirect) jobs.

11 Impacts to population out to 80 km (50 mi).

12 Appendix F provides reference to existing documents of No Action accidents. Appendix section F.3 describes a comparison of accidents for No Action versus accidents associated with downsizing. NA - not applicable; EBA - evaluation basis accident; BEBA - beyond evaluation basis accident.

13 If nonnuclear fabrication were transferred to LANL, LLNL, and SNL, impacts of phaseout at KCP would also occur.

14 All data for operations are based on three-shift except for No Action, which is based on single-shift.

15 This number represents 29-percent of the Kirtland Air Force Base groundwater rights. SNL can obtain water from other groundwater sources.

16 Three-shift operation, single-shift operation would be 1,669 nonnuclear direct workers and 671 support workers.

17 At LANL, 194 of the 315 jobs would be new jobs. f At LLNL, 60 of the 114 jobs would be new jobs. **g** Three-shift operation; single-shift operation would result in a loss of 2,319 (839 direct and 1480 indirect) jobs. NA - not applicable.

18 All data for operations are based on three shift except for No Action, which is based on one shift.

19 Percent groundwater allotment only applies to LANL.

20 At LANL, 260 of the 628 jobs would be new jobs.

21 Impacts to population out to 80 km (50 mi). NA - not applicable; EBA - Evaluation Basis Accident; BEBA - Beyond Evaluation Basis Accident.

22 If secondary and case fabrication mission were transferred to LANL or LLNL, impacts of phase-out at Y-12 would also result.

23 All data for operations based on three shift except for No Action, which is based on one shift.

24 Percent groundwater allotment only applies to LANL.

25 Total site workforce is for Y-12 only.

26 Three-shift operation, single-shift operation would be 784 secondary and case direct workers and 1,980 support and other workers. 1,152 workers would support D&D of the facilities vacated by downsizing.

27 At LANL, 321 of the 523 jobs would be new jobs.

28 At LLNL, 290 of the 760 jobs would be new jobs.

29 Three-shift operation; single-shift operation would result in a loss of 4,200 (805 direct and 3,395 indirect) jobs.

30 Impacts to population out to 80 km (50 mi).

31 Appendix F provides reference to existing documents for No Action accidents. Section F.3 describes a comparison of accidents for No Action versus accidents associated with downsizing.
NA - not applicable; EBA - Evaluation Basis Accident; BEBA - Beyond Evaluation Basis Accident.

4.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS

Chapter 4 describes the affected environment and the environmental impacts associated with stockpile stewardship and management alternatives. The chapter begins with an overview of applicable environmental assessment methodologies. The affected environment and environmental impacts of stockpile stewardship and management facilities are then discussed for each of the following sites: Oak Ridge Reservation, Savannah River Site, Kansas City Plant, Pantex Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratories, and Nevada Test Site. Each discussion begins with a brief site description and the stockpile stewardship and management alternatives being considered for that site, continues with a description of the affected environment at the site, and concludes with a description of environmental impacts, a sensitivity analysis for management alternatives, and potential mitigation measures. The general potential environmental impacts of next generation stockpile stewardship facilities and underground nuclear testing are discussed in separate sections. Following the sections that address individual sites, are discussions of potential impacts from intersite transportation, cumulative impacts, and several issues that are common to all sites: unavoidable adverse environmental impacts, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, irreversible and irretrievable commitments of resources, and facility transition.

Discussions of the environment that may be affected at each alternative site, and the associated environmental impacts that would result from the Stockpile Stewardship and Management Program make up the core of this chapter. In accordance with Council on Environmental Quality (CEQ) regulations, the affected environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment" (40 CFR 1508.14). The environmental impacts sections provide the analytical basis for the comparisons of potential impacts of the various stockpile stewardship and management facilities and the No Action alternative that are presented in chapter 3.

Affected Environment. The descriptions of the affected environment provide a basis for understanding the direct, indirect, and cumulative effects of the proposed Program and alternatives. The localities and characteristics of each potentially affected environmental resource are described for each site. The scope of the discussions varies by resource to ensure that all relevant issues are included.

For land resources, geology and soils, biotic resources, and cultural and paleontological resources, discussions of each Department of Energy (DOE) site and its surroundings are included along with descriptions of the representative area within that site that could be affected by the Program alternatives. This information provides a basis for understanding both direct effects and the overall resource base that could be affected by ancillary activities that may be defined in later stages of Program development.

Ambient conditions are described for air and water resources. Discussions focus on air conditions at site boundaries and the surface water bodies and groundwater aquifers that could be affected. This information serves as a basis for analyzing key air and water quality parameters to obtain results that can then be compared to regulatory standards.

Socioeconomic conditions are described for the counties and communities that could be affected by regional population changes associated with the proposed stockpile stewardship and management facilities. The affected environment discussions include projections of regional growth and related socioeconomic indicators. Each region is large enough to account for growth related to direct project employment as well as secondary jobs that may be created by the project.

In addition to those natural and human environmental resources discussed above, the affected environment sections include a number of issues related to ongoing DOE activities at each site. These issues involve facility operations and site infrastructure, intersite transport of nuclear materials, waste management, and radiological and hazardous chemical impacts during normal operation and from accidents. Where reasonably foreseeable changes to any of these factors can be predicted, they are discussed.

Environmental Impacts . In accordance with CEQ regulations, the environmental consequences discussions provide the analytical detail for comparisons of environmental impacts associated with the various stockpile stewardship and management facilities. Discussions are provided for each DOE site and each environmental resource and relevant issues that could be affected.

For comparison purposes, environmental concentrations of emissions and other potential environmental effects are presented with appropriate regulatory standards or guidelines. However, compliance with regulatory standards is not necessarily an indication of the significance or severity of the environmental impact for purposes of the *National Environmental Policy Act (NEPA)* of 1969.

The purpose of the analysis of environmental consequences is to identify the potential for environmental impacts. The environmental assessment methods used and the factors considered in assessing environmental impacts are discussed in section 4.1 and in the appropriate appendixes. The potential for impacts to a given resource or relevant issue is described in the introduction to each section within the site discussions (sections 4.2 through 4.9) that follow.

4.1 Environmental Resource/Issue Methodologies

4.1.1 Land Resources

This section considers land use plans and policies, zoning regulations, specially protected lands, and existing land use as appropriate for all sites. The potential impacts associated with changes to land use as a result of the alternatives are discussed.

Land use changes associated with upgraded and/or experimental stockpile stewardship facilities could occur in both rural and urban settings and could affect both developed and undeveloped land. The analysis of land use considers impacts that could result from the modification of existing facilities or the construction of new facilities on or adjacent to each site. Potential changes in land use are expected to occur within the existing boundaries of most, if not all, DOE sites. However, the use of lands adjacent to or in the vicinity of DOE sites (i.e., non-DOE land) could be affected by these changes, including new or expanded safety zones.

The degree to which the alternatives affect future use or development of land at each DOE site is considered. Land use impacts are assessed based on the extent and type of land that would be affected. The land use analysis also considers potential direct impacts resulting from the conversion of, or the incompatibility of, land use changes with special status lands such as prime and unique farmlands, and other protected lands such as Federal- and state-controlled lands (e.g., public land administered by the Bureau of Land Management or other Government agencies).

4.1.2 Site Infrastructure

Changes to site infrastructure are assessed by overlaying the support requirements of the respective stockpile stewardship and management facilities upon the projected site infrastructure capacities. These assessments focus upon electrical power and fuel requirements. Projections of electricity availability, site development plans, and other DOE mid- and long-range planning documents are utilized to project site infrastructure conditions. Tables are presented that depict the additional infrastructure requirements resulting from the alternatives. Mitigation considerations that could reduce impacts due to changes in infrastructure are identified on a site-by-site basis.

4.1.3 Air Quality

The air quality assessment evaluates the consequences of criteria and hazardous/toxic air pollutants associated with each alternative at each site. The criteria pollutants are specified in 40 CFR 50, Environmental Protection Agency (EPA) Regulations on National Primary and Secondary Ambient Air Quality Standards. The hazardous/toxic air pollutants are listed in Title III of the 1990 Clean Air Act (CAA) Amendments, the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61), and standards or guidelines proposed or adopted by the respective states.

Air quality concentrations from modeling site emission rates projected to 2005 define No Action concentrations of pollutants. This programmatic environmental impact statement (PEIS) presents the estimated impacts on air quality based on No Action air quality conditions at each site and the projected impacts resulting from the alternatives and compares the total concentrations to the most restrictive Federal and/or state ambient air quality standards and guidelines.

The modeling of site-specific emissions was performed in accordance with EPA's Guideline on Air Quality Models. The EPA-recommended Industrial Source Complex Short-Term (ISCST) Model (Version 2) (EPA 1992f) was chosen as the most appropriate model to perform the air dispersion modeling analysis for this PEIS because it allows for the estimation of dispersion from a combination of point, area, and volume sources. Input data for the model was provided by DOE sites. For source characteristics that are not available, characteristics were estimated based on similar source configurations at sites employing similar processes.

EPA guidelines are conservatively applied in the air quality assessment. The "highest-high" was selected for comparison to applicable standards and guidelines for all averaging times, instead of the EPA-recommended "highest-high" and "highest second highest" concentration for long-term and short-term averaging times, respectively. The concentrations evaluated are the maximum occurring at or beyond the site boundary or public access roads. It was also assumed that the toxic/hazardous emissions for DOE sites with incomplete source characteristics originate from a single point source. This assumption generally results in higher concentrations than would actually occur since emission sources are commonly geographically separated from one another.

A more detailed and quantitative assessment will be performed in site-specific NEPA documents designed to support a construction-level siting decision. This PEIS assessment of impacts from the No Action alternative and the other alternatives uses a screening level analysis and is based on conservative assumptions for modeling of potential impacts. The screening level modeling analysis presented in this document is a programmatic approach intended to provide a comparison of the air quality among each of the DOE sites. Modeled concentrations of air pollutants presented in this document that exceed the Federal or state air quality standards provide an indication of a potential problem, not a de facto exceedance. Detailed modeling and/or monitoring at each site would be required in order to obtain more accurate estimates of pollutant concentrations. The assessment in site-specific NEPA documents would be more refined with detailed design, source characteristics, and exact source locations.

Uncertainties. The performance of the ISCST Model has been evaluated with field data for its point source submodel (EPA 1977a; EPRI 1983a; EPRI 1985a; EPRI 1988a) and for its special features, such as gravitational settling/dry deposition option (EPA 1981a; EPA 1982a) and building downwash option (APCA 1986a; EPA 1981a). The ISCST Model is an extended version of the Single Source (CRSTER) Model; based on field data measured at four large power plants, it was concluded that the model was acceptable for predicting the upper percentile of the frequency distributions of 1-hour concentrations and of the corresponding distributions of 24-hour concentrations. The highest second-highest 1-hour concentrations were predicted within a factor of two at two-thirds of the field sampling sites for elevated power plant plumes. The ratio of the highest second-highest 24-hour concentration tended to be underpredicted by the model, with the ratio of predicted concentration to measured concentration ranging from about 0.2 to 2.7 at about 90 percent of the sampling sites (EPA 1977a:F-31).

In other validation studies for the Point Source Model, the CRSTER Model predicted peak short-term (i.e., 1-, 3-, and 24-hour) concentration values within 30 to 70 percent at a plain site (EPRI 1983a:7-1). The CRSTER Model predicted peak 1-hour concentrations within 2 percent and underpredicted peak 3-hour concentrations by about 30 percent at a moderately complex terrain site (EPRI 1985a:7-1). The ISCST Model overpredicts 1-hour concentrations by about 60 percent with better predictions for longer time periods at an urban site (EPRI 1988a:5-2). Uses of gravitational settling/dry deposition and building downwash options were found to improve the model performance significantly over that of the model without such features (APCA 1986a; EPA 1981a; EPA 1982a). The concentrations presented in this document are the highest concentrations predicted by the model in order to present conservative estimates of pollutant concentrations.

4.1.4 Water Resources

The quality and quantity of surface water and groundwater resources are described using available data. Potential effects on surface water and groundwater availability and quality are assessed.

Surface Water. Local surface water resources in the project region, flow characteristics and relationships, and stream classifications are used to describe current conditions. Data used for impact assessments include rates of water consumption and wastewater discharge for both construction and operation phases. Changes in the annual low flows of surface water resulting from proposed withdrawals and discharges are determined. In cases where low flow data are unavailable, average flow data are used. The existing water supply is evaluated to determine if sufficient quantities are available to support an increased demand by comparing projected increases with the capacity of the supplier and existing water rights, agreements, or allocations.

The water quality of potentially affected receiving waters is determined by reviewing current monitoring data for nonradiological parameters. Potential impacts from radiological parameters are discussed in the radiological and hazardous chemical impacts sections of the normal operation and accidents sections. Focus is given to parameters that exceed applicable water quality criteria, as determined by the individual states. Monitoring reports for discharges permitted under the National Pollutant Discharge Elimination System (NPDES) program are examined for compliance with permit limits and requirements. The performance of each candidate DOE site in complying with the permit requirements is presented. In most cases, current design data do not include information on the constituents present or the rate of discharge. The assessment of water quality impacts from wastewater (sanitary and process) and stormwater runoff qualitatively addresses potential impacts to the receiving waters' minimum or average flow, as available and appropriate. Suitable mitigation measures for potential impacts such as stream channel erosion and sedimentation, stream bank flooding, and thermal changes are identified. Water quality management practices are also reviewed. If effluent constituent data are available, parameters with the potential to further degrade existing receiving water quality along with parameters exceeding existing NPDES permit limits are identified.

Floodplains are identified to determine whether any of the proposed stockpile stewardship and management facilities are located within a floodplain. Where possible, the proposed location is compared with the 500-year floodplain.

Groundwater. Groundwater resources are analyzed for effects on aquifers, groundwater usage, and groundwater quality within the regions. Groundwater resources are defined as the aquifers underlying the site and their extensions down the hydraulic gradients to, and including, discharge points. The affected environment discussion includes a description of the potentially affected groundwater basins.

The local aquifers are described in terms of the extent, thickness, character of rock formations, and quality of the groundwater. Recharge areas are also noted. Total baseline groundwater use at the facility is compiled using the best available data. Groundwater usage is described and projections of future usage are made based on changing patterns of usage and anticipated growth patterns, whenever site-specific groundwater availability issues are identified.

Drawdown estimates are made both onsite and offsite. Short- and long-term impacts associated with construction withdrawals are estimated. Both proposed facilities and existing facilities are considered in determining cumulative impacts.

Available data on existing groundwater quality conditions are compared to Federal and state groundwater quality standards, effluent limitations, and safe drinking water standards. Additionally, Federal and state permitting requirements for groundwater withdraw and discharge are identified. Impacts of groundwater withdrawals on existing contaminant plumes due to construction and facility operation are assessed to determine the potential for changes in their rates of migration and the effects of any changes in the plumes on groundwater users. Impacts are assessed by the degree to which groundwater quality, drawdown of groundwater levels, and groundwater availability to other users would be affected. Impacts on groundwater quality are presented when effluent constituent data are available

4.1.5 Geology and Soils

Geology. Impacts to the geological environment considers destruction of or damage to unique geological features, subsidence caused by groundwater withdrawal, and landslides or shifting caused by loading or removal of supporting rock or soil. The local geology that could affect the alternatives, including geomorphology, stratigraphy, structural attitude of rocks, faults and seismicity, general foundation, and boring conditions, are described as appropriate for each alternative site. The locations of faults are identified and an overview of the seismicity of the site areas, including the history and significance of earthquakes, along with their intensity and ground acceleration, is presented. Areas of potentially unstable slopes and impacts to the stability of slopes by the removal or addition of large volumes of earth in construction are characterized.

Soils. Soil types at the proposed project sites are described and the capability of supporting construction of the proposed facilities is assessed. Shrinking or swelling of ground as a result of landscaping, irrigation, or construction dewatering and soil erosion susceptibility associated with construction are also addressed.

4.1.6 Biotic Resources

During construction, impacts to biotic resources, including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species, may result from land-clearing activities, erosion and sedimentation, and human disturbance and noise. Operations may affect biotic resources as a result of changes in land use, emission of radionuclides, water withdrawal, wastewater discharge, and human disturbance and noise. In general, potential impacts are assessed based on the degree to which various habitats or species could be affected by an alternative. Where appropriate, impacts are evaluated with respect to Federal and state protection regulations and standards.

The analysis of impacts of project alternatives to biological resources is addressed at a level that is appropriate to the specificity of available information. In general, the analysis of impacts to biological resources presented in this PEIS is qualitative rather than quantitative. Quantitative analyses would be performed in site- and project-specific NEPA documentation.

Terrestrial Resources. Impacts of the proposed alternatives on terrestrial plant communities are evaluated by comparing data on site vegetation communities to proposed land requirements for construction and operation. The analysis of impacts to wildlife is based to a large extent on plant community loss or modification, which directly affects animal habitat. The loss of important or sensitive habitats and species is considered more important than the loss of regionally abundant habitats or species. Where appropriate, the disturbance, displacement, or loss of wildlife is evaluated in accordance with wildlife protection laws such as the *Migratory Bird Treaty Act* . Impacts on biotic resources from the release of radionuclides are not evaluated. Radiological releases associated with the various alternatives would generally be at or below natural background levels and would be within limits established to protect workers and the public. Since humans have generally been shown to be the most sensitive organism to radiation release these levels should also be protective of biota (AEC 1968a:220; NAS 1972a:34). Radiological effects on humans are addressed in the human health sections.

Wetlands. The potential direct loss of wetlands resulting from construction and operation of the proposed alternatives is addressed in a way similar to the evaluation of impacts on terrestrial plant communities; that is, by comparing data on site or regional wetlands to proposed land requirements. Sedimentation impacts are evaluated based on the proximity of wetlands to project areas and with the knowledge that an erosion control and sedimentation plan would be required. Impacts resulting from wastewater discharge into a wetland system are evaluated, recognizing that effluents would be required to meet Federal and state standards.

Aquatic Resources. Impacts to aquatic resources resulting from sedimentation and wastewater discharge are evaluated as described for wetlands. Potential impacts from radionuclides are not addressed for the same reasons described for terrestrial resources. Where appropriate, impingement and entrainment impacts are evaluated as is compliance with protective measures, such as the *Anadromous Fish Conservation Act* .

Threatened and Endangered Species. Impacts on threatened and endangered species are determined in a manner similar to that used to describe terrestrial and aquatic resources since the sources of potential impacts are similar. A list of species potentially present on each site or in proximity to the site or region (appendix C) was developed using information obtained from the U.S. Fish and Wildlife Service (USFWS) and appropriate state agencies. This list, along with consideration of site environmental and engineering data, and provisions of the *Endangered Species Act* valuate whether the various alternatives could impact any threatened or endangered plant or animal (or its habitat).

Species that are Federal proposed or candidates for listing as threatened or endangered species do not receive legal protection under the Endangered Species Act. However, the USFWS recommends that impacts to these species be considered in project planning since their status can be changed to threatened or endangered in the foreseeable future. The USFWS has recently changed the classification of species under review for listing as threatened or endangered (61 FR 7596). Proposed species include those plants and animals for which a proposed rule to list as threatened or endangered has been published. Candidate species include those plants and animals for which the USFWS has on file sufficient information on biological vulnerability and threat to support issuance of a proposed rule for listing as threatened or endangered. Candidate species previously included Category 1 (species appropriate for listing as protected) and Category 2 (species possibly appropriate for listing as protected). Due to the recent rule change, candidate species include only those which are appropriate for listing as protected species (i.e., species formerly listed as Category 1). The Category 2 designation has been omitted. Some of the species previously identified as Federal candidate Category 2 in the Draft PEIS also have a state status and continue to be evaluated for potential impacts. However, due to the change in candidate classification described above, many species have been eliminated from proposed site threatened and endangered species lists.

4.1.7 Cultural and Paleontological Resources

Included in these sections are evaluations of the impacts of the Stockpile Stewardship and Management Program alternatives on prehistoric, historic, Native American, and paleontological resources. The effects considered include those resulting directly from land disturbance during construction, visual intrusion to the settings or environmental context of historic structures, visual and audio intrusions on Native American sacred sites, reduced access to Native American traditional use areas, unauthorized artifact collecting, and vandalism. Laws, regulations, Executive orders, and DOE orders mandating protection of cultural and paleontological resources are described for each site in chapter 5.

Prehistoric Resources. Prehistoric resources are physical properties resulting from human activities that predate written records. They are generally identified as either isolated artifacts or sites. Sites may contain concentrations of artifacts (e.g., stone tools and ceramic sherds), features (e.g., remains of campfires and houses), and plant and animal remains. Depending on their age, complexity, integrity, and relationship to one another, sites may be important for and capable of yielding information about past populations and adaptive strategies. The affected environment section for prehistoric resources includes a brief overview of the number and types of prehistoric sites in the project areas, if known, and their status on the National Register of Historic Places (NRHP). The overview consists of a summary of existing information about prehistoric resources in the region and a discussion of types of sites that are likely to occur.

Impact assessments for prehistoric resources focus mainly on those properties likely to be eligible for the NRHP. Impacts are assessed by considering whether or not the proposed action could substantially add to an existing disturbance of resources in the project areas, adversely affect NRHP-eligible resources, or cause loss of or destruction to important prehistoric resources.

Historic Resources. Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date from 1492 onward. Historic resources include architectural structures or districts (e.g., buildings, dams, and bridges), objects, and archaeological features (e.g., foundations of mills or residences, trails, and trash dumps). Ordinarily, sites less than 50 years old are not considered historic for analytical purposes, but exceptions can be made for younger properties if they are of exceptional importance (e.g., structures associated with Cold War themes [36 CFR 60]). The affected environment section for historic resources includes a brief overview of the number and types of historic sites in the project areas, if known, and their status on the NRHP. The overview consists of a summary of existing information about historic resources in the region and a discussion of the types of sites that are likely to exist.

Impact assessments for historic resources focus mainly on those properties likely to be eligible for the NRHP. Impacts are assessed by considering whether or not the proposed action could substantially add to an existing disturbance of resources in the project areas, could adversely affect NRHP-eligible resources, or could cause loss of or destruction to important historic resources.

Native American Resources. Native American resources are sites, areas, or materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Of primary concern are concepts of sacred space that create the potential for land-use conflicts. Native American concerns would be identified through direct consultation with tribal representatives and field visits with tribal religious specialists during preparation of project-specific tiered NEPA documents. Contacts would be identified by reference to the ethnographic literature, by state and national pantribal organizations, and by agency and academic anthropologists.

The individual resource type, the proximity of impact areas to the resources, and the likely duration of impacts are considered in the analysis of Native American resources. Specific concerns include the relative importance of the resource in the Native American physical universe or religion, the distance at which activities in the vicinity of a sacred area constitute a disturbance, the extent to which affected resources may be restored, and the extent to which alternative sources for raw materials are available and/or suitable. Impacts to Native American resources are assessed by considering whether or not the proposed action has the potential to affect sites important for their position in the Native American physical universe or belief system, or the possibility of reducing access to traditional use areas or sacred sites.

Paleontological Resources. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. They include casts, molds, and trace fossils such as burrows or tracks. Fossil localities typically include surface outcrops, areas where subsurface deposits are exposed by ground disturbance, and special environments favoring preservation, such as caves, peat bogs, and tar pits. Paleontological resources are important mainly for their potential to provide scientific information on paleoenvironments and the evolutionary history of plants and animals. The affected environment section for paleontological resources includes a description of known paleontological localities and geological formations in the project areas that may be fossil bearing.

Impact assessments for paleontological resources are based on the numbers and kinds of resources that could be affected, as well as the quality of fossil preservation in a given deposit, particularly in deposits with high research potential. Such deposits include poorly known fossil forms; well-preserved terrestrial vertebrates; unusual depositional contexts; assemblages containing a variety of fossil forms, particularly associations of vertebrates, invertebrates, and plants; or deposits recovered from poorly studied regions or in unusual concentrations.

4.1.8 Socioeconomics

These sections describe and assess impacts on local and regional socioeconomic conditions and factors including employment, economy, population, housing, and public finance. This PEIS assesses the socioeconomic impacts of both the gains and losses of missions at each site. The potential for socioeconomic impacts on population, housing, and local government finance is greatest in those local jurisdictions immediately adjacent to each site and those that are the residential locations of the majority of DOE site employees. Potential socioeconomic impacts on the economy (employment and income) are not bounded by local government jurisdictions but rather by industrial linkages to a regional market. Therefore, potential socioeconomic impacts are assessed using two geographic regions, a regional economic area, and a region of influence (ROI). Regional economic areas are used to assess potential effects on the economy. ROIs are used to assess effects which are more localized in political jurisdictions surrounding the sites.

The regional economic area for each site encompasses a broad market that involves trade among and between regional industrial and service sectors. It is characterized by strong economic linkages between the communities located in the region. These linkages determine the nature and magnitude of multiplier effects on economic activity (i.e., purchases, earnings, and employment) at each candidate site. Regional economic areas are defined by the U.S. Bureau of Economic Analysis as consisting of an economic node that serves as the center of economic activity and the surrounding counties that are economically related and include the places of work and residences of its labor force.

The U.S. Bureau of Economic Analysis measures multiplier effects of interindustry linkages with the Regional Input-Output Modeling System (RIMS II). RIMS II is based on an accounting framework called an input-output table. An input-output table shows, for each industry, industrial distributions of inputs purchased and outputs sold. RIMS II Total Direct-Effect Multipliers are used in this PEIS to estimate additional regional employment and income generated by employment and income directly associated with the proposed alternatives. RIMS II is also used to estimate the effects of jobs and income lost in a region due to downsizing or phaseout.

Additional potential demographic impacts were assessed on a smaller geographic area (ROI) where the housing market and community public finances could be most affected. Proposed Program alternatives at alternative sites were assessed using a site-specific ROI, comprising those local jurisdictions likely to experience the greatest socioeconomic impacts. The ROI is defined as those counties where approximately 90 percent of the current DOE and contractor employees reside. This residential distribution reflects existing commuting patterns and attractiveness of area communities for people employed at each site, and is used to estimate the future distribution of direct workers with the proposed alternative. The evaluation of impacts is based on the degree to which changes in employment and population affect the regional economy, housing market, and public finance. It is assumed that most new or lost jobs would occur within the ROI where the majority of DOE and contractor employees live. The changes to these factors are projected to 2030 because the projected life of the DOE facilities for the alternatives under study is 25 years starting in 2005. The following sections discuss each of the socioeconomic conditions and factors considered.

Employment. The construction and operation of stewardship and management technologies and facilities could affect employment at DOE sites. Changes in site employment would, in turn, directly affect local and regional populations, economies, housing, and public finance. Current employment at each site is described, as well as projected employment associated with other planned DOE initiatives. Socioeconomic trends and the relationship of site employment to these trends are examined for each potentially affected socioeconomic region. Emphasis is placed on evaluating total direct and indirect employment changes and impacts associated with potential mission relocations.

Economy. The regional economies surrounding each site are characterized. Emphasis is placed on the measurement of the relative contribution and importance of each site's employment payroll and purchases to the economy. Changes to regional economic conditions are evaluated based on each site's relative contribution and changes to employment. Emphasis is placed on the economic effects of mission changes associated with the operation of stewardship and management technologies and facilities.

Population. The demographic changes in the ROI surrounding each site are described and assessed. Demographic characteristics are presented for the site's ROI to support the assessment of socioeconomic impacts. Trends are identified and used to project demographic changes over the environmental baseline period. Cumulative population impacts include the population impacts of other DOE actions under consideration, including planned environmental restoration activities.

Housing. Changes in employment at each site would affect the demand and supply of housing units, including the need for temporary housing (e.g., rental units) to support in-migrating construction workers. Trends in the housing availability within each site's socioeconomic ROI are characterized and evaluated. Numbers of in-migrating and out-migrating site employees associated with each of the alternatives are then used to evaluate housing impacts.

Public Finance. Each site is located on land owned by the Federal Government, which exempts these lands from state and local taxation. However, all employee income, property, and purchases are subject to applicable Federal, state, and local taxation requirements.

The additional workforce associated with any of these alternatives is small, and would require few in-migrating workers. For that reason, there would be little increased demand on specific community services. However, there would be fiscal impacts associated with additional missions or the phaseout of existing missions which could affect the community's ability to provide basic infrastructure and services. Therefore, the fiscal impacts on each site's ROI are assessed for counties, cities, and school districts, rather than the change in demand for specific community services. For a more detailed discussion of public finance, see appendix D.

4.1.9 Radiation and Hazardous Chemical Environment

4.1.9.1 Normal Operation

Public Health Risks. The risks to the general public during the 25-year operational interim are determined in three ways. Radiological releases/doses, which are conveyed in site-specific reports, are used to calculate risks associated with predicted baseline (No Action) operations in 2005. Incremental radiological/chemical doses and respective subsequent risks for management alternatives associated with each applicable site examined in this PEIS are calculated (modeled) via predicted release quantities supplied by "technology-specific" data reports and from site-dependent parameters. Incremental radiological/chemical doses and respective subsequent risks associated with certain proposed stewardship alternatives (on a per site basis) pursuant to this PEIS, are directly referenced from technology-specific or site-specific data reports.

Radiological Impacts. The assessment of incremental (or decremental) impacts incurred at each of the DOE sites are performed using the GENII computer code. This type of assessment uses such site-dependent factors as meteorology, population distributions, agricultural production, and an assumed facility location on a given site. Health risks to the maximally exposed individual and population within 80 kilometers (km) (50 miles [mi]) at Oak Ridge Reservation (ORR), Savannah River Site (SRS), Pantex Plant (Pantex), Sandia National Laboratories (SNL), and Nevada Test Site (NTS) are analyzed for each management and/or stewardship alternative, with the assumption that any two or more alternatives (with the exception of No Action) are not concurrently existing. At Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL) however, a cumulative calculation is provided which includes all possible alternatives simultaneously existing at each respective site.

Resulting doses are compared with regulatory limits, and for perspective, are also compared with background radiation levels in the area of the site. These doses are then converted into the projected number of fatal cancers using a dose-to-risk conversion factor of 500 fatal cancers per 1,000,000 person-rem ($5x10^{-4}$ fatal cancers per person-rem) derived from data presented in a report prepared by the National Research Council's Committees on the Biological Effects of Ionizing Radiations (BEIR V) and also cited in the *1990 Recommendations of the International Commission on Radiological Protection* . The calculated health effects from each of the alternatives are then compared to one another (including the No Action alternative).

Hazardous Chemical Impacts. Public health risks from hazardous chemical releases during normal operation at the respective DOE sites are assessed by essentially the same analytical approach using conservative assumptions. This conservative approach is applied uniformly to all alternative sites using guidance provided under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The initial assessment in risk analysis is considered a screening step that was determined to be the appropriate level of analysis for this PEIS. Under this guidance, if the Hazard Index (HI) is 1x10-*6* (the default value, not a regulatory standard), no further analysis is indicated. A cancer risk of 1x10-*6* is considered acceptable by EPA (40 CFR 300.430) because this incidence of cancers cannot be distinguished from the cancer risk for an individual member of the general population.

Engineering designs used for the stockpile stewardship and management process and/or storage facilities include the anticipated emissions of hazardous chemicals. From emission data, concentrations at the site boundary are assumed to represent the maximum that any member of the public will encounter; therefore, the site boundary concentrations are derived through the ISCST Model (version 2) recommended by EPA. The noncancer risks of the maximally exposed individual of the public will consist of hazard quotients (HQs) that compare chemical exposure levels to the reference concentration values published by EPA in the Integrated Risk Information System. The cancer risk to the maximally exposed individual is calculated from the doses derived from modeling exposure levels, using slope factors or unit risks for individual chemicals published in the Integrated Risk Information System or the health effects summary tables. The health effects summary tables are the yearly summary of EPA's regulatory toxicity data. The HI values (i.e., the sum of the HQs) and cancer risks are conservative because a single source and a single point at the site boundary are chosen for the calculations. The cancer risks are also conservative due to the single point concentration and the position where the exposure is assumed to occur. The HI is independent of the cancer risk.

The HIs and cancer risks are used as screening tools to identify potential health concerns that may require further analysis. If the HI meets OSHA standards and cancer risks are within the default value, then further analysis is most likely not warranted. However, if in the conservative approach, there are sites or activities wherein the HI and/or cancer risk exceed acceptable limits, then these sites or activities become candidates for further in-depth analysis. The in-depth analysis should identify the individual chemicals that contribute to substantial adverse HI and/or cancer risk impacts, starting with those chemicals showing the highest HQs and/or cancer risk and grouping them according to their specific health effects. These chemicals then may be identified for inclusion in more specific site analyses. It should be noted that when the OSHA standards for HIs and/or the cancer risk default value are exceeded, a health concern may not necessarily exist. This PEIS does not purport to provide the level of detail needed to go beyond a conservative screening process for hazardous chemicals. As such, the analysis in this PEIS for the No Action alternative should not be relied upon as a basis for judging whether the sites have a health concern. The model used to calculate HI and cancer risk in this PEIS only establishes a baseline for comparison of alternatives among different sites. The baseline is then used to determine the extent to which each alternative adds or subtracts from the No Action HI and cancer risk to the public at each site.

Information pertaining to OSHA-regulated permissible exposure limits, reference concentrations, reference doses, cancer slope factors (if any), and toxicity profiles for all hazardous chemicals described in this PEIS may be found in the *Chemical Health Effects Technical Reference* (TTI 1996b.)

Occupational Health Risks. Health risks are assessed for two types of workers. The first type is the involved worker who would be located inside a facility that is involved with any of the given alternatives being examined. The second type is the noninvolved worker who would be located somewhere else on a given site but is not involved with occupational tasks associated with any of the given alternatives.

Radiological Impacts. Involved worker exposures are either based on values reported in technology-specific data reports or in occupational dose histories for similar operations. The doses to noninvolved workers at each respective site are determined based on occupational dose histories; in most cases for these workers, impacts associated with normal operation for each management and/or stewardship alternative are assumed to be negligible compared with those associated with their primary onsite activities. Worker impacts associated with each alternative at ORR, SRS, Pantex, SNL, and NTS are analyzed with the assumption that any two or more alternatives (with the exception of No Action) are not concurrently existing. At LANL and LLNL however, a cumulative calculation is reported that includes all possible alternatives simultaneously existing at each respective site.

The worker doses are converted into the number of projected fatal cancers using the dose-to-risk conversion factor of 400 fatal cancers per 1,000,000 person-rem (4x10-4 fatal cancers per person-rem) given in ICRP Publication 60. This lower risk estimator, compared with that for members of the public, reflects the absence of children in the workforce.

Hazardous and Toxic Chemical Impacts. Since direct chemical monitoring data on worker exposure is not available for specific operations, the onsite worker is assumed to receive the maximum exposure any involved or noninvolved onsite person will receive. OSHA-regulated levels (i.e., permissible exposure levels) are applied to all hazardous chemicals that are released at the site. This includes both the project-specific releases as well as those that are a result of other site operations. All onsite exposures are assumed to occur at a distance of 100 meters (m) (330 feet [ft]) from a centralized point of release, which will yield a conservative concentration level for each chemical. The concentrations are derived through the ISCST Model recommended by EPA. The noncancer risks to the onsite worker consist of HQs that compare chemical exposure levels to the permissible exposure level values established by OSHA. The HI for each alternative is the sum of all HQs for the alternative. The cancer risks to the onsite worker are calculated from doses derived from modeled exposure level, using slope factors or unit risks for individual chemicals published in the Integrated Risk Information System or the health effects summary tables . The worker exposure is based on an 8-hour day and 52 weeks of 40 hours each (i.e., 0.237 fractional year). The HI values and cancer risks are conservative because a single point at 100 m (330 ft) from a centralized source term is chosen for the calculations. The cancer risks are conservative due to the single point concentration and the position where the exposure is assumed. The HI is independent of cancer risk. The cancer risks to the facility worker for each chemical are computed from the dose (converted from air concentrations) and the unit risk or slope factors to yield a probable risk. The risks are also conservative because a single point at or near the maximum onsite concentration is selected for calculating the exposure of the facility worker.

As described for public health risks, this conservative approach is applied uniformly to workers at all sites using guidance under CERCLA. Under this guidance, if the HI is $1x10^{-6}$ (the default value, not a regulatory limit), no further analysis is indicated. If the HI exceeds the OSHA standards and/or the cancer risk exceeds the default value, a need for a more in-depth analysis of the data is indicated. It should be noted that when the OSHA standards for HIs and/or the cancer risk default value are exceeded, a health concern may not necessarily exist. The model used to calculate HI and cancer risk in this PEIS only establishes a baseline for comparison of alternatives among different sites. The baseline is then used to determine the extent to which each alternative adds or subtracts from the No Action HI and cancer risk for workers at each site.

Information pertaining to OSHA-regulated permissible exposure limits, reference concentration, reference doses, cancer slope factors (if any), and toxicity profiles for all hazardous chemicals described in this PEIS may be found in the *Chemical Health Effects Technical Reference* (TTI 1996b).

Epidemiological Studies . In March 1990, the Secretary of Energy announced that DOE would turn over responsibility for analytical epidemiologic research on long-term health effects on workers at DOE facilities and the public in surrounding communities to the Department of Health and Human Services. Further, DOE directed that this worker and public health and exposure data be released. A Memorandum of Agreement with the Department of Health and Human Services was signed in January 1991. The Department of Health and Human Services is now conducting the ongoing health effects research program. The National Institute for Occupational Safety and Health also initiated a study in 1994 but does not expect the results before 1997. Discussions are presented of past and ongoing health studies for each site.

4.1.9.2 *Facility Accidents*

Accident Analysis for Postulated Accident Scenarios. The relative consequences of postulated accidents in the evaluation of each alternative are considered. In evaluating the magnitude and consequences of each alternative, a suitable accident analysis is performed to produce results for decision-making purposes. Although the concepts used are analogous to a formal Probabilistic Risk Assessment, which would be appropriate for a project-level analysis, the accident analysis involves considerably less detail and only addresses a representative spectrum of beyond design-basis accidents (high-consequence, low-probability) and a representative spectrum of possible operational accidents (low-consequence but high-probability of occurrence). The technical approach for the selection of accidents is consistent with the DOE Office of NEPA Oversight Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements (May 1993), which recommends consideration of two major categories of accidents: within design-basis accidents and beyond design-basis accidents.

For the purpose of this assessment, risk is defined as the mathematical product of the probability and consequences of an accident. Both probability and consequences are presented in this PEIS. The risk-contributing scenarios consider both design-basis and severe accidents. The specific accidents consider the types of facilities. Examples of accidents include those resulting from operator errors, spills, criticalities, fires, explosions, airplane crashes, common-cause failures, collocated facilities, severe weather, earthquakes, and transportation. Information on potential accidents includes those that have been postulated and analyzed for similar facilities. The risks of the various stockpile stewardship and management facilities are evaluated in terms of the incremental increase in risk and the cumulative effect of that risk with respect to normal day-to-day risks to which the general population is exposed.

For each alternative, a number of evaluation and beyond evaluation accidents have been identified and are generally referred to as the composite set of accidents. Two subsets of the composite set are also referred to as the composite set of evaluation basis accidents (EBAs) and the composite set of beyond evaluation basis accidents (BEBAs). Impacts are presented for the composite set of accidents to reflect the combined impacts of EBAs and BEBAs. The impacts for the composite set of EBAs are also provided to reflect the impacts of high-frequency/low-consequence accidents. Impacts for the composite set of BEBAs are provided to show the impacts of low-frequency/high-consequence accidents. EBAs are generally in a frequency range greater than 10-*6* per year, while BEBAs are generally in a frequency range of 10-*7* to 101x10-*6* per year. In some cases, accidents less than 10-*7* are included in the composite set of BEBAs.

Accident risk to collocated workers was calculated for a hypothetical worker at 1,000 m (3,281 ft) from the facility, or at the site boundary, whichever is closer. For distances less than 1,000 m (3,281 ft), the screening model techniques used in the programmatic level analyses are less effective because of the effects of buildings on meteorology and dispersion.dent scenarios addressed in this PEIS. Where information is available, risks to involved workers from accidents are presented. It should be noted that the purpose of this PEIS is to assist the decisionmaker in making programmatic site selection decisions. Since the activities are the same for a given stockpile management function regardless of location, the risk to involved workers would be independent of site location and would not be a discriminating factor for programmatic siting decisions. Risk to workers from radiological accidents would be addressed in greater detail in site-specific tiered NEPA documents when more detailed information is available.

Sensitivity Analysis. Adequate data is not available to support a quantitative sensitivity analysis for accident impacts; therefore, a discussion of the subject is not presented in the accident discussion for the management alternatives in this PEIS. However, it is expected that higher case workloads could increase the quantity of hazardous materials at risk in an accident and the accident frequency. Therefore, this could result in a corresponding increase in accident impacts.

Uncertainties . The sequence of analyses performed to generate the radiological impact estimates from normal operation and facility accidents include selection of normal operational modes and accident sequences, estimation of source terms, estimation of environmental transport and uptake of radionuclides, calculation of radiation doses to exposed individuals, and estimation of health effects. There are uncertainties associated with each of these steps. Uncertainties exist in the way the physical systems being analyzed are represented by the computational models and in the data required to exercise the models due to measurement errors, sampling errors, or natural variability.

The analysis is designed to ensure--through judicious selection of release scenarios, models, and parameters--that the results represent the potential risks, and that there is a consistent basis for comparing alternatives. This is accomplished by making conservative assumptions in the calculations at each step.

The risk analysis presented in this PEIS is not a complete risk assessment in the sense of identifying and analyzing all physically possible accidents including those high consequence accidents whose probability is so remote as to render them not reasonably foreseeable. The accident analyses do include, however, a spectrum of reasonably foreseeable accidents including high consequence accidents and their associated risks for the technologies and facilities. These severe accidents have low accident frequencies, often less than 1.0x10-*6* per year. The accident analyses also include higher frequency accidents (evaluation-basis and other operational 1x10-*6* per year.

In summary, the radiological and hazardous chemical impact estimates presented in this document were obtained by:

- Using the best available data
- Considering the processes, events, and accidents that are reasonably foreseeable for the facilities described in this study and the environment
- Making conservative assumptions when there is doubt about the exact nature of the processes and events taking place
- Ensuring the consistency of analysis across alternatives

Emergency Preparedness. Emergency preparedness and planning has the effect of mitigating the consequences of facility accidents. Emergency preparedness plans exist for all sites and are summarized for each site.

4.1.10 Waste Management

A major effort of the Stockpile Stewardship and Management Program has been and would continue to be the minimization of waste generation. The proposed alternatives would incorporate waste minimization and pollution prevention practices to the maximum extent practicable. Waste minimization efforts and the management of Program-related wastes are discussed for each DOE site. Waste management facilities that would support stockpile stewardship and management facilities would treat and package waste into forms that would enable long-term storage or disposal. For sites under consideration that do not have existing or planned onsite low-level waste (LLW) disposal, the number of additional shipments required to transport LLW from the site to a DOE LLW disposal facility is estimated. For example, for purposes of this analysis it is assumed that Pantex would ship its LLW to NTS as per current practice. The risks associated with additional shipments are addressed as part of the intersite transport assessment (section 4.10). Waste management activities that would support the Program are assumed to be per current site practice and are contingent upon decisions to be made through the Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (DOE/EIS-0200-D, August 1995). Any future waste management facilities that may be required to support the Program would be coordinated with any decisions resulting from the Waste Management PEIS and any respective site-specific NEPA documentation.

The construction and operation of stockpile stewardship and management facilities would generate several types of wastes. Generation points are in some cases different among alternative sites depending upon specific siting of various facilities. Construction wastes are similar to those generated by any construction project of comparable scale. Wastes generated during the operation of stockpile stewardship and management facilities consist of five primary types: transuranic (TRU), low-level, mixed, hazardous, and nonhazardous wastes. The types and amounts of waste vary according to the alternative and facility. For example, the Pit Fabrication Facility is the only facility projected to generate any TRU waste.

The nuclear weapons facilities provide for the short-term stabilization, staging, storage, and management of waste, including the means to minimize waste generation, until DOE either disposes of the waste or places it in long-term storage. To provide a framework for addressing the impacts of waste management for stockpile stewardship and management facilities, descriptive information is presented on the waste management activities anticipated for each DOE site. The volumes of each type of waste generated are estimated by facility and DOE site. These estimates have included waste minimization provisions. The impact assessment addresses the waste types and projected waste volumes from the various stockpile stewardship and management facilities at each site compared to No Action. Impacts are assessed in the context of existing site practices for treatment, storage, and disposal, including the applicable regulatory setting and requirements. Existing permits, compliance agreements, and other site-specific waste management practices were reviewed and analyzed to assess the ability to conduct the required activities.

Decontamination and decommissioning (D&D) activities are also addressed. Such activities depend upon the historic use of the facility and the final disposition of a facility. D&D activities could range from performing a simple radiological survey to completely dismantling and removing a radioactively contaminated facility. The D&D waste volumes from transition facilities no longer required for stockpile stewardship and management missions are estimated.

4.1.11 Environmental Justice

This PEIS assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations in accordance with Executive Order 12898, *Federal Action to Address Environmental Justice in Minority Populations and Low Income Populations* . Because both the Federal Working Group on Environmental Justice and DOE are still in the process of developing guidance on criteria for identifying effects to these populations, the approach taken in this PEIS analysis may differ somewhat from whatever guidance may be issued.

This PEIS environmental justice analysis addressed selected demographic characteristics of the ROI (80 km [50 mi]) for each of the eight alternative sites. The analysis identified census tracts where racial or ethnic minorities comprise 50 percent, or a simple majority, of the total population in the census tract, or where racial or ethnic minorities comprise less than 50 percent but greater than 25 percent of the total population in the census tract. The analysis also identified low-income communities where 25 percent or more of the population is characterized as living in poverty (yearly income of less than $8,076 for a family of two). Impacts are assessed based on the analysis presented for each resource and issue area for each of the proposed alternatives at each site. Any disproportionately high and adverse human health or environmental effects on minority and low-income populations are discussed.

4.1.12 Cumulative Impacts

Cumulative impacts address the incremental effects of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (43 FR 55978; 40 CFR 1500-1508).

Other DOE programs (including environmental management missions) and other Federal, state, and local development programs all have the potential to contribute to cumulative effects on DOE sites. "Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). To the extent information was available for these other actions at a given site, the cumulative impacts are presented.

Continuing Department of Energy Missions . Continuing DOE missions and any reasonably foreseeable changes to these missions are addressed as part of the affected environment baseline. Continuing missions at each site are discussed in the site infrastructure section of the affected environment discussion for each DOE site. These missions provide the baseline against which the stockpile stewardship and management facilities are compared. For example, water requirements for the proposed stockpile stewardship and management facilities are combined with requirements of continuing missions to assess the total impact to water resources.

Environmental Management Missions . Any planned and reasonably foreseeable new or modified waste handling facilities are discussed in the waste management section for each site. In addition, to the extent that other environmental management missions or strategies are planned and defined, they are also discussed as bounding environmental impacts of waste management actions. Specific waste management activities are being addressed in the Waste Management PEIS being prepared by the DOE Office of the Assistant Secretary for Environmental Management (EM).

Other Federal and State Programs. Other Federal and state programs are identified, but only planned, reasonably foreseeable programs are considered. Typical programs in this category include public works projects and military base closures and reuse projects. Potential consequences of any major programs that increase impacts when combined with the stockpile stewardship and management alternatives are presented.

Local Development Programs. Local development programs are not specifically identified. However, socioeconomic projections take into account anticipated regional growth. Local development programs are a part of this growth and are addressed collectively using growth as a substitute. Socioeconomic projections form the baseline for much of the environmental analysis presented in this document.

Approach for Cumulative Impact Assessments. There is no generic methodology for the assessment of cumulative impacts. Therefore, the following approach represents a design for analyzing programmatic cumulative impacts relative to past, present, and probable future activities. It incorporates a wide ranging view of DOE defense programs, environmental management, and other outside interactions. This strategy is integrated with detailed resource-specific assessment methods where appropriate, and can be developed further in site-specific tiered NEPA documentation to ensure compatibility across the DOE Office for the Assistant Secretary for Defense Programs (DP), EM, and other programs.

The rationale for this approach is that this PEIS is a programmatic document. The reference condition for cumulative effects is the No Action alternative. The strategy has four major components:

- Focus analysis primarily on the impacts at each stockpile stewardship and management site where other DP and/or EM activities are reasonably anticipated. Past, baseline, and future DP and EM activities are more clearly defined and have a higher degree of certainty than offsite activities. These activities tend to be much more speculative the further into the future they are planned.
- Address quantitatively cumulative impact analyses associated with offsite activities in site-specific, tiered NEPA documentation.
- Coordinate efforts between DP and EM activities through the Memorandum of Agreement between DP and EM
- Focus on site-specific cumulative effects from stockpile stewardship and management, addressing them in terms of both the temporal and spatial aspects of DP activities, as well as the level, phasing, and site-specific locations of proposed EM facilities and activities. This is appropriate due to the uncertainty and lack of specificity associated with offsite activities that could result in significant incremental, indirect, or synergistic cumulative impacts; these activities are more effectively addressed in site-specific, tiered NEPA documentation.

This method is flexible and allows for the assessment of cumulative impacts to regulated resources at a lower level of analysis due to the protection afforded to them through applicable regulations. In addition, the method recognizes that the focus on a given resource may vary according to site-specific characteristics of the local environment. Where these types of variations are identified, a level of analysis would be performed commensurate to the importance of the potential cumulative impacts on that resource.

4.10 Intersite Transportation

4.10.1 Methodology

This PEIS evaluates the potential impacts from transporting special nuclear materials, hazardous wastes, and other weapons-related materials associated with the activities under consideration by the Stockpile Stewardship and Management Program. All materials shipped by DOE are first stabilized, then packed and shipped in accordance with all applicable Federal and state transportation regulatory requirements. In most cases, DOE requirements exceed DOT and NRC standards for commercial transport. Baseline information, the existing transportation patterns for each site, and the types of containers required to ship the materials have been included for this analysis, as appropriate.

Actual and projected inventories were used for the transportation analysis. Data already collected were used to the extent possible. Environmental impacts of transporting materials between facilities were estimated using a homogeneous population (i.e., urban, suburban, and rural), an average container or truckload of material, and a unit of measure (i.e., risk per kilometer) for each of the material forms. The assessment provides an overview comparison of transportation impacts for the alternatives being considered.

The estimated health risks in terms of potential total fatalities from transporting special nuclear material and radioactive material between the sites were quantitatively analyzed with the RADTRAN 4 computer code. Unit risk factors were developed for each type of special nuclear material and radioactive material to estimate the potential risk of transporting truckload shipments by DOE safe secure trailer over intersite routes or transporting shipments by air. These unit risk factors were used in conjunction with the quantity of material, form, distance, and number of shipments to estimate potential radiological and nonradiological impacts to the transport crew and public. The potential fatality impacts are presented for each alternative considered. The transportation of HE was evaluated qualitatively based on past shipping experience.

4.10.2 Affected Environment

The volume of DOE's hazardous material (radioactive and nonradioactive) shipments is extremely small in comparison to the volume of non-DOE hazardous materials shipments. DOT estimates that approximately 3.6 billion t (4 billion tons) of regulated hazardous materials are transported each year and that approximately 500,000 shipments of hazardous materials occur each day (PL 101-615, Section 2[1]). There are approximately 2 million shipments of radioactive materials, involving about 2.8 million packages, annually. This is about 2 percent of the Nation's total annual hazardous materials shipments. Most radioactive shipments involve small or intermediate quantities of material in relatively small packages. By comparison, the Complex ships about 6,200 radioactive packages (commercial and classified) between its sites, annually. This represents less than 0.3 percent of all radioactive shipments in the United States.

DOE's unclassified radioactive, HE, and other hazardous materials are transported by commercial carrier (truck, rail, or air). The hazardous and nonhazardous cargo shipped by commercial carriers to and from each of the alternative sites is described in appendix tables G.2-1, G.2-2, and G.2-3. Special nuclear materials, such as plutonium and HEU in the form of pits and secondaries included in this assessment, are transported by DOE-owned and -operated safe secure trailers. The safe secure trailers are vehicles designed specifically for the cargo's safety and security, and the special nuclear materials receive continual surveillance and accountability from DOE's Transportation Safeguards Division at Albuquerque, NM. Shipments by safe secure trailer are accompanied by armed guards and are monitored by a tracking system. Tritium components are transported by DOE's air cargo contractor.

HE is a nonradioactive, hazardous material. HE shipments must meet the standard shipping criteria established by DOT (49 CFR Subchapter C) and supplemented by state, local, and DOE regulations. These standards require the shipper to comply with selecting the proper, authorized packaging for the material; properly certifying what is being shipped; properly marking, labeling, loading, blocking, and bracing the material; and meeting safety requirements. HE is usually transported by commercial or Government truck (although DOE contract air shipments are allowed by DOT exemption).

4.10.2.1 Materials Transported Between Existing Sites (No Action)

Kansas City Plant. KCP produces nonnuclear components for nuclear weapons. These nonnuclear components are primarily transported from KCP to Pantex and SRS. A limited number of nonnuclear components are also shipped from KCP to LLNL and LANL for reliability testing. Nonnuclear components are transported by commercial truck.

Lawrence Livermore National Laboratory. LLNL performs nuclear weapons research, development, and testing (RD&T). LLNL also maintains a limited capability to fabricate plutonium components (pits), which are transported between sites by safe secure trailer. Presently, LLNL does not manufacture components for nuclear weapons. A limited amount of intersite transportation by commercial carriers, to or from LLNL, and the other DOE facilities is currently conducted to allow for research and testing needs. This transportation activity is unrelated to the direct weapons production activities.

Los Alamos National Laboratory. LANL performs nuclear weapons RD&T. Similar to LLNL, LANL also maintains a limited plutonium component (pit) fabrication capability. LANL currently produces and ships some nonnuclear components for nuclear weapons. Like LLNL, it does send and receive a limited number of weapons components to and from other DOE facilities by commercial carriers.

Nevada Test Site. NTS maintains the capability to conduct underground nuclear weapons testing and nonnuclear experiments. Nuclear weapons and fissile components to conduct such tests are transported by safe secure trailer from LLNL, LANL, and Pantex. Currently, there is no underground nuclear weapons testing. NTS has historically received LLW by truck from other DOE nuclear weapons sites, such as Pantex, for disposal. LLW is routinely transported to NTS from other DOE facilities by certified commercial truck carriers for disposal. NTS does not currently ship or receive nuclear weapon components for production, disposition, or testing.

Oak Ridge Reservation. The Y-12 Plant at ORR processes depleted uranium and HEU, and fabricates uranium components. Y-12 also produces lithium compounds and parts, provides precision machining and specialty subassembly of structural components, and provides storage for HEU. Y-12 ships secondaries to and receives secondaries from Pantex. A small number of secondaries are sometimes supplied to and from LLNL and LANL. HEU and secondaries and cases are transported by safe secure trailer. Other nonfissile components required by Y-12 are typically transported by commercial truck.

Pantex Plant. Pantex assembles and disassembles nuclear weapon components; performs weapons repair, modification, and disposal; conducts stockpile evaluation and testing; fabricates HE and nonnuclear components; and provides storage for plutonium in the form of pits. Fissile components such as pits, secondaries, or nuclear weapons are transported by safe secure trailer. Tritium reservoirs are transported between Pantex and SRS by air. HE and nonnuclear components are transported by commercial or Government truck. Pantex receives weapons from the stockpile for disassembly, uranium components from Y-12, tritium reservoirs from SRS, and nonnuclear components from KCP. Pantex ships nuclear weapons to the stockpile, uranium components to Y-12, tritium limited-life components to SRS, and LLW to NTS.

Sandia National Laboratories. Nonnuclear components for nuclear weapons systems are designed and engineered at SNL. SNL currently ships a limited number of nonnuclear weapons components to Pantex, LLNL, and LANL by commercial truck.

Savannah River Site. SRS recovers tritium from returned reservoirs, purifies the recovered tritium, and fills and surveys new and refurbished tritium reservoirs. SRS also stores a limited amount of weapons-grade plutonium. Under its current tritium recycling mission, SRS ships and receives tritium reservoirs to and from Pantex and DOD sites. Tritium reservoirs are transported almost exclusively by air. Plutonium is transported by safe secure trailer.

4.10.2.2 Site Transportation Interfaces for the Transport of Special Nuclear Materials

The existing transportation modes that serve each candidate site and the links to those modes for the intersite transport of special nuclear materials, weapon components, radioactive waste, and other hazardous materials are summarized in table 4.10.2.2-1.

Although hazardous materials could be transported by rail, truck, air, and barge, the materials discussed in this PEIS would normally be transported by truck or aircraft. Plutonium and HEU would be transported exclusively by DOE safe secure trailer. Tritium reservoirs would be transported by DOE contract air carrier. TRU waste and LLW would be transported by certified commercial truck carriers to licensed or permitted disposal facilities. It is unlikely that there would be any barge or rail shipments.

Table 4.10.2.2-1 also depicts the relative transportation ratings of the Stockpile Stewardship and Management Program alternative sites. This table was established using the rating methodology and evaluation procedures established by the Nuclear Weapons Complex Reconfiguration Site Panel and has been adapted for the stockpile stewardship and management alternatives.

Table 4.10.2.2-1.-- Transportation Modes and Comparison Ratings for the Candidate Sites

Site	Nearest Interstate Highway (km)	Distance to Airport for Cargo Shipments (km)	Possible Weather Delays--TSS Shipments	Overall Level of Transport Service
KCP	5	68[1]	Minimal	Good
LLNL	3	61	No	Good
LANL	66	177	Yes	Satisfactory
NTS	97	105[1]	No	Good
ORR	6	50	Minimal	Good
Pantex	11	32	Minimal	Outstanding
SNL	88	11	Minimal	Good
SRS	48	32	Minimal	Good

4.10.2.3 Packaging

Plutonium, HEU, and components containing tritium would always be transported in Type B packaging that meets stringent Nuclear Regulatory Commission (10 CFR) and DOT (49 CFR) requirements. Type B packaging is designed and tested to retain its containment and shielding properties in an accident. Thus, during normal operation, plutonium, HEU, or tritium-related transportation poses no significant risk to transportation workers or the public. Typical types of packagings used for stewardship and management materials are shown in table 4.10.2.3-1. Packaging is discussed further in appendix G.

Table 4.10.2.3-1.-- Types of Packaging for Stewardship and Management Materials

Material	DOE-Approved Type B Packaging (NRC Performance Criteria)	DOT/NRC-Approved Type B Packaging	DOT-Approved Type A Wood or Metal Box	DOT-Approved Type A Drum	Strong Industrial; Packaging
Pits	X				
Secondaries	X				
Tritium components	X	X			
Nonnuclear components					X
Transurancic waste		X			
Low-level waste			X	X	
Plutonium		X			
Highly enriched uranium		X			
HIgh explosives			X		

NRC - Nuclear Regulatory Commission.
49 CFR Subchapter C; NRC 1992a.

4.10.3 Environmental Consequences

Two kinds of intersite transportation of special nuclear materials are analyzed in this PEIS: the one-time relocation of strategic reserve materials and the transport of plutonium pits, canned subassemblies, and tritium reservoirs to support normal operation.

Under No Action, key weapons functions would continue to be performed at existing locations. These functions include pit storage and weapons A/D at Pantex, HEU storage and secondary and case fabrication at ORR, pit fabrication at LANL (in limited quantities), and production of tritium components at SRS. The combined annual radiological and nonradiological impacts from transporting pits, secondaries, and tritium components for normal operation (100 weapons per year) under No Action is estimated to be 3.33x10-*3* fatalities per year (see table 4.10.3-2).

For the stockpile stewardship and management alternatives, the one-time relocation of the plutonium strategic reserve (pits) from storage at Pantex to storage at NTS and/or the relocation of the HEU strategic reserve secondaries from ORR to either NTS or Pantex could be required. The impact from transporting these materials was calculated using the RADTRAN computer code for standardized truckloads of material. The assumed truckloads consisted of 117 kg (256 lbs) of plutonium per truckload or 54 kg (119 lbs) of uranium per truckload. The annual impacts from transporting these materials are shown in table 4.10.3-1.

The transportation in support of normal operation would affect the individual sites as indicated below:

- The nonnuclear fabrication mission could remain at KCP with transportation requirements the same as No Action. Alternative sites to perform KCP's nonnuclear functions are LLNL, LANL, and SNL (many sites would absorb the mission).

Table 4.10.3-1.-- Annual Health Impacts from the One-Time Transportation of Strategic Reserve Materials

Option	**Existing Storage Location**	**Potential Storage Location**	**Total Health Effect**[2]
Relocate pits	Pantex	NTS	2.66×10^{-3}
Relocate secondaries	ORR	NTS	0.0170
Relocate secondaries	ORR	Pantex	9.06×10^{-3}

- Functions that could be relocated to LLNL are manufacturing secondary and case assemblies, nonnuclear components, and HE components. These functions would require the transport of nuclear components between LLNL and the A/D and/or the consolidated storage site and nonnuclear and HE components between LLNL and the A/D site.
- Functions that could be located at LANL would be fabricating pits, secondary and case assemblies, HE components, and nonnuclear components. These functions would require the transport of nuclear components between LANL and the A/D and/or the consolidated storage site and nonnuclear and HE components from LANL to the A/D site.
- NTS could be an alternative site to perform weapons A/D, which includes modifying existing plutonium pits, and could include storing the strategic reserve of plutonium and HEU. Placing the A/D function at NTS would require the shipment of weapon components (nuclear, nonnuclear, limited-life, and HE) between NTS and the pit and secondary and case fabrication, nonnuclear fabrication, HE fabrication, and the tritium recycling locations. It would also require the shipment of weapons to and from DOD facilities.
- The secondary and case fabrication mission could remain at ORR with transportation requirements the same as No Action. The alternative sites to fabricate ORR's fabrication of secondary and case assemblies are LLNL and LANL.
- The A/D and HE functions or the A/D function alone could remain at Pantex. If the A/D and HE functions remained, the transportation requirements would be the same as No Action except that the locations might change for primaries, secondaries, and nonnuclear components. Moving only the HE mission from Pantex would require shipping HE components and HE waste between Pantex and the new HE site or sites.
- SNL could be an alternative site for location of the majority of nonnuclear fabrication. This function would require shipping more nonnuclear weapon components to the A/D site.
- The function to fabricate pits could be reestablished at SRS. This would require the transportation of plutonium components between SRS and the A/D site and/or the plutonium storage site.

The Storage and Disposition PEIS is evaluating alternatives that could possibly move the plutonium strategic reserve from existing storage at Pantex to either Hanford, Idaho National Engineering Facility (INEL), NTS, ORR, or SRS, and the HEU strategic reserve from ORR to either Hanford, INEL, NTS, Pantex, or SRS. The one-time transport of materials to these potential consolidated storage locations is not addressed in this Stockpile Stewardship and Management PEIS. The impacts from the relocation of the strategic reserve pits from Pantex to NTS and the relocation of the strategic reserve secondaries from ORR to either NTS or Pantex under stockpile stewardship and management are presented in table 4.10.3-1. This section evaluates the potential impacts associated with the operational transportation requirements necessary to support the proposed management alternatives with storage at one of these storage and disposition sites.

Tritium reservoirs would continue to be recycled at SRS; thus, in the future these components would be transported between the A/D site (NTS or Pantex) and SRS. Tritium reservoirs would be transported by DOE contract air carrier.

If the A/D and HE missions remain collocated at Pantex (No Action), there would be no intersite transportation of HE, except for small quantities being shipped to LANL and LLNL for testing. If the HE mission is relocated, or if NTS is selected as the A/D site, an estimated 150 classified HE component shapes would be transported from either LLNL or LANL to Pantex, or from LLNL, LANL, or Pantex to NTS. In addition, HE waste material generated from the disassembly of weapons would be transported from the A/D Facility to the HE fabrication site.

Most of Pantex's shipments of HE material have been surplus material sold to commercial buyers. It is assumed surplus shipments would continue from a relocated HE mission (see appendix G for a description of HE shipments in 1994). Transporting HE component shapes is estimated to require approximately 12 round-trip shipments per year (the return leg would transport HE waste). There would be no impacts from normal (accident-free) transportation. The accident risk from transporting this material would be no greater than that encountered by the public from industry's transport of similar explosives. The HE accident impacts from transportation are bounded by the risk analyzed and presented in the facility accident sections.

For the alternatives under consideration, there are eight potential sites which could fabricate nuclear components, store strategic reserves of plutonium and uranium, recycle tritium, or perform A/D. All possible route combinations between these sites were evaluated to determine the potential impacts from transporting pits, secondaries, and tritium components for normal operation. The annual health risk for each potential combination of routes is described in appendix table G.1-1. Radiological and nonradiological and accident and accident-free risks are included.

There are 12 possible combinations of the stockpile stewardship and management alternatives for A/D, pit fabrication, and secondary and case fabrication. For each of these combinations, table 4.10.3-2 gives the annual health impact for the situation where strategic storage is collocated with the A/D function. In addition, taking into account the other possible consolidated storage locations considered in the Storage and Disposition Draft PEIS, table 4.10.3-3 gives the highest and lowest risk determined by the storage location for each possible combination of stockpile stewardship and management functions. Specific risks for all possible routes, including a breakout of accident and accident-free risks, are presented in appendix G.

In summary, annual transportation risk to support the activities required by the alternatives considered in this PEIS could range from 0.0154 to 2.85×10^{-3} fatalities. More detailed information is presented in appendix G. The route combinations required to support the alternatives considered in this PEIS are expected to increase upper and lower bound limits as follows:

- The maximum annual transportation health impact would be 0.0154, or approximately one additional fatality in 65 years. It is projected that this potential upper bound impact would result from the alternative which would require transporting pits from consolidated storage at Hanford to pit fabrication at SRS, then transporting them to weapons assembly at NTS; transporting secondaries from Hanford to secondary and case fabrication at ORR, then transporting them to weapons assembly at NTS; and transporting tritium reservoirs from SRS to weapons assembly at NTS.

- It is projected that the potential minimum annual transportation health impact would be 2.85x10-*3* , or approximately one additional fatality in 351 years. This projected impact would result from selecting the alternative that would require transporting pits from storage at Pantex to pit fabrication at LANL, then transporting them to weapons assembly at Pantex; transporting secondaries from Pantex to secondary and case fabrication at LANL, then transporting them to weapons assembly at Pantex; and transporting tritium reservoirs from SRS to weapons assembly at Pantex.

Table 4.10.3-2.-- Summary of Annual Transportation Health Risk for Proposed Stockpile Stewardship and Management Alternatives

		Health Effects[3]		
Alternative	**Pit/Secondary and Case Storage Site**	**Accident**	**Accident-Free**	**Total**
No Action	Pantex/ORR	$2.57x10^{-3}$	$7.64x10^{-4}$	$3.33x10^{-3}$
Assembly/Disassembly at NTS				
Pit Fabrication at LANL				
Secondary and case fabrication at ORR	NTS/ORR	$4.78x10^{-3}$	$1.34x10^{-3}$	$6.12x10^{-3}$
Secondary and case fabrication at LANL	NTS/NTS	$3.87x10^{-3}$	$1.02x10^{-3}$	$4.89x10^{-3}$
Secondary and case fabrication at LLNL	NTS/NTS	$3.58x10^{-3}$	$1.08x10^{-3}$	$4.66x10^{-3}$
Pit Fabrication at SRS				
Secondary and case fabrication at ORR	NTS/ORR	$7.03x10^{-3}$	$2.03x10^{-3}$	$9.06x10^{-3}$
Secondary and case fabrication at LANL	NTS/NTS	$6.13x10^{-3}$	$1.70x10^{-3}$	$7.83x10^{-3}$
Secondary and case fabrication at LLNL	NTS/NTS	$5.83x10^{-3}$	$1.77x10^{-3}$	$7.60x10^{-3}$
Assembly/Disassembly at Pantex				
Pit Fabrication at LANL				

Secondary and case fabrication at ORR	Pantex/ORR	2.57x10^{-3}	7.64x10-4	3.33x10^{-3}[4]
Secondary and case fabrication at LANL	Pantex/Pantex	2.25x10^{-3}	5.96x10^{-4}	2.85x10^{-3}[5]
Secondary and case fabrication at LLNL	Pantex/Pantex	5.92x10^{-3}	1.71x10^{-3}	7.63x10^{-3}
Pit Fabrication at SRS				
Secondary and case fabrication at OR	Pantex/ORR	3.89x10^{-3}	1.20x10^{-3}	5.09x10^{-3}
Secondary and case fabrication at LAN	Pantex/Pantex	3.57x10^{-3}	1.03x10^{-3}	4.60x10^{-3}
Secondary and case fabrication at LLNL	Pantex/Pantex	7.24x10^{-3}	2.15x10^{-3}	9.39x10^{-3} [6]

Table 4.10.3-3.-- High and Low Range of Annual Transportation Health Risk for All Possible Site Combinations (Strategic Storage Located at Any Site)

	Highest Risk				**Lowest Risk**			
		Health Effects[7]				**Health Effects[7]**		
Alternative	**Pit/ Secondary and Case Storage Site**	**Accident**	**Accident-Free**	**Total**	**Pit/ Secondary and Case Storage Site**	**Accident**	**Accident-Free**	**Total**
Assembly/Disassembly at NTS								
Pit Fabrication at LANL								
Secondary and case fabrication at ORR	Hanford/ Hanford	9.88x10^{-3}	2.84x10^{-3}	0.0127	NTS/ORR	4.78x10^{-3}	1.34x10^{-3}	6.12x10^{-3}

Secondary and case fabrication at LANL	SRS/SRS	6.39x10^{-3}	1.85x10^{-3}	8.24x10	Pantex/ Pantex	3.06x10^{-3}	8.06x10^{-4}	3.87x10^{-3}
Secondary and case fabrication at LLNL	SRS/SRS	8.16x10^{-3}	2.44x10^{-3}	0.0106	NTS/NTS	3.58x10^{-3}	1.08x10^{-3}	4.66x10^{-3}
Pit Fabrication at SRS								
Secondary and case fabrication at ORR	Hanford/ Hanford	1.19x10^{-2}	3.49x10^{-3}	0.0154[8]	ORR/ORR	5.55x10^{-3}	1.61x10^{-3}	7.16x10^{-3}
Secondary and case fabrication at LANL	Hanford/ Hanford	7.92x10^{-3}	2.23x10^{-3}	0.0102	Pantex/ Pantex	4.84x10^{-3}	1.37x10^{-3}	6.21x10^{-3}
Secondary and case fabrication at LLNL	SRS/SRS	8.00x10^{-3}	2.39x10^{-3}	0.0104	NTS/NTS	5.83x10^{-3}	1.77x10^{-3}	7.60x10^{-3}
Assembly/Diassembly at Pentax								
Pit Fabrication at LANL								
Secondary and case fabrication at ORR	Hanford/ Hanford	7.90x10^{-3}	2.28x10^{-3}	0.0102	Pantex/ ORR	2.57x10^{-3}	7.64x10^{-4}	3.33x10^{-3}
Secondary and case fabrication at LANL	SRS/SRS	5.58x10^{-3}	1.64x10^{-3}	7.22x10^{-3}	Pantex/ Pantex	2.25x10^{-3}	5.96x10^{-4}	2.85x10^{-3}[9]
Secondary and case fabrication at LLNL	SRS/SRS	9.33x10^{-3}	2.74x10^{-3}	0.0121	NTS/NTS	4.76x10^{-3}	1.39x10^{-3}	6.15x10^{-3}
Pit Fabrication at SRS								

Secondary and case fabrication at ORR	Hanford/ Hanford	$9.44\text{x}10^{-3}$	$2.85\text{x}10^{-3}$	0.0123	ORR/ORR	$3.10\text{x}10^{-3}$	$9.67\text{x}10^{-4}$	$4.07\text{x}10^{-3}$
Secondary and case fabrication at LANL	Hanford/ Hanford	$6.64\text{x}10^{-3}$	$1.90\text{x}10^{-3}$	$8.54\text{x}10^{-3}$	Pantex/ Pantex	$3.57\text{x}10^{-3}$	$1.03\text{x}10^{-3}$	$4.60\text{x}10^{-3}$
Secondary and case fabrication at LLNL	SRS/SRS	$8.71\text{x}10^{-3}$	$2.59\text{x}10^{-3}$	0.0113	NTS/NTS	$6.54\text{x}10^{-3}$	$1.96\text{x}10^{-3}$	$8.5\text{x}10^{-3}$

4.11 Next Generation Stockpile Stewardship Facilities

DOE recognizes that to be viable, its Stockpile Stewardship and Management Program must change over time to be responsive to national needs and the results of current research and evaluation activities. Accordingly, all facilities needed to fully implement the stockpile stewardship program over time cannot be fully identified at present. DOE has done some preliminary conceptual planning and research associated with the next generation of stockpile stewardship facilities, but is not yet able to define the facilities and/or their requirements sufficiently for decisionmaking. However, these next generation facilities can be defined in general terms at this time based on existing operating or proposed facilities such that broad environmental impacts can be discussed. These general impacts from construction and operation of such facilities are presented so that any significant cumulative environmental impacts that might be related to the ultimate science-based stockpile stewardship program can be identified in this PEIS and considered in the PEIS Record of Decision (ROD). At this time DOE has identified four potential facilities as next generation facilities for science-based stockpile stewardship: Advanced Hydrotest Facility (AHF), Advanced Radiation Source (ARS [X-1]), the Jupiter Facility, and High Explosive Pulsed Power Facility (HEPPF). The following section provides a broad description of what these proposed future facilities might look like and the types of environmental impacts associated with their construction and operation. In the future, DOE may choose to drop these concepts, expand upon them, or add to them. Any proposals would be subject to NEPA review prior to any decision to implement them.

Advanced Hydrotest Facility. AHF would be the next generation hydrodynamic test facility following the DARHT Facility at LANL. The AHF would be an improved radiographic facility that would provide for imaging on more than two axes, each with multiple time frames, though the number of axes and time frames is still subject to requirements definition and design evolution. The facility would be used to better reveal the evolution of weapon primaries implosion symmetry and boost-cavity shape under normal conditions and in accident scenarios. Due to the nature of the dynamic experiments and hydrodynamic testing to be conducted with the facility, AHF would probably be considered for location at NTS and LANL only.

At this point, the feasibility and definition of an AHF is still insufficiently determined for DOE to propose such a facility or adequately analyze it for the purposes of NEPA. For example, performance requirements and specifications for such a facility (i.e., determination of what capabilities should be required of an AHF for assessment of stockpile aging and related effects, beyond those of DARHT) have not been fully established. In addition, the type of technology to provide the basis for the facility has not been determined, and concepts for the resultant physical plant accordingly would vary significantly. Three basic technology approaches are currently being examined. These include linear induction accelerators of a type similar to that in the baseline DARHT

Facility design (DOE/EIS-0228), an inductive-adder pulsed-power technology based on technology now in use for other purposes at SNL and elsewhere, and high-energy proton accelerators similar to technology in use at LANSCE and a number of facilities in the U.S. and internationally. The first two are different approaches to accelerating a high-current burst of electrons, which when stopped in a dense target produce x-rays for radiography. This is the approach used in the existing PHERMEX (LANL) and FXR (LLNL) facilities, and which will be used in DARHT. The third approach would use bursts of very energetic (approximately 20 billion-electron-volt) protons, magnetic lenses, and particle detectors to produce the radiographic image. These technologies still require development and validation.

It is likely that an AHF would require new building construction and considerable infrastructure (i.e., facilities, equipment, and personnel) in support of test events. Existing infrastructure at LANL or NTS might be used to the extent practical. The construction and operational requirements for AHF might be greater than that of the DARHT Facility. The impacts associated with construction and operation of facilities based on the different technology approaches could be significantly different. For example, the acreage required could be comparable to or somewhat larger than the 3.1 ha (9 acres) of land resources required for DARHT, but use of proton radiography could require an accelerator comparable in scale to the kilometer-long LANSCE or to other large accelerators operated by DOE. Based on information on the DARHT Facility, it is estimated that over 250 additional workers would be required for construction and operation of AHF. Construction and operation of AHF is not anticipated to use large quantities of water. New construction activities would be expected to result in an increase in short-term air emissions. Operation of AHF would be expected to have a minimal impact on the air quality considering the impacts projected for DARHT operations. AHF would not be expected to impact existing community infrastructure or services in the area; however, depending on the specific design, a proton accelerator could require significant electrical power resources. Waste volumes would not be expected to increase substantially over existing operations at LANL. Waste management associated with dynamic experiments with plutonium at NTS could require additional infrastructure.

To the extent the potential environmental impacts of an AHF can be forecast at this time, a significant part of the public and worker exposures and impacts due to normal operation of AHF would be those related to the conduct of hydrodynamic tests and dynamic experiments at the facility. While the impacts are inherently site-dependent, the hydrodynamic tests and dynamic experiments themselves can be anticipated to be similar to such activities as analyzed at DARHT in the DARHT Facility EIS (DOE/EIS-0228); therefore the DARHT Facility impacts are summarized here for reference. Population-based impacts may be expected to be lower at NTS. The normal radiological impacts of the DARHT Facility to the annual collective dose to the population residing within 80 km (50 mi) would be expected to be 0.57 person-rem. Latent cancer fatalities at this dose would not be expected. The maximum annual dose to any nearby resident would be about $2x10^{-5}$rem with a corresponding latent cancer fatality of $1x10^{-8}$. The average annual dose to individual workers would probably not exceed 0.02 rem with a corresponding maximum probability of latent cancer fatality of 8x10-*6* . Routine exposure to chemicals is expected to be low. The likelihood of a severe facility accident occurring would be very small. The population dose resulting from acute accidental release in the bounding facility accident, accidental uncontained detonation of a plutonium-containing assembly, evaluated on a what-if basis (related DOE safety studies indicate a probability of less than 10-*6* per year), would be expected to range from 9,000 to 24,000 person-rem in the maximally exposed sector, based on 50th or 95th percentile atmospheric dispersion factors, respectively. Five to twelve latent cancer fatalities would [not] be expected from this dose. Population dose from acute accidental plutonium release from a containment breach was estimated to range from 210 to 560 person-rem, for which no latent cancer fatalities would be expected. For workers, the likelihood of a severe accident occurring and resulting in death would be minimized by a comprehensive training program and an explosives safety program.

Advanced Radiation Source (X-1) and Jupiter Facility. ARS (X-1) would be an advanced pulsed-power x-ray source that would provide enhanced capabilities in the areas of weapons physics, radiation science effects, and pulsed-power technology. SNL would be a principal candidate site because of its extensive expertise in this weapon physics and radiation effects technology and because the ARS (X-1) could probably utilize existing infrastructure associated with the Saturn Facility and Technical Area IV. The ARS (X-1) would likely require new building construction. The Saturn Facility accelerator is used as a nuclear weapon effects and weapon physics simulator with a large area and intense source of radiation. The Saturn Facility accelerator is designed to generate bremsstrahlung, x rays, and other electromagnetic radiation.

New construction activities for ARS (X-1) would be expected to result in an increase in short-term air emissions. The construction and operational requirements for the ARS (X-1) would be similar to those of the existing Saturn Facility. Operation of ARS (X-1) would be expected to have a minimal impact on the air quality of Albuquerque and the surrounding region considering the impacts resulting from operating the Saturn Facility. Based on Saturn Facility information, it is estimated that additional workers would be required for construction and operation of ARS (X-1). However, they would not be expected to impact existing community infrastructure or services in the area. Waste volumes would not increase substantially over existing operations. No radioactive materials would be expected to be produced or released from ARS (X-1). Materials handling and disposal of other wastes would serve to minimize the pollution and/or contamination risks.

Based on operation of the Saturn Facility, no significant risk to the public health and safety or to the environment would be expected from operation of ARS (X-1). Offsite impacts to the environment would be expected to be negligible or nonexistent. Onsite personnel exposures would be expected to be below 0.1 rem/yr and site boundary annual exposure would most likely be undetectable. Employee risk from industrial accidents during operation of ARS (X-1) would be identified and reduced to a level that is as low as reasonably achievable for the facility.

The Jupiter Facility would be a next generation facility well beyond ARS (X-1). It is not expected to have any significant or unusual environmental impacts based on the similar types of experiments and technology involved.

High Explosives Pulsed Power Facility. HEPPF, a potential next-generation facility, would be a possible follow-on HE firing site, configured specially for HE-driven pulsed power experiments, beyond the existing capabilities in the Complex to support such experiments. These experiments would, for example, study physics related to weapons secondary at shock pressures and velocities approaching those of actual weapon conditions.

DOE has pursued the application of electrical pulsed power on the microsecond time scale to weapons research since the 1960s. This R&D program has involved HE pulsed-power generators of various types, which have been used at existing HE firing sites in the Complex, in addition to fixed-facility capacitor banks such as Pegasus II at LANL and the proposed Atlas Facility. HE generators are used to explore higher energy (higher current) frontiers than may be available in existing fixed facilities without major capital investment, albeit at a relatively low data rate, and capacitor banks provide repeatable (and indoor) experimental facilities with higher data rates, for broad experimental use. These activities are programmatically complementary aspects of R&D (appendix K considers reliance on explosive-driven pulsed-power experiments and discusses why this is not a reasonable alternative to Atlas). Ongoing HE pulsed-power experiments are conducted for pulsed-power technology R&D, for weapons stockpile stewardship applications, and for unclassified scientific collaborations including those with Russian and other foreign scientists.

A variety of HE pulsed-power generator types are used in experiments. These generators are one-time-use assemblies of HE and metal and other components (commonly copper, structural materials such as aluminum, steel, and plastic, and possibly other materials depending on the experiment). When detonated, the explosive motion of the assemblies acts as an electrical generator to produce a large current, which is delivered to an experimental configuration. High magnetic fields result from the current pulse. In principle, such experiments can be performed at any appropriately equipped firing location, of which there are many in routine use at the DOE stockpile stewardship sites, within environmental limits and the structural design limits of the individual firing site. However, some HE firing sites (e.g., at TA-39 at LANL) have been specially configured to support these HE pulsed-power experiments; a principal firing site at TA-39 has within its bunker a capacitor bank to provide the seed electrical current for the HE pulsed-power generators. Currently, most of the largest-scale HE pulsed-power experiments in the United States are conducted at this LANL location. The highest-current generator design presently in routine use in the United States is called Procyon, and is about 3 m (10 ft) in length. Impacts of these ongoing R&D activities are included in the cumulative impacts for the No Action alternative in this PEIS.

HEPPF, as conceptualized, would be specially designed to support HE pulsed-power experiments of larger scale and of greater complexity in support of the stockpile stewardship mission: for example, to support generators using much larger explosive charges, which though not yet fully demonstrated for experiments, could produce higher pressures in larger masses and volumes than can be accessed at the LANL site. HEPPF would probably be sited at NTS because of the amount of HE and because an existing infrastructure is already available. Since the idea of a new HEPPF was first conceived some years ago, Big Explosives Experimental Facility (BEEF) has been separately developed as a firing site at NTS, based on refurbished bunkers originally developed for atmospheric nuclear tests. Although BEEF does not have specially configured HE pulsed power like the principal LANL firing site, in its current configuration BEEF is suitable for a variety of HE experiments, including many pulsed-power technology experiments. Experiments related to such purposes have been part of recent qualification tests. Therefore it may be possible to make modifications to BEEF when the need for and definition of such modifications is clear, to satisfy any future need for a new HEPPF.

BEEF is located in north-central Area 4 of Yucca Flat. BEEF comprises Bunkers 4-300 and 4-480, which house modern test equipment for use during detonations of very large, conventional HE charges and devices. Bunker 4-300 contains the control room, the laser room, and the utility room. The control and utility rooms were modified to house the diagnostic and firing control electronics, digitizers, electronic recording equipment, and other electronic equipment necessary for hydrodynamic and pulsed power experiments. The laser room was modified to accommodate a pulsed Ruby laser for image-converter camera illumination and a laser for multibeam Fabry-Perot velocimetry. Bunker 4-480 is designed to contain up to five helium or nitrogen-gas-driven rotating-mirror framing cameras and five optical ports with access to the gravel firing pad. The area surrounding the bunkers is graded with new earthen berms which provide blast protection, shield from radiation, and serve as a downrange projectile stop.

BEEF contains a firing table approximately 20x20 m (66x66 ft), consisting of pea gravel 1.8 m (6 ft) to 2.4 m (8 ft) deep, within the graded area west of the bunkers. Three large steel cylinders (3 m [10 ft] in diameter and 6 m [20 ft] long) are placed outside the bunkers near the firing pad to house 2.3-million-electron volt Febetron x-ray sources for high-energy x-ray radiography. As at other firing sites, among the HE experiments that can be performed at BEEF are pulsed-power-generating experiments. The facility has the capability to support many of the sophisticated diagnostic techniques needed for the evaluation of hydrodynamic and pulsed-power experiments containing large amounts of HE. Analysis of the impacts of operating the existing BEEF for explosive experiments, including those that involve pulsed-power technology, is incorporated in the NTS EIS (DOE/EIS 0243). These impacts are also included in cumulative impacts for the No Action alternative in this PEIS.

Should a need for HEPPF be determined, existing infrastructure at NTS would be used, to the extent practical, to develop the facility. Definition of the required modifications and additions is not yet mature enough to support environmental analysis in this PEIS. However, modifications to BEEF could include construction of additional bunker/shelter space near the firing location. The additional bunker space could be reinforced concrete construction, buried or earth covered in a manner virtually identical to Bunkers 4-300 and 4-480. In addition, future experiments conducted at HEPPF may require recording of a large number (several hundred) of channels of electronic and optical data. An expanded, suitably sheltered recording station also may be required. Additional shelters and blast-shields may be temporary or permanent and constructed of native soil to form earth berms or steel and sandbags to form structures. Upgrading construction activities would be expected to result in an increase in short-term air emissions.

Additional workers would be required for construction; however, for operation, the number of workers would be expected to be similar to that of BEEF. Operation of HEPPF would be expected to have minimal impact on the air quality of Clark County and the surrounding region considering the impacts projected for BEEF operations. HEPPF would not be expected to impact existing community infrastructure or services in the area.

Based on the operation of BEEF as analyzed in the NTS EIS, no significant risk to workers, to the public health and safety, or to the environment would be expected for HEPPF. Offsite impacts to the environment would be expected to be negligible or nonexistent.

4.12 Environmental Impacts of Underground Nuclear Testing

The last underground nuclear test was conducted in the United States in 1992. Since then, the Nation has been observing a moratorium on underground nuclear testing while pursuing a Comprehensive Test Ban Treaty (CTBT). On August 11, 1995, the President announced that, "one of my Administration's highest priorities is to negotiate a Comprehensive Test Ban Treaty to reduce the danger posed by nuclear weapons proliferation." In this announcement, the President also stated that he would seek a "zero-yield" CTBT, which would "ban any nuclear weapon test explosion or any other nuclear explosion immediately upon entry into force." The President declared his commitment "to do everything possible to conclude the Comprehensive Test Ban Treaty negotiations as soon as possible so that a treaty can be signed next year."

As part of this announcement, the President also stated that he had been assured "that we can meet the challenge of maintaining our nuclear deterrent under a Comprehensive Test Ban Treaty through a science-based Stockpile Stewardship Program without nuclear testing." However, the President cautioned that, "while I am optimistic that the Stockpile Stewardship Program will be successful, as President I cannot dismiss the possibility, however unlikely, that the program will fall short of its objectives." The President went on further to say that, "In the event that I were informed by the Secretary of Defense and Secretary of Energy...that a high level of confidence in the safety or reliability of a nuclear weapons type which the two Secretaries consider to be critical to our nuclear deterrent could no longer be certified, I would be prepared, in consultation with Congress, to exercise our `supreme national interests' rights under the Comprehensive Test Ban Treaty in order to conduct whatever testing might be required."

One of the primary purposes of the Stockpile Stewardship and Management PEIS is to evaluate ways of maintaining a continued safe and reliable nuclear deterrent in the absence of nuclear testing. Thus, the proposal described in chapter 3 of this PEIS does not include nuclear testing. However, because it is possible--although not probable--that under the CTBT the United States might one day exercise its "supreme national interests" rights to conduct underground nuclear testing to certify the safety and reliability of its nuclear weapons, the following programmatic evaluation of the environmental impacts of underground nuclear testing at NTS is provided. More detailed information on the environmental impacts of underground nuclear testing is contained in the *Environmental Impact Statement for the Nevada Test Site and Off-site Locations in the State of Nevada (DOE/EIS 0243, 1996).*

The various steps involved in conducting an underground nuclear test are summarized below to provide an overview to the reader, and to aid in understanding the potential environmental impacts associated with underground nuclear testing. (For other descriptions of the testing process, see NT USGS 1994a; OTA 1989a). Variations to this general description will occur based on which national laboratories performs the weapon emplacement and testing.

- In recent years, emplacement holes were drilled using mud or detergent and water and a dual-string reverse-circulation method. This method replaced the conventional circulation method that used bentonite or sepiolite mud. Steel casing is installed and extends 9 to 30 m (30 to 98 ft) from the surface. If the test point is below the static water level, a liner is also installed in the bottom of the emplacement hole, and the emplacement hole is dewatered. Otherwise, no liner is installed. Cement grout is placed around the casing and liner.

- Each test includes a test rack made of steel that is used to support the nuclear device and the various instruments and detectors used to measure test results. Typically, racks are more than 30 m (98 ft) in height and include from 2 to as many as 20 line-of-sight pipes, each with a window of a composition compatible with the desired measurement. The rack sits on top of a steel canister that contains the nuclear device.
- The canister is often lined with a mixture of boron and polyethylene. Large quantities of polyethylene are used on the racks. Other organic materials used include polyvinyl chloride, TeflonTM, polystyrene, phenolic, and neoprene. Complex fluorescing compounds and laser dyes are used as part of some detectors. Typically, tens of tons of lead are used to shield both the canister and the rack. Copper is used for wiring and other purposes. Beryllium, nickel, and zinc may be present in small quantities in detector packages. Arsenic, chromium, cadmium, osmium, and thallium have been used in rare instances. Other commonly used metals include tungsten, tantalum, stainless steel (iron, chromium, and nickel), and aluminum.
- Each test device contains nuclear materials, such as uranium, plutonium, tritium, lithium, and structural materials, such as steel, aluminum, beryllium, and gold. Radiochemical detectors (for example, yttrium, zirconium, thulium, and lutetium) and tracers (isotopes of uranium, plutonium, americium, or curium) are also used. The detectors and tracers are generally less than 100-g (3.5-oz) quantities.
- Magnetite powder is poured downhole to cover the sides and top of the rack. This naturally occurring mineral contains thorium and a variety of other impurities. Stemming materials are used to prevent the escape of radioactivity from the device upwards in the emplacement hole. Stemming materials consist of layers of coarse gravel with layers of fine gravel, sand, or bentonite. The gravel and sand are native materials. Two or more plugs made of two-part epoxy, coal-tar epoxy, sanded gypsum concrete, or sanded gypsum aggregate are placed in the hole, well above the cavity formed by the detonation, and remain intact after the test.
- As shown in figure 4.12-1, Stage I, the explosion initially creates a nearly spherical cavity filled with gases that are formed by atomization and vaporization of materials from the explosive device and its immediate surroundings. The molten cavity walls subsequently flow down to form a puddle that is vitrified as a result of quenching during condensation of the cavity gases as the cavity cools (Stage II). As gas pressure decreases, the rock above the cavity generally falls into the cavity with rubble (Stage III); this chimney-forming process may proceed upward all the way to the surface to form a crater, or it may stop at some intermediate point (Stage IV). Vaporized material is condensed and incorporated into molten rock or escapes into the chimney rubble where it may condense on solid rock. Volatile elements or materials tend to be enriched in the rubble zone, whereas refractory materials tend to remain in the puddle glass.

- The melt zone created by the nuclear test incorporates a mass (expressed in tons) of the same order of magnitude as the device yield (expressed in tons); the zone would extend well beyond the top of a 30-m (98-ft) rack if the yield was about 100 kt or more. In every test with a significant nuclear-energy release, the entire device is atomized and mixed with a relatively large quantity of rock.
- Reentry holes are typically drilled at an angle directed to intercept the test debris and puddle glass near its center. A profile of the radioactive material along the hole is measured with a downhole Geiger counter, and then samples of the puddle glass are collected using a sidewall sampler. The drilling procedure uses drilling mud with various additives, and a significant fraction of the mud is generally lost downhole into the highly permeable structure of the rubble created by the test. LLNL uses air foam for the upper part of the drill-back hole and drilling mud for the lower part of the hole.

The consequences of underground testing on the environment of the NTS can be evaluated on the basis of past testing actions. Through 1992, there have been 928 announced nuclear detonations on the NTS; 828 of these tests were underground tests. In general, the effects of underground testing that have occurred in the past, and those to be anticipated in the future, include impacts to land, geology, water resources, biotic, air quality, radiological and human health, and transportation. Each of these resource areas is discussed below.

Land. As shown in figure 4.12-2, underground nuclear testing would likely be conducted in the Yucca Flats, Painted Mesa, or Rainer Mesa Areas that are designated as the Nuclear Test Zone. Including a buffer zone, each underground nuclear test requires approximately 16 ha (40 acres). Approximately 5 ha (12 acres) of surface geologic media are disturbed in each underground nuclear test in Yucca Flat (Data Sheets, 1995). Radii of cavities at NTS range up to about 50 m (160 ft), and rubble chimneys range from up to about 50 m (160 ft) to about 350 m (1,150 ft) high (NT LLNL 1976a).

Because the land designated as the Nuclear Test Zone encompasses several hundred thousand hectares, the amount of potentially affected land would be a relatively small percentage (less than 1 percent). Additionally, underground testing would be a compatible use of the land; therefore, a change in land-use designation would not be required.

The formation of underground cavities and subsidence craters, as a result of underground testing, represent an unavoidable impact on the land in the vicinity of the planned tests. However, there are already hundreds of such cavities and craters on NTS.

Geology. Potential impacts on geological resources include fault reactivation and associated seismicity induced by underground testing of nuclear devices, offsite disturbances, and onsite radiological contamination of geological media. Fault reactivation from testing of nuclear devices disturbs subsurface and surface geologic media, which is potentially significant in terms of resultant limitations on land use or resultant changes in surface and subsurface water movement. Ground-motion studies have played a large role in the weapons testing program. SNL has developed a program for recording surface and subsurface motions resulting from underground nuclear explosions (SNL 1979a; SNL 1982b). There are several factors that influence the level and duration of ground motion from underground explosions, including yield of the device; ground-coupling at the source of explosion, which is a function of depth of the device, local geology, and stratigraphy; geological complexity along the transmission path; and the topography and geology at the location receiving ground motion. There is always some variation or unknown associated with estimating these factors; but, because of the long history of conducting weapon tests, the effects are reasonably predictable.

The yield or size of underground nuclear explosions is limited by the Limited Test Ban Treaty to a maximum HE equivalent of 150 kt. For the purposes of this evaluation, all future weapons testing is assumed to occur under this limitation. Historically, most underground nuclear testing has been conducted in the Paihute Mesa and Yucca Flat areas. Because geologic structure may differ considerably among the testing areas, effects of tests in the unused areas are uncertain. Nevertheless, the geographic areas for testing and the yield limits can be used to estimate ground-motion effects from future weapons tests.

Ground-motion hazards can result from the underground nuclear explosion and secondary seismic effects. Because of the rather complete recording of ground motions emanating from NTS activities, the effects of the weapons testing program are predictable, and damage effects have been documented. Communities within about 48 km (30 mi) of testing areas that could be most affected by ground motion from underground nuclear explosions are Beatty, Amargosa Valley, and Indian Springs. The closest potential testing areas for these communities are 31 to 40 km (19 to 25 mi) away. Table 4.12-1 is a tabulation of peak horizontal ground-motions for 150-kiloton tests at 31 km (19 mi) away, using regressions developed by Long (NT SNL 1986a). Peak ground acceleration, velocity, and displacement were computed at the 50th and 84th percentiles of the log-normal distributions given by Long (NT SNL 1986a) for rock and alluvium recording geology at 31 km (19 mi) for 150 kt tests. Expected peak ground accelerations are well below 0.05, which is the acceleration where slight damage might occur in typical buildings less than several stories in height.

Table 4.12-1.-- Predicted (50th and 84th Percentiles) Peak Ground Motions at Localities 31 Kilometers (19 Miles) from Underground Testing Areas

		Acceleration (g's)[10]		Velocity (m/sec)[11]		Displacement (cm)[12]	
Distance (km)	**Yield (kt)[13]**	**50 Percent**	**84 Percent**	**50 Percent**	**84 Percent**	**50 Percent**	**84 Percent**
Rock 31	150	0.012	0.029	0.009	0.021	0.23	0.5
Alluvium 31	150	0.009	0.016	0.009	0.018	0.28	0.61

Data pertaining to offsite damage support conclusions based on expected motion. Since the Threshold Test Ban Treaty, only a few reports of damage to local communities occur each year, and these are of a very minor nature. Beyond about 48 km (30 mi), structures would have to be higher than several stories tall before they would be affected. The closest location where structures of that height are located is in Las Vegas. A smaller number of similar complaints have been recorded from people in Las Vegas high-rise structures.

Several Nye County mines are located in the testing vicinity, but all are at a distance greater than 40 km (25 mi) from the closest potential testing area. Because the distances from these mines to the underground nuclear explosions are approximately the same as, or greater than, the distances for communities, damage to structures in the mines is not expected. In investigations of earthquake effects to mines (Owen 1981a), there are very few reports of damage. Surveys of mines in the vicinity of NTS by Owen and Scholl further support these findings (NT ERDA 1977a).

In addition to direct ground motion effects of underground nuclear explosions, there is also a potential hazard from secondary seismic effects. Secondary effects are associated with co-seismic strain release attributed to release of tectonic strain, aftershocks that can be associated with tectonic strain release, and events associated with the collapse of cavities created by the underground nuclear explosions. Beyond 5 to 10 km (3 to 6 mi) of even the largest, pre-Limited Test Ban Treaty underground nuclear explosion (greater than 1 megaton), there was no evidence of significant secondary seismic effects associated with testing, and in no case has the magnitude of an aftershock been larger than the magnitude of the underground nuclear explosion (NT SNL 1986b).

Underground conventional HE, hydrodynamic, and hydronuclear experiments would produce some of the physical effects on geologic media and processes associated with underground tests of nuclear devices (e.g., compression and fracturing). These effects are anticipated to be significant and irrevocable although small in relation to the effects of detonation of nuclear devices.

In addition to the direct effect on geologic media and processes of detonating nuclear and other devices, preparation for such tests also disturbs geologic media. Disturbances include any associated infrastructure, excavated tunnels, and an inventory of deep boreholes up to 3.6 m (11.8 ft) in diameter for detonation of nuclear devices. Geologic media excavated in tunnels, boreholes, and borrow pits are considered to be permanently lost. Excavation of tunnels and any testing conducted in those tunnels potentially could impact slope stability.

During an underground detonation, large quantities of neutrons are released. Naturally occurring materials in the host rock, such as iron, lead, and zinc, capture some of these neutrons. The result is the formation of unstable radioactive nuclei. The majority of atoms in the host rock occur in a stable form; the activation products that are generated are considered part of the total release from a test. Radioisotope contamination might extend up to five cavity radii from the point of detonation where radioactivity has been released into the geologic media. However, most of the radioactive materials that are created during an underground nuclear explosion are expected to be trapped within a pocket of resolidified rock melt in the explosion cavity. Radioactive noble gases and tritium may be released to the surface by gradual seepage from the cavities and by escape of gases during sampling operations. The effects of subsidence and the confined radioactivity on the environment will persist for many years.

Water Resources. Because underground nuclear testing does not utilize any significant amount of groundwater, it is unlikely that there would be any potential to impact groundwater availability. However, as an unavoidable consequence of underground nuclear testing, the quality of the groundwater under some portions of NTS has been affected. If any underground tests were to be detonated under or near the water table, additional impacts to water quality could be expected.

The effects of underground testing have been well documented (NT LLNL 1976a), and the hazardous materials associated with testing have been detailed by Bryant (NT DOE 1996c). The potential for a given test event to result in groundwater contamination is a function of the yield of the test device and its location relative to the water table.

The types of contaminants related to active testing include four major categories of radionuclides and hazardous substances: source term and fission products, activation products, stemming material, and ancillary operations that use radioactive or hazardous substances. The exact quantity of substances that are released during a given test is unknown, but can be approximated based upon the similarity in materials used and in the overall testing procedures.

Information concerning releases from a test is summarized in Borg et. al. (NT LLNL 1976a) and Glasstone (DOD 1962a). The source term that is released during a test includes the original nuclear material that did not undergo reaction during detonation. The fission products are those direct products generated as a consequence of the detonation. About 80 different fission products result from the fission of a given nuclear detonation, and about 200 different isotopes of 36 elements can be formed through their decay into a complex mixture of daughter products. There are also 3 specific source-term radionuclides (tritium, plutonium, and uranium) and 24 specific fission products that result from a typical nuclear test. The estimated total release of fission and source-term radionuclides and activation products is 804,500 curies per kiloton.

Another source of contamination from underground testing is from the use of stemming materials. For most tests, significant quantities of nonradioactive materials are emplaced underground, along with the nuclear device, and are collectively termed stemming materials. For a typical test, at least 59,000 kg (130,000 lb) of rack and stemming materials are placed underground (NT DOE 1996c). Lead is by far the major hazardous constituent at about 450 kg (1,000 lb) per test. Small quantities (less than 0.5 kg [1 lb] each) of arsenic, beryllium, naphthalene, and zinc are also commonly present in the stemming materials.

Because test yields and the location and proximity to the water table of any tests that might be conducted have not been defined, it is not possible to estimate the total potential releases to the groundwater. If any tests are conducted in or near the water table, then significant releases to the groundwater are to be expected. If any tests are conducted in or near the water table, then significant releases of radionuclides and hazardous materials into the near test environment are to be expected. Tests conducted well above the water table would release significant quantities of radionuclides and hazardous materials into the unsaturated zone. Some downward migration of these contaminants might occur and might have the potential to contaminate the underlying groundwater.

The ancillary operations related to testing are primarily surface based and have little potential for groundwater contamination. Minor quantities of drilling fluids or lost circulation materials might be introduced into the near-water-table environment during test hole drilling and postshot drill-back operations. Any contamination that results from these activities would be considered inconsequential compared to the releases from the actual test.

It is difficult to predict the significance of the releases from underground testing on the water resources of NTS. Perhaps the best gauge can be made based upon the results of past testing activities. There have been 111 tests conducted under the water table and 124 tests where the lower shot cavity was under, or within 75 m (250 ft) of the water table. The combined yield of the tests conducted under the water table and tests with cavities that extended below the water table was 28 megatons.

The results of the Long Term Hydrology Monitoring Program and research into tritium migration have found that the migration of radionuclides beyond the near test environment is rare. Instances have been found where radionuclides have moved through fracture injection at the time of the test (NT DOE 1996c). Tritium migration via groundwater flow has been confirmed, but in the more than 30 years that underground testing has been done, no offsite releases of tritium in the groundwater have been detected.

Underground testing would be expected to have a significant impact on groundwater quality only if the testing is conducted in, or near, the water table. In this event, large scale contamination of the near-test groundwater resources could occur. However, because of the conditions at NTS (low hydraulic conductivities, high absorption geologic media, and slight hydraulic gradients), it is not considered likely that any significant impacts would occur in areas downgradient of the underground testing locations.

Biotic Resources. Because DOE has already prepared sufficient sites to handle numerous underground tests, no new impacts on biological resources would arise from preparation for these tests. A subsidence crater would be created by the underground test of the nuclear device. Because this crater would form in the area disturbed during site preparation for the test, no new loss of habitat would occur. Underground testing might impact individuals of recreational important species, such as waterfowl and doves, and candidate species of bats and birds, as they would be exposed to drilling fluid in drilling sumps constructed during postshot operations. Exposure to drilling fluid additives might increase these organisms' probability of drowning (NT DOE 1996c). The impact would not be large enough to decrease offsite recreational opportunities.

Hazardous or radioactive material releases could cause the mortality of plants and animals over tens or hundreds of hectares (NT DOE 1996c). This could have a significant impact on the viability of rare plants found in the northern half of NTS. However, because past aboveground tests and vented underground tests have not caused the expiration of any species from NTS, it is unlikely that future accidental venting would have that effect.

Because nuclear tests are conducted north of the range of the desert tortoise and because these tests normally are conducted when the wind is blowing to the north or northeast, accidental venting should not impact this threatened species (DOD 1977a; NT DOE 1995i). Additional releases of tritium into the aquifer from the underground nuclear test would not likely increase the impact to threatened and endangered species located at Devils Hole National Monument or Ash Meadows National Wildlife Refuge, given the short half-life of tritium and the slow rate of water exchange between the nuclear test sites and those springs (GTI 1995a; NT LLNL 1976a). Transportation to study sites would be infrequent enough as to not significantly increase the impact of this program on biological resources.

Air Quality. The average, annual fugitive dust emission rate (PM_{10}), including various drilling and construction activities, is about 1,290 t (1,422 tons). These emissions represent 0.16 percent of the total Nye County fugitive emissions. Fugitive dust calculations assume a 50-percent reduction as a result of watering the sites. As construction activities are only expected to occur on a short-term basis, long-term air quality impacts are not expected. Nevada Administrative Code 445B.365 regulates fugitive dust from surface disturbance of 2 ha (5 acres) or more. DOE has current Operating Permit 2743, which expires March 1998, for variable disturbance of land at NTS. If any radioactive noble gases and tritium were released to the surface by gradual seepage from the cavities or by escape during sampling operations, such releases are expected to be so small that impacts would be negligible.

Radiological and Human Health. Potential exposures of workers are possible during the tests conducted as part of the underground nuclear testing. The human health effects due to these exposures are based on an average annual dose reported in the NTS Site-Wide EIS (DOE/EIS 0243), with the results included in table 4.12-2.

Potential accidental releases from underground nuclear weapons testing were determined based on historical information from past testing at the site. These effects are also included in table 4.12-2.

Should DOE be directed by the President to conduct underground nuclear-yield testing under Alternative 1 of the NTS Site-Wide EIS, the probability of a single latent cancer fatality in the offsite population being caused as a result of radiological accidents over the 10 years evaluated by the EIS would be about 0.0055 (about one in 180). The probability of any other detrimental health effect occurring in the offsite population would be about 0.0025 (about one in 400).

Device delivery and assembly, as part of the underground nuclear weapons testing, are conducted at the Device Assembly Facility. Accident analyses performed as part of the Device Assembly Facility SAR show that for various design basis and operational accident scenarios considered, the impacts in terms of latent cancer fatalities fall well below the nuclear safety goal. All device assembly facility risk estimates are based on the SAR for the Device Assembly Facility. Section 4.9.3.9 of this PEIS discusses potential impacts associated with accidents at the Device Assembly Facility.

Transportation. DOE evaluated and reported the risks (consequences and probabilities) associated with transporting DP materials in SNL's Defense Programs Transportation Risk Assessment: Probabilities and Consequences of Accidental Dispersal of Radioactive Material Arising from Off-Site Transportation of Defense Programs Material (U) (SAND93-1617, September 1994). In that study, the annual risk of shipments of various cargos was evaluated based on many factors, including, but not limited to the transportation mode, how often and how far each cargo must be shipped, the specific route, and the population density along specific routes.

Table 4.12-2.-- Human Health Risks and Safety Impacts from Underground Nuclear Testing

	Routine Operation		**Construction**	
Project	**Cancer**	**Detriment**	**Injury**	**Fatality**
Underground nuclear weapons testing	0.034	0.013	6.8	0.012

Source: NT DOE 1996c.

Detailed information relating to methods and assumptions used for the risk analysis of DP materials is provided in appendix B of the transportation study. The results of the risk analysis indicate a very low potential for accidents; data analyzed from fiscal year 1984 through 1993 yielded an estimated 6.6 accidents per 161 million km (100 million mi). The risk of latent cancer fatalities (total to members of the public) and radiation detriment are significantly lower than the risk of fatalities and injuries from accidents (e.g., collision with a truck). Relating to onsite (within NTS) risk, the only potential hazard is on the 32 to 40 km (20 to 25 mi) of roadway that the safe secure trailer would travel. A group of flammable-liquid storage tanks located near the Mercury Facility is located about 30 m (100 ft) off the roadway and are protected by dikes. Based on accepted transportation accident rates, a transportation accident having serious consequences along this route would have a probability of less than or equal to 1 in 1 million.

[1] A closer onsite or nearby airfield could be used for DOE Transportation Safeguards System air cargo shipments only.
Note: TSS - Transportation Safeguards System. Source: DOE 1991j.

[2] Fatalities.
Source: RADTRAN model results.

[3] Estimated fatalities per year.

[4] Same as No Action risk.

[5] Lowest potential impact of all site combinations.

[6] Highest potential impact of all site combinations.
Source: RADTRAN model results.

[7] Estimated fatalities per year. Specific risk for these different cases is presented in appendix table G.1-1.

[8] Highest potential impact of all site combinations.

[9] Lowest potential impact of all site combinations.
Source: RADTRAN model results.

"Lime"

[10] Local acceleration due to gravity.

[11] Meters per second.

[12] Centimeters.

[13] Kilotons. All peak values reported are the largest of the radial and transverse components.
Source: NT DOE 1996c.

4.14 Operating Conditions Common to All Sites

Current operations at each Complex site result in the emission of pollutants to the atmosphere, discharge of pollutants in wastewater, and the generation of wastes. DOE orders require that site operations be conducted in accordance with all regulatory standards and provide for protection of the public and the environment. Monitoring is conducted at each site to determine compliance with these standards. When monitoring indicates noncompliance, DOE orders require that appropriate corrective actions and followups be performed. Monitoring activities conducted at DOE sites are reported in accordance with permit, regulatory, and DOE operational requirements. Additionally, monitoring results and analyses are included in the site's annual environmental surveillance reports, which are available to the public as required by DOE Order 5400.1, General Environmental Protection Program.

All sites are subject to state environmental requirements for solid mixed and hazardous waste under RCRA and regulated wastes under TSCA. Nonhazardous (sanitary) solid wastes are governed by RCRA subtitle D standards. All radioactive and mixed waste management activities at the sites are conducted primarily under DOE Order 5820.2A and RCRA. All mixed waste storage areas must meet RCRA containment system requirements. The recent Federal Facility Compliance Act (October 6, 1992) required DOE to submit site-specific plans to EPA and the states containing schedules for providing treatment capacity for mixed waste streams at DOE sites. DOE has developed proposed treatment plans that are being negotiated with EPA and the states.

In accordance with RCRA, as amended, the Pollution Prevention Act of 1990, and DOE Order 5400.1, all sites have an active pollution prevention and waste minimization program to reduce the volume and toxicity of waste generated, to the extent that is economically practical. The site programs are an organized and continual effort to systematically reduce waste generation. The overall focus of these programs is on pollution prevention, which involves the elimination/minimization of pollutant releases to all environmental media from all aspects of site operations. This includes air emissions and water discharges to sewer systems, as well as the offsite disposal of solid waste.

Some of the solvents used in the Complex and used in the nonnuclear facilities have been identified as ozone-depleting pollutants. Attempts are being made, both internationally and nationally, to reduce ozone-depleting gases. In September 1987, 27 nations, including the United States, signed the Montreal Protocol, which limits the production of chlorofluorocarbons and halogens. Schedules contained in Title VI of the CAA Amendments (November 1990) call for the phaseout of all chlorofluorocarbons and halogens between 2015 and 2030. A second meeting regarding the Montreal Protocol extended the phasing out of ozone-depleting gases into the early 21st century because of the slow development of chlorofluorocarbon alternatives. All DOE sites have, or are developing, site-specific plans to meet the CAA-mandated phaseout schedule. Potential ozone-depleting chemicals identified in 40 CFR 82 and discussed in this PEIS include 1,1,1-trichloroethane, CCI4, chlorodifluoromethane, dichlorodifluoromethane, and trichlorotrifluoroethane.

Workplace Safety and Accidents. Operations at all DOE sites expose workers to occupational hazards during the normal conduct of their work activities. Occupational safety and health training is provided for all employees at DOE facilities and includes specialized job safety and health training appropriate to the work performed. Such training also includes informing employees of their rights and responsibilities under OSHA Executive Order 12196, which established OSHA Federal agency standards; 29 CFR 1960, *OSHA Standards for Federal Agencies* , which describes the safety and health programs that Federal agencies must establish and implement under Executive Order 12196; and DOE O 440.1, Worker Protection Management for DOE Federal and Contractor Employees. DOE provides implementation guidance in DOE O 440.1, including the requirements and guidelines for the DOE *Federal Employee Industrial Hygiene Program* . The following is DOE policy:

- Provide places and conditions of employment that are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm
- Assure that employees and employee representatives shall have the opportunity to participate in the *Federal Employees Occupational Safety and Health Program*
- Establish programs in safety and health training for all levels of Federal employees
- Consider 29 CFR 1960 requirements to be the minimum standards for DOE employees

DOE contractor operations at each site expose workers to hazardous constituents. DOE orders require that site operations have programs for the protection of workers. DOE O 441.1, Radiological Protection for DOE Activities, and DOE O 440.1, Worker Protection Management for DOE Federal and Contractor Employees, establish procedures for protection of workers against radiological and hazardous materials, respectively. DOE M 232.1-1, Occurrence Reporting and Processing of Operations

Information, provides for reporting and guides appropriate corrective action and followup should exposure occur.

DOE O 451.1, National Environmental Policy Act Compliance Program; DOE O 5480.23, Nuclear Safety Analysis Reports; and DOE O 430.1, Lifecycle Asset Management, provide the basis for review of all planned and existing construction and operation for potential accidents and the assessment of the associated human health and environmental consequences of an accident. These reviews are required before authorization of construction or start of operation. These reviews also involve the identification of hazards and an analysis of normal, abnormal, and accident conditions. This analysis includes consideration of natural and manmade external events, including fires, floods, tornadoes, earthquakes, other severe weather events, human errors, and explosions. The sites associated with the Stockpile Stewardship and Management Program have complied with applicable DOE orders.

In accordance with DOE O 151.1, *Comprehensive Emergency Management System* , emergency response planning and training are provided to mitigate the consequences of potential accidents. Additionally, should an accident occur, the incident would be reported in accordance with DOE M 232.1-1, Occurrence Reporting and Processing of Operations Information. The reports would also include appropriate corrective actions and followup.

Operation Consequences Common to All Sites. Consolidating or relocating stockpile stewardship and management functions to a site could increase the emissions of pollutants to the atmosphere, discharge of pollutants in wastewater, and generation of wastes. Members of the public could be exposed to pollutants that are released to the environment. Additionally, these functions, as with all industrial processes, would have the potential for exposing workers to hazardous constituents and accidents.

The monitoring currently conducted at each Complex site would be reviewed to ensure that monitoring activities are adequate to assess whether new operations and site conditions are adversely affecting members of the public, workers, or the environment. At each site, modifications to monitoring activities would be made, as appropriate. Any modifications, as well as the bases for the modification, would be documented in the sites' Environmental Protection Program. The results of these monitoring activities and the potential for exposures to the public and workers would be reviewed, processed, and reported, as discussed earlier.

In many cases, the functions proposed for relocation are similar to or the same as activities currently being performed at the receiver site. In addition, the processes and materials associated with relocated functions are similar to or the same as those currently performed and used at the receiver sites. These processes and materials have been previously reviewed and analyzed in accordance with applicable regulatory and DOE order requirements and have been documented in various forms, including memoranda, safety assessments, and various NEPA documents. In all cases, current activities at these sites have received the appropriate authorization to operate.

The human health impacts of relocating a stockpile stewardship and management function to a receiver site were assessed in the following manner for each site: from an operational perspective, the additional impacts associated with the activity and the cumulative impacts after relocation were determined and presented; from an accident perspective, the processes to be transferred and the potential hazards they present were assessed. This assessment included the review of NEPA documents, SAR, and other applicable documents. Additionally, all proposed stockpile stewardship and management functions to be consolidated or relocated are currently being performed at existing DOE sites and do not constitute new activities within the Complex.

Potential Consequences of the Stockpile Stewardship and Management Program on Workplace Safety and Accidents. Downsizing and consolidating Complex missions could potentially result in increased exposure of site workers to industrial-type work hazards and accidents. In addition, levels of risk to workers in new construction increases in relation to the amount of new construction required for stockpile stewardship and management facilities. Based on the length of construction periods for new facilities, the new A/D Facility at NTS (2,768 worker years) would have the largest construction accident risk and the new Nonnuclear Fabrication Facility at SNL (781 worker years) would have the lowest construction accident risk. Table 4.14-1 shows the relative risk of fatalities due to construction (both new building and existing building modification) by alternative. Before implementing the Stockpile Stewardship and Management Program alternatives at any site, the site's environment, safety, and health staff would be notified that a new process or facility was being considered for change or modification to allow them to evaluate the impact of the anticipated change on the work environment.

Table 4.14-1.-- Estimated Number of Construction Worker Fatalities by Alternatives

Alternatives	Worker Years	Construction Period (years)	Potential Accidental Workers Deaths[1]
Stewardship			
National Ignition Facility	1,627	5	0.358
Contained Firing Facility	60	2	0.013
Atlas Facility>/td>	53	4	0.012
Management			
Assembly/Disassembly			
Pantex Plant	99	3	0.022
Nevada Test Site	2,768	6	0.609
Nonnuclear Fabrication			
Kansas City Plant	459	4	0.101
Los Alamos National Laboratory	12	2	0.003
Lawrence Livermore National Laboratory	19	5	0.004
Sandia National Laboratories	781	3	0.172
Pit Fabrication			
Los Alamos National Laboratory	216	3	0.048
Savannah River Site	801	5	0.176
Secondary and Case Fabrication			
Oak Ridge Reservation	72	6	0.016
Los Alamos National Laboratory	205	4	0.045
Lawrence Livermore National Laboratory	330	3	0.073
High Explosives Fabrication			
Pantex Plant	46	3	0.01
Los Alamos National Laboratory	77	2	0.017
Lawrence Livermore National Laboratory	19	1	0.004

Appropriate measures would be implemented to minimize work hazards and accidents based on this early evaluation. Once operational, as part of the Occupational Safety and Health Program at each site, ongoing surveillance of the new or modified processes or activities would be performed to identify potential health hazards. If potential health hazards are identified, a hazard evaluation would be conducted to determine the extent of the hazard and, if required, the recommended control measures. Where feasible, engineering controls would be used to protect worker health and safety. Administrative controls and personal protective equipment would supplement engineering controls, as appropriate.

4.15 Unavoidable Adverse Environmental Impacts

Siting, construction, modification, and operation of stockpile stewardship and management facilities at ORR, SRS, KCP, Pantex, LANL, LLNL, SNL, or NTS would result in adverse environmental impacts. The impact assessment conducted in this PEIS has identified these potential adverse impacts along with mitigative measures that could be implemented to either avoid or minimize these impacts. The residual adverse impacts remaining after mitigation are unavoidable and the bounding case impacts of all stockpile stewardship and management alternatives at all alternative sites are discussed below.

At NTS 18.2 ha (45 acres) of land would be disturbed to construct and operate the proposed NIF and provide additional supporting infrastructure and access roads. Loss of habitat in the disturbed area would be unavoidable. Land requirements for the proposed NIF would represent less than 11 percent of the uncommitted land at each alternative site except for the NLVF alternative at NTS where 56 percent would be required. Soil erosion in the disturbed area due to wind and stormwater runoff would be minor with appropriate sediment control measures. Small areas of potential wetlands could be unavoidably impacted, but mitigation measures approved by the U.S. Corps of Engineers would be implemented.

Construction, modification, and operation of stockpile stewardship and management facilities would generate criteria and toxic/ hazardous pollutants that have the potential to exceed Federal and state ambient air quality standards and guidelines. Concentrations of PM *10* and TSP are expected to be close to or exceed the *24-hour ambient* PM *10 and TSP* standards during peak construction periods under dry and windy conditions. Such exceedances are not uncommon for large construction projects. Air pollutant concentrations during operation are expected to remain within Federal and state ambient air quality standards, except for 1-hour ozone concentrations at KCP, 1-hour nitrogen dioxide concentrations at LLNL, 24-hour nitrogen dioxide concentrations at LANL, and annual PM *10* concentrations at KCP.

For each of the alternatives considered, use of water is unavoidable and could represent an adverse impact depending on the site. The maximum amount of surface water required for stockpile stewardship and management facilities operation would be about *1,510 MLY (400 MGY)* at ORR, and the maximum groundwater requirement would be 893 MLY (236 MGY) at SNL. Increased turbidity during construction activities could impact some fish spawning and feeding habitat. It is expected that this loss would be small in comparison with resident fish populations and reproductive capabilities.

Federal-listed threatened or endangered species, such as the desert tortoise, could be affected directly or by disruptions to benthic and foraging habitats during construction and operation of stockpile stewardship and management facilities. Several candidate or state-listed animal species and special status plant species may also be affected at different sites. Preactivity surveys for such species would be conducted prior to the start of projects and any mitigation measures would be developed in consultation with the USFWS. It may be necessary to survey the sites for the nests of migratory birds prior to construction and to avoid clearing operations during the breeding season. While such disruptions may be unavoidable, appropriate measures would be implemented and monitored to ensure that any impacts are not irreversible. Construction of new facilities would have some adverse unavoidable effects on animal populations. Larger mammals and birds would move to similar habitats nearby, while less mobile animals within the project areas, such as amphibians, reptiles, and small mammals, would be destroyed during land-clearing activities.

Some NRHP-eligible prehistoric and historic resources may occur within the disturbed area at each candidate site. The appropriate SHPO would be consulted to minimize unavoidable adverse impacts. Monitoring of construction activities by a paleontologist may be an appropriate mitigative measure in areas where scientifically important paleontological materials may be affected. Native American resources may be unavoidably affected by land disturbance and audio or visual intrusions on Native American sacred sites or due to reduced access to traditional use areas. DOE would consult with the affected tribes to minimize any impacts.

During construction of stockpile stewardship and management facilities, there would be no in-migration at any site. However, for operation of these facilities, there would be in-migration at some of the sites. The site and regional population would increase by as much as 1,950 (0.1 percent) during A/D operation at NTS. In most cases, vacancies in the existing housing stock would be sufficient for the in-migrating population. Some additional housing construction would be needed during operation of pit fabrication at SRS. Effects on the public finances of local governments in the ROI would be for the most part positive. An increase in vehicle traffic associated with construction and operation of stockpile stewardship and management facilities would affect the roads and transportation network surrounding some of the alternative sites. The resulting impacts in traffic, congestion, and road accidents resulting from socioeconomic growth is unavoidable, but can be reversed. For example, site access roads which are degraded during construction can be upgraded beyond their original condition to accommodate increased worker traffic.

Some amount of radiation would be released unavoidably by normal stockpile stewardship and management operations. The largest annual radiation dose to the maximally exposed member of the public would be 6.7 mrem from atmospheric and liquid releases at LANL. The associated risk of fatal cancers from 25 years of operations with these doses is $8.4\text{x}10^{-5}$. The greatest annual population dose from total site operations through 2030 would be 40.8 person-rem at ORR; such a total dose would result in 0.52 fatal cancers over the entire 25 years of operation. The largest average annual dose to a site worker would be 380 mrem at SRS and LANL and would result in an associated risk of fatal cancer of $3.8\text{x}10^{-3}$ from 25 years of operation. The greatest annual dose to the total site workforce would be 505 person-rem occurring at SRS and would result in 5.0 fatal cancers over 25 years of operation.

Since hazardous and toxic chemicals are present during construction and operation of stockpile stewardship and management facilities, worker exposure to these chemicals is unavoidable. The maximum hazard to site workers, based solely on emissions of hazardous chemicals, is represented by an HI of 2.39 at LLNL for the No Action alternative. The incremental effects of the stockpile stewardship and management alternative at SRS would not appreciably change this No Action value. The incremental cancer risks to the public and site workers are essentially zero.

Although each site would implement waste minimization techniques, generation of additional low-level, hazardous and nonhazardous wastes is unavoidable. Any introduction of new waste types could be an adverse impact since treatment, storage, and disposal facilities may have to be developed and permitted to deal with certain new types of wastes. In addition, the generation of additional LLW at Pantex would require one additional shipment to NTS every 2 years. Generation of additional hazardous or mixed wastes could require expansion of existing or planned treatment, storage, and disposal facilities for these wastes at some sites. Generation of additional nonhazardous wastes may also require expansion of existing, or construction of new, liquid and solid waste treatment facilities, or reduce the lifetimes of current solid waste landfills.

4.16 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The use of land on any of the eight alternative sites being considered for stockpile stewardship and management facilities would enhance the long-term productivity on each site in two ways. First, stockpile stewardship and management missions represent long-term R&D and production functions compatible with historic nuclear weapons support and require a technically competent, skilled and stable workforce. Second, in light of current reductions in the nuclear weapons stockpile, the lack of new weapons development or production, the moratorium on nuclear testing, and concerns about safety and reliability in the aging stockpile, DOE plans to downsize or consolidate existing facilities. In addition, DOE plans to provide upgraded or new experimental and computational capabilities that will enhance the long-term productivity of the selected sites.

Each alternative requires the use of additional land for increased disposal of radiological and hazardous materials. Such short-term usage would remove this land from other beneficial uses indefinitely because of the presence of long-lived hazards. Disposal of solid nonhazardous waste generated from facilities construction and operations would require additional land at onsite sanitary landfills. Solid nonhazardous waste generated from these facilities would continuously require additional land at a sanitary landfill site that would be unavailable for other uses in the long term. LLW would require additional space for onsite storage and waste processing and would involve the commitment of associated land, transportation, processing facilities, and other disposal resources. Creation of land disposal facilities allows the site to be productive for the long term by protecting the overall environment and complying with Federal and state environmental requirements.

One specific activity has been identified that requires short-term resource use that could compromise long-term productivity. The range of the endangered desert tortoise lies in the southern third of NTS. Construction and operation of new facilities associated with the A/D mission have the potential to impact the Federal-listed threatened desert tortoise. Measures designed to avoid impacts to the desert tortoise from previous projects at NTS have been implemented with mitigation measures developed in consultation with USFWS.

Losses of other terrestrial and aquatic habitats from natural productivity to accommodate new facilities and temporary disturbances required during construction are possible. Land clearing and construction activities resulting in large numbers of personnel and equipment moving about an area would disperse wildlife and temporarily eliminate habitats. Although some destruction would be inevitable during and after construction, these losses would be minimized by site selection and through environmental reviews at the site-specific level. In addition, short-term disturbances of previously undisturbed biological habitats from the construction of new facilities could cause long-term reductions in the biological productivity of an area. These long-term effects could occur, for example, at facilities located in arid areas of the western United States such as SNL, LANL, LLNL, and NTS, where biological communities recover very slowly from disturbances.

Potential termination of DP activities at ORR, KCP, and Pantex offers the possibility of restoring existing facilities at these sites to other purposes. Environmental restoration activities could have minor or short-term impacts similar to those normally associated with construction activities such as habitat disturbance and soil erosion. If contaminated structures were removed and site areas restored to a natural state, these areas could provide improved conditions for the long term.

4.17 Irreversible and Irretrievable Commitments of Resources

This section describes the major irreversible and irretrievable commitments of resources that can be identified at this programmatic level of analysis. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for later use by future generations.

The Stockpile Stewardship and Management Program was initiated to ensure the safety and reliability of the Nation's nuclear weapons stockpile. As such, the programmatic decisions resulting from this PEIS will ensure the commitment of resources to the new construction or modification of facilities that are essential to the efficacy and efficiency of the Complex. This section discusses three major resource categories that are committed irreversibly or irretrievably to the proposed action: land, materials, and energy. Values for irreversible or irretrievable commitments of resources are shown in tables 4.17-1 through 4.17-4.

Land Use . The land that is currently occupied by, or designated for, future stockpile stewardship and management facilities, could ultimately be returned to open space uses if buildings, roads, and other structures were removed, areas cleaned up, and the land revegetated. Alternatively, the facilities could be modified for use in other nuclear programs. Therefore, the commitment of this land is not necessarily irreversible.

However, land rendered unfit for other purposes, such as that set aside for radiological and hazardous chemical waste disposal facilities, represents an irreversible commitment because wastes in below-ground disposal areas may not be completely removed at the end of the project. The land could not be restored to its original condition or to minimum cleanup standards, nor could the site feasibly be used for any other purposes following closure of the disposal facility. This land would be perpetually unusable because the substrata would not be available for other potential intrusive uses such as mining, utilities, or foundations for other buildings. However, the surface area appearance and biological habitat lost during construction and operation of the facilities could be restored to a large extent.

Material . The irreversible and irretrievable commitment of material resources during the entire lifecycle of stockpile stewardship and management existing or proposed facilities includes construction materials that cannot be recovered or recycled, materials that are rendered radioactive but cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Where construction is necessary, materials required include wood, concrete, sand, gravel, plastics, steel, aluminum, and other metals. At this time, no unusual construction material requirements have been identified either as to type or quantity. The construction resources, except for those that can be recovered and recycled with present technology, would be irretrievably lost. However, none of these identified construction resources is in short supply and all are readily available in the vicinity of locations being considered for new functions. The commitment of materials to be manufactured into new equipment that cannot be recycled at the end of the project's useful lifetime is irretrievable. Consumption of operating supplies, miscellaneous chemicals, and gases, while irretrievable, would not constitute a permanent drain on local sources or involve any material in critically short supply in the United States as a whole. Materials consumed or reduced to unrecoverable forms of waste, such as uranium, are also irretrievably lost. However, strategic and critical materials, or resources having small natural reserves, are of such value that economics promotes recycling. Plans to recover and recycle as much of these valuable, depletable resources as is practical would depend on need. Each item would be considered individually at the time a recovery decision is required.

Energy. The irretrievable commitment of resources during construction and operation of the facilities would include the consumption of fossil fuels used to generate heat and electricity for the sites. Energy would also be expended in the form of diesel fuel, gasoline, and oil for construction equipment and transportation vehicles. The amounts of irretrievable energy required to construct and operate new or modified facilities are estimated in chapter 3. These estimates are roughly comparable to past energy requirements for the Complex.

Table 4.17-1.-- Irreversible and Irretrievable Commitments of Construction Resources for Assembly/Disassembly,

Nonnuclear Fabrication, and Stockpile Stewardship Facilities

Construction	Contained Firing Facility	National Ignition Facility [2]	Atlas Facility	Assembly/ Disassembly		Nonnuclear Fabrication			
				Pantex	NTS[3]	KCP	LANL[4]	LLNL[3]	SNL[3]
Resource Requirements									
Electrical energy (MWh)	64	24	520	609	38,000	0	0.105	21	46.8
Liquid fuel (L)	56,800	1,500,000	<1,000	28,800	3,030,000	0	0	19,900	2,600,000
Concrete (m^3)	3,000	60,000	<100	840	75,000	286	0	7.6	12,800
Carbon and stainless steel (t)	1,500	10,000	<10	15	16,300	220	0	7.3	5,440
Industrial gases (m^3)	4,300	9,000	0	600	65,100	0	0	7.5	0
Water (L)	3,790,000	1.43x107	<10,000	1,400,000	9.84x1077	0	9,500	79,500	2,200,000
Employment									
Total employment (worker years)	60	1,627	53	99	2,768	459	12	19	781
Construction period (years)	2	5	4	3	6	4	2	5	3

Table 4.17-2.-- Irreversible and Irretrievable Commitments of Construction Resources for Stockpile Management Alternatives

Construction	Pit Fabrication and Modification		Secondary and Case Fabrication			High Explosives Fabrication		
	SRS[5]	LANL[6]	ORR	LANL[7]	LLNL[7]	Pantex	LANL[8]	LLNL[8]
Resource Requirements								
Electrical energy (MWh)	15	Minimal	2.7	4,130	3,500	257	Minimal	15
Liquid fuel (L)	175,000	Minimal	10,000	22,700	908,000	12,200	Minimal	9,500
Concrete (m3)	1,600	Minimal	100	245	612	356	Minimal	190
Carbon and stainless steel (t)	249	Minimal	20	54	73	6	Minimal	15
Industrial gases (m3)	3,780	Minimal	300	11,500	142	258	Minimal	3
Water (L)	30,000,000	Minimal	2,000,000	4,160,000	8,710,000	644,000	Minimal	1,230,000
Employment								
Total employment (worker years)	801	216	72	205	330	46	77	19
Construction period (years)	5	3	6	4	3	3	2	1

Table 4.17-3.-- Irreversible and Irretrievable Commitments of Operation Resources for Assembly/Disassembly, Nonnuclear Fabrication, and Stockpile Stewardship Facilities

Operations	**Contained Firing Facility**	**National Ignition Facility**[9]	**Atlas Facility**	**Assembly/ Disassembly**		**Nonnuclear Fabrication**			
				Pantex	**NTS**[10]	**KCP**	**LANL**[11]	**LLNL**[11]	**SNL**[11]
Resource Requirements									
Electrical energy (MWh/yr)	1,600	58,000	5,360	43,000	45,000	225,000	525	108	39,700
Fuel, gas (m3/yr)	0	1,100,000	0	7,150,000	3,680,000	18,900,000	340	28,900	3,270,000
Liquid fuel (L/yr)	2,650	5,820	0	740,000	432,000	0	0	0	0
Coal (t/yr)	0	NA	0	NA	NA	NA	NA	NA	NA
Total water (L/yr)	2.3x106	1.52x108	10,000	1.96x108	9.84x107	1.34x109	4.83x107	3,790,000	8.93x108
Liquid chemicals (kg/yr)	0	0	90	49,216	18,979	15,259,650	8,343	283,203	15,259,650
Solid chemicals (kg/yr)	0	0	0	70,068	11,027	0	124,860	0	0
Gaseous chemicals (kg/yr)	0	0	0	65,772	65,772	9,305	0	135	9,305
Plant Footprint (ha)[12]	0.4	20	0.3	[13]	4.3	[13]	[13]	[13]	9
Employment									
Total workforce	26	267	15	1,266	1,093	2,257	315	114	1,160

Table 4.17-4.-- Irreversible and Irretrievable Commitments of Operation Resources for Stockpile Management Alternatives

Operations	**Pit Fabrication and Modification**		**Secondary and Case Fabrication**			**High Explosives Fabrication**		
	SRS [14]	**LANL** [15]	**ORR**	**LANL** [16]	**LLNL** [16]	**Pantex**	**LANL** [17]	**LLNL** [17]
Resource Requirements								
Electrical energy (MWh/yr)	9,700	5,480	118,000	36,000	15,000	3,250	5,600	4,300

Fuel, gas (m3/yr)	0	30,900	1.7x107	0	566,000	500,000	3,650,000	0
Liquid fuel (L)	28,400	0	250,000	100,000	85,200	55,600	94,600	53,100
Coal (t/yr)	1,090	0	500	0	NA	NA	NA	NA
Total water (L/yr)	4.62x107	3.02x107	1.51x109	5.5x107	1.94x108	1.25x107	1.3x107	5.82x107
Liquid chemicals (kg/yr)	9,191	57,772	199,466	153,728	58,107	8,050	9,049	2,776
Solid chemicals (kg/yr)	7,138	99,278	54,223	56,340	15,845	51,480	49,669	76,159
Gaseous chemicals (kg/yr)	52,521	1,533,089	6,488,333	1,568,333	1,883,037	1,810	1,361	885
Plant Footprint [18]	[18]	[19]	[18]	[18]	[18]	[18]	[18]	0.8
Employment								
Total Workforce	813	628	1,376	523	760	37	200	232

4.18 Facility Transition

The final disposition of all Complex facilities is the responsibility of DOE. DOE is committed to remediate these sites, to comply with all applicable environmental requirements, and to protect public and worker health and safety. DOE is currently considering many technologies for the treatment of contaminated materials and equipment, and for the long-term management of sites. DOE is preparing a PEIS to identify configurations for selected waste management facilities. The term "configurations" as used in this context means the arrangement of facilities and related activities at one or more DOE sites for a specific waste type. The selected waste management facilities for each of these waste types are: interim storage facilities for treated HLW; treatment and storage facilities for TRU waste in the event that treatment is required before disposal; treatment and disposal facilities for LLW; interim storage facilities for commercial Greater-Than-Class C LLW; treatment and disposal facilities for mixed LLW; and treatment facilities for hazardous waste.

4.19 Use of Plutonium-242 for Research and Development

Interim Management of Nuclear Materials Environmental Impact Statement (DOE/EIS-0220) dated October 20, 1995, categorized certain isotopes of plutonium, neptunium, americium, and curium as programmatic, leaving the issue of long-term use of these materials to various Program offices within DOE. The ROD for the Interim Management of Nuclear Materials EIS dated December 12, 1995, left programmatic decisions for the plutonium-242 material to DP. DP has determined that the plutonium-242 from SRS would be useful for future R&D activities. The issue for this PEIS concerns where to store the plutonium-242 material for such use. This section provides an analysis of the alternatives for storing SRS plutonium material for future R&D use. Further information regarding use of this material is contained in a classified appendix to this PEIS.

As discussed in the ROD for the Interim Management of Nuclear Materials EIS, existing plutonium-242 in nitrate solutions at H-Canyon will be stabilized by conversion to plutonium oxide in the HB-line. The portion of the HB-line where the conversion to oxide will occur is called Phase III. Phase III is being used to produce plutonium-238 for National Aeronautic and Space Administration for use as a thermal power source. The plutonium-242 in solution will be converted to oxide form (stabilized) between July and December 1996. The oxide will then be stored at existing facilities at either FB-Line or Building 235F at SRS.

A new DOE standard entitled *DOE Criteria for Safe Storage of Plutonium Metals and Oxides (DOE-STD-3013-94)* requires the handling and packaging of plutonium without the use of plastic and other organic materials (e.g., rubber or elastomeric seals). The ROD for the Interim Management of Nuclear Materials EIS determined that a new Actinide Packaging and Storage Facility will be constructed in the F-Area at SRS to allow for packaging this oxide as specified in the above-mentioned standard. The Actinide Packaging and Storage Facility is planned to be a fiscal year 1997 construction line item and construction completion is expected by May 2001. If the plutonium oxide were to remain at SRS, the material would be transferred from its storage location at FB-Line or Building 235F to the Actinide Packaging and Storage Facility once construction is completed.

The alternatives being evaluated in this Stockpile Stewardship and Management PEIS for the plutonium-242 oxide are to leave the material in place at SRS (the No Action alternative) or transport the material to LANL or LLNL for use in R&D. Both LANL and LLNL have a history of working with plutonium (including plutonium oxide) for research purposes. LANL currently performs most of the plutonium research for the Complex and has the necessary analytical facilities for plutonium. LLNL, although a reasonable alternative, is currently reducing its inventory of plutonium.

Environmental Impacts. The plutonium-bearing nitrate solutions in the F- and H- Canyons at SRS are being converted to plutonium oxide to stabilize the material in accordance with the Interim Management of Nuclear Materials and the F-Canyons Plutonium Solutions RODs. As stated above, the plutonium oxide will be stored at existing SRS facilities.

Under the No Action alternative, the material would be stored at FB-Line or Building 235F until it could be treated and then stored in the new Actinide Packaging and Storage Facility at SRS in accordance with newly developed standards. At LANL, TA-55 is the expected location for storing the material. The potential storage location at LLNL is Building 332 within the high security Superblock Complex. Regardless of the storage location for this material, there would be negligible environmental impacts. At SRS, LANL, or LLNL, this small quantity of plutonium oxide is within the historical quantities stored at these sites. Previous environmental analyses (LLNL and SNL Final EIS [DOE/EIS-0157, August 1992], Final EIS Interim Management of Nuclear Materials [DOE/EIS-0220, October 1995], and *the Environmental Assessment for Nuclear Material Storage for TA-55* [DOE/EA-0273, November 1985]) provide the NEPA documentation for continued storage of radioactive materials. No new additional risks to workers or the public would result from storage of this material at any of the three sites. No wastes are generated from storing the material. No additional site infrastructure or workers are required. No additional air or liquid releases would occur from normal operation. Therefore, this Stockpile Stewardship and Management PEIS analyzes the transportation from SRS to LANL or LLNL, against the No Action alternative of not transporting the plutonium oxide.

Transportation. The No Action alternative is to leave the plutonium oxide stored at SRS in the Actinide Packaging and Storage Facility. Under No Action, there would be no transportation impacts, and thus, no further environmental impacts associated with this storage.

Transportation of this plutonium oxide from SRS to either LANL or LLNL would only require a fraction of one safe secure trailer shipment. Although the material could be packaged in a small number of containers, for the purposes of this analysis, a safe secure trailer loaded with 26 containers was assumed. The actual quantity of plutonium-242 is much less than is assumed for this analysis. Thus, these stated risks conservatively bound the true risk of transportation. The potential total health impacts of transportation of one such safe secure trailer shipment from either SRS to LANL, or SRS to LLNL, are shown in table 4.19-1. There could be a total health impact of 6.63x10-4 deaths from a one-time shipment of 26 canisters of plutonium-242 from SRS to LLNL. A one-time shipment of the same material from SRS to LANL could result in a total health impact of 4.14x10-4 deaths. The risks from transportation to LLNL are slightly higher only because of the greater distance traveled from SRS to LLNL. This table indicates that there are essentially no impacts from either alternative.

Table 4.19-1.---Total Potential Fatalities from the One-Time Transportation of Plutonium-242 (Oxide) from Savannah River Site to Lawrence Livermore National Laboratory or Los Alamos National Laboratory

Route	**Health Effects** [20]		
	Accident	**Accident-Free**	**Total**
SRS to LLNL	$5.10\text{x}10^{-4}$	$1.53\text{x}10^{-4}$	$6.63\text{x}10^{-4}$
SRS to LANL	$3.17\text{x}10^{-4}$	$9.70\text{x}10^{-5}$	$4.14\text{x}10^{-4}$

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[1] Results are based on the death rates experienced for construction workers in 1993. For the construction industry in general in 1993, the death rate was 22 deaths per 100,000 worker-years.
Source: NSC 1994a.

[2] NIF values reflect nonsite-specific requirements. See appendix I for site-specific information.

[3] Values reflect requirements if Pantex is phased out.

[4] Values reflect requirements if KCP is phased out. Derived from text.

[5] Values reflect requirements if SRS receives this mission.

[6] Values reflect requirements if LANL receives this mission.

[7] Values reflect requirements if ORR is phased out.

[8] Values reflect requirements if Pantex is phased out. Derived from text.

[9] NIF values reflect nonsite-specific requirements. See appendix I for site-specific information.

[10] Values reflect requirements if Pantex is phased out.

[11] Values reflect requirements if KCP is phased out.

[12] In addition to existing facilities.

[13] Existing facilities would be used. NA - not applicable. Derived from text.

[14] Values reflect requirements if SRS receives this mission.

[15] Values reflect requirements if LANL receives this mission.

[16] Values reflect requirements if ORR is phased out.

[17] Values reflect requirements if Pantex is phased out.

[18] In addition to existing facilities.

[19] Existing facilities would be used.
NA - not applicable. Derived from text.

[20] Assumes all plutonium-242 would be transported in one truckload.
RADTRAN model results.

4.2 Oak Ridge Reservation

ORR is a Government-owned, contractor-operated reservation located in the State of Tennessee. The regional location of ORR is shown in figure 4.2-1 and the principal facilities at ORR are shown in figure 4.2-2. The prime contractor manages the Y-12 Plant (Y-12), Oak Ridge National Laboratory (ORNL), the K-25 Site (K-25), and most other properties on the reservation. The facilities began operation in 1943 as part of the World War II Manhattan Project. The primary missions at each facility have changed over the past 50 years, with the current missions described in section 3.2.2. Although Y-12 is the main focus area with respect to the proposed actions, baseline environmental information and impact assessment are presented for ORR due to the proximity and potential impacts of nearby facilities, both present and future.

4.2.1 Description of Alternatives

No Action. ORR would continue to perform the missions described in section 3.2.2.

Stockpile Management Alternatives. The secondary and case fabrication mission could be consolidated and downsized, and remain at Y-12. In this scenario, storage of the strategic reserve of uranium would remain at Y-12. The Y-12 secondary and case fabrication mission could also be transferred to either LANL or LLNL. In the event the secondary and case fabrication mission is transferred to the laboratories, the DP missions at Y-12 would be phased out and the facilities transitioned to EM for disposition. In addition, the strategic reserve of uranium in the form of canned subassemblies would be relocated to the weapons assembly/disassembly (A/D) Facility at either Pantex or NTS.

Stockpile Stewardship Alternatives. There are no stockpile stewardship alternatives that include ORR.

4.2.2 Affected Environment

The following sections describe the affected environment at ORR for land resources, air quality, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure at ORR, the radiation and hazardous chemical environment, and the waste management conditions are described.

4.2.2.1 *Land Resources*

ORR is located on approximately 13,980 hectares (ha) (34,545 acres) within the corporate limits of the city of Oak Ridge, approximately 19 km (12 mi) west of Knoxville, TN. All the land within ORR is owned by the Federal Government and is administered, managed, and controlled by DOE. Generalized land uses at ORR and in the vicinity are shown in figure 4.2.2.1-1.

Land uses within ORR can be grouped into four major land use classifications: industrial, forest/undeveloped, public/quasi-public, and water. The industrial areas account for approximately 4,700 ha (11,700 acres) or approximately 33 percent of the total site area. An additional 490 ha (1,200 acres) are used for a security buffer zone around various facilities. About 320 ha (800 acres) of ORR's land is classified as public land and consists mainly of the 36-ha (90-acre) Clark Center Recreational Park, numerous small public cemeteries, and an onsite public road (OR DOE 1989a:5-10). The remaining area, about 8,700 ha (21,600 acres), consists of forest/undeveloped land, some of which is managed as pine plantations for production of pulpwood and saw timber. The DOE Water Treatment Facility, which provides water to many ORR facilities and the city of Oak Ridge, is located just north of Y-12. There are no prime farmlands on ORR.

In 1980, DOE designated approximately 5,500 ha (13,600 acres) of ORR undeveloped land as a National Environmental Research Park. The park is used by the national scientific community as an outdoor laboratory for environmental science research on the impact of human activities on the eastern deciduous forest ecosystem (DOE 1985a:3,27).

Land bordering ORR is predominately rural and used largely for residences, small farms, forest land, and pasture land. The city of Oak Ridge, along the northeast portion of the site, has a typical urban mix of residential, public, commercial, and industrial land uses. There are four residential areas along the northern boundary of ORR; each has several houses within approximately 30 m (98 ft) of the boundary.

Y-12 is largely developed and encompasses 328 ha (811 acres) of which 255 ha (630 acres) are enclosed by security fencing. Y-12 is the primary location used for supporting DP missions, including nuclear components production and surveillance and nuclear production mission assignments. These activities are housed in approximately 425 buildings containing 152,911 square meters (m^2) (5.4 million square feet [ft^2]) of floor space. *Y-12 also has approximately 20 buildings, containing 8,495 m^2 (300,000 ft^2)* of floor space, *that house support activities and several organizations of the DOE Oak Ridge Field Office.*

4.2.2.2 *Site Infrastructure*

To support the current missions at ORR, as described in section 3.2.2, an extensive infrastructure exists as shown in table 4.2.2.2-1. These resources support operations at Y-12, ORNL, and K-25.

Table 4.2.2.2-1.--*Baseline Characteristics for Oak Ridge Reservation.*

Characteristics	Current Value
Land	
Area (ha)	13,980
Roads (km)	71

Railroads (km)	27
Electrical	
Energy consumption (MWh/yr)	726,000
Peak load (MWe)	1110
Fuel	
Natural gas (m^3/yr)	95,000,000
Liquid (L/yr)	416,000
Coal (t/yr)	16,300
Steam	
Generation (kg/hr)	150,000
Water	
Usage (MLY)	14,210
OR LMES 1996i.	

4.2.2.3 Air Quality

The following section describes existing air quality and reviews the meteorology and climatology in the vicinity of ORR. More detailed discussions of the air quality methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.3.2.

Meteorology and Climatology. The Cumberland and Great Smoky Mountains have a moderating influence on the climate at ORR. Winters are generally mild and summers warm, with no noticeable extremes in precipitation, temperature, or winds.

The annual average temperature at ORR is 13.7 °Celsius (C) (56.6 °Fahrenheit [F]); the average daily minimum temperature in January is -3.8 °C (25.1 °F), and the average daily maximum temperature in July is 30.4 °C (86.7 °F). The average annual precipitation is approximately 136.6 centimeters (cm) (53.77 inches [in]). Prevailing wind directions at ORR tend to follow the orientation of the valley; up valley, from west to southwest; or down valley, from east to northeast. The average annual wind speed is approximately 2.0 meters per second (m/s) (4.5 miles per hour [mph]) (NOAA 1994c:3). Additional information related to meteorology and climatology at ORR is presented in appendix section B.3.2.

Ambient Air Quality. ORR is located in Anderson and Roane Counties in the eastern Tennessee and southwestern Virginia Interstate Air Quality Control Region (AQCR) 207. As of 1995, the areas within this AQCR were designated by EPA as attainment areas with respect to all National Ambient Air Quality Standards (NAAQS) for criteria pollutants (40 CFR 81.343). Applicable NAAQS and Tennessee State ambient air quality standards are presented in appendix table B.3.1-1.

One Prevention of Significant Deterioration Class I area can be found in the vicinity of ORR. This area, the Great Smoky Mountains National Park, is located approximately 48 km (30 mi) southeast of ORR. Since the promulgation of regulations, no Prevention of Significant Deterioration permits have been required for any emissions source at ORR.

The primary emission sources of criteria pollutants are the steam plants at Y-12, K-25, and ORNL. Other emission sources include fugitive particulates from coal piles, the Toxic Substances Control Act (*TSCA)* incinerator, other processes, vehicles, and temporary emissions from various construction activities (OR DOE 1987a:33-49). Appendix table B.3.2-1 presents emission rates of pollutants from ORR.

Table 4.2.2.3-1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at ORR. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Table 4.2.2.3-1.--*Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Oak Ridge Reservation, 1992*

Pollutant	**Averaging Time**	**Most Stringent Regulation or Guideline (g/m^3)**	**Baseline Concentration (g/m^3)**
Criteria Pollutant			
Carbon monoxide	8-hour 1-hour	10,000[1] 40,000[1]	5 11
Lead	Calendar quarter	1.5 [1]	0.05 [2]
Nitrogen dioxide	Annual	100[1]	3
Ozone	1-hour	235[1]	[3]
Particulate matter	Annual 24-hour	50[1] 150[1]	1 2
Sulfur dioxide	Annual 24-hour 3-hour	80[1] 365[1] 1,300[1]	2 32 80
Mandated by Tennessee			
Gaseous fluoride (as hydrogen fluoride)	30-day 7-day 24-hour 12-hour 8-hour	1.2 [4] 1.6 [4] 2.9 [4] 3.7 [4] 250[4]	0.2 0.3 <0.6 <0.6 0.6

Total suspended particulates	24-hour	150[4]	2
Hazardous and Other Toxic Compounds			
Chlorine	8-hour	150[4]	4.1
Hydrogen chloride	8-hour	750[4]	57
Mercury	8-hour	5[4]	0.06 [5]
Nitric acid	8-hour	[6]	78
Sulfuric acid	8-hour	100[4]	20

4.2.2.4 *Water Resources*

This section describes the surface and groundwater resources at ORR.

Surface Water. The major surface water body in the immediate vicinity of ORR is the Clinch River, which borders the site to the south and west. There are four major subdrainage basins on ORR that flow into the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek. Drainage from Y-12 enters both Bear Creek and East Fork Poplar Creek; K-25 drains predominantly into Poplar Creek and Mitchell Branch; and ORNL drains into the White Oak Creek drainage basin (OR DOE 1992c:1-16). Several smaller drainage basins, including Ish Creek, Grassy Creek, Bearden Creek, McCoy Branch, Kerr Hollow Branch, and Raccoon Creek, drain directly to the Clinch River. Each drainage basin takes the name of the major stream flowing through the area. Within each basin are a number of small tributaries. The natural surface water bodies in the vicinity of ORR are shown in figure 4.2.2.4-1.

The Clinch River and connected waterways supply all raw water for ORR. The Clinch River has an average flow of 132 cubic meters (m $^{3)}$ /s (4,647 cubic feet [ft $^{3]}$ /s) as measured at the downstream side of Melton Hill Dam at mile 23.1. The average flow of Bear Creek near Y-12 is 0.11 m *3* /s (3.9 ft *3* /s). The average flow at East Fork Poplar Creek is 1.3 m *3* /s (45 ft *3* /s) (OR USGS 1986a:161,168-169). Y-12 uses approximately 7,530 million liters per year (MLY) (1,989 million gallons per year [MGY]) of water, while ORR uses approximately twice as much (14,760 MLY [3,900 MGY]). The ORR water supply system, which includes the DOE treatment facility and the K-25 treatment facility, has a capacity of 44,347 MLY (11,716 MGY).

At Y-12, there are six treatment facilities with NPDES-permitted discharge points to East Fork Poplar Creek. Y-12 is also permitted to discharge wastewater to the City of Oak Ridge Wastewater Treatment Facility. At ORNL, three NPDES-permitted wastewater treatment facilities discharge into White Oak Creek basin. K-25 operates one sanitary sewage system which discharges to Poplar Creek (OR DOE 1994c:4-17-4-19).

Clinch River water levels in the vicinity of ORR are regulated by a system of dams operated by the Tennessee Valley Authority. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast sides of ORR. Watts Bar Dam, located on the Tennessee River downstream of the lower end of the Clinch River, controls the flow of the Clinch River along the southeast side of ORR (ORNL 1986a:1-17).

The Tennessee Valley Authority has conducted flood studies along Clinch River, Bear Creek, and East Fork Poplar Creek. Portions of Y-12 lie within the 100- and 500-year floodplains of East Fork Poplar Creek; however, proposed alternative facilities are located outside the 500-year floodplain (ORR 1995a:6).

Surface Water Quality. The streams and creeks of Tennessee are classified by the Tennessee Department of Environment and Conservation and defined in the State of Tennessee Water Quality Standards. Classifications are based on water quality, designated uses, and resident aquatic biota. The Clinch River is the only surface water body on ORR classified for domestic water supply. Most of the streams at ORR are classified for fish and aquatic life, livestock watering, and wildlife (OR DOE 1992c:1-16). White Oak Creek and Melton Branch are the only streams not classified for irrigation. Portions of Poplar Creek, East Fork Poplar Creek, and Melton Branch are not classified for recreation.

Both routine and NPDES-required surface water monitoring programs (over 225 sites) are performed at Y-12 to assess the impacts of the plant effluents upon natural receiving water and to estimate the impacts of these effluents on human health and the environment. At Y-12, Bear Creek, McCoy Branch, Rogers Quarry, and East Fork Poplar Creek receive effluent from treated sanitary wastewater, industrial discharges, cooling water blowdown, stormwater, surface water runoff, and groundwater. The chemical water quality of Bear Creek has been affected by the infiltration of contaminated groundwater. Contaminants included high concentrations of dissolved salts, several metals, chlorinated solvents, and polychlorinated biphenyls (PCBs) (OR DOE 1994d:5-9). DOE is currently involved with remediation of East Fork Poplar Creek under CERCLA because the creek was contaminated by past releases from Y-12. Significant cleanup activities are required onsite and offsite. Contaminants present in East Fork Poplar Creek included mercury, organics, PCBs, and radionuclides (OR DOE 1994d:5-9).

There are 455 NPDES-permitted outfalls associated with the three major facilities at ORR; many of these are stormwater outfalls. Approximately 57,000 NPDES laboratory analyses were completed in 1993, with a compliance rate of over 99 percent. Most excursions were associated with precipitation runoff (OR DOE 1994c:2-13).

As shown in table 4.2.2.4-1, all parameters were below state water quality criteria where the Clinch River leaves ORR. Monitoring data from this sampling site are compared with monitoring data from the Melton Hill Dam sampling site, located upstream of all ORR discharges, and therefore are representative of background water quality. The concentrations downstream of ORR discharges were lower than concentrations upstream in all cases except gross beta and total suspended solids. Concentrations at Melton Hill Dam were also well below applicable water quality criteria.

Table 4.2.2.4-1.-- *Summary of Surface Water Quality Monitoring of the Clinch River, 1993*

			Average Water Body Concentration	
Parameter	**Unit of Measure**	**Water Quality Criteria[6]**	**Downstream from all DOE Inputs**	**Melton Hill Reservoir Above City of Oak Ridge Water Intake**
Radiological				
Alpha (gross)	pCi/L	15[7]	0.85 (0.30)	1.7 (0.46)
Beta (gross)	pCi/L	50 [8]	4.8 (0.54)	2.9 (0.32)
Cesium-137	pCi/L	120[9]	0.65 (1.2)	NST
Technetium-99	pCi/L	4,000 *d*	2.9 (1.1)	NST
Uranium, Total[10]	pCi/L	20[9]	1.6 (0.97)	1.0 (0.50)
Nonradiological				
Chemical oxygen demand	mg/L	NA	~8.2[11]	15
Fluoride	mg/L	4.0 [7], *2.0*[12]	~0.10 [9]	NST
Manganese	mg/L	0.05[12]	0.036	0.91
Nitrate	mg/L	10.0 [7]	3.3	
pH	pH units	6.5-8.5 [11]	8.0	8.0
Sodium	mg/L	NA	4.1	4.8
Sulfate	mg/L	250 [11]	21.0	22.0
Suspended solids	mg/L	NA	~11.0 [7]	~6.6
Total dissolved solids	mg/L	500[10]	150	170

Surface Water Rights and Permits. In Tennessee, the state's water rights laws are codified in the Water Quality Control Act. In effect, the water rights are similar to riparian rights in that the designated usages of a water body cannot be impaired. The only requirement to withdraw water from available supplies would be a U.S. Army Corps of Engineers permit to construct intake structures.

Groundwater. ORR is located in an area of sedimentary rocks of widely varying hydrological characteristics. However, because of the topographic relief and a decrease in bedrock fracture density with depth, groundwater flow is restricted primarily to shallow depths of the saturated zone in the aquitards, and groundwater discharges primarily to nearby surface waters within ORR (OR DOE

1994c:7-5). Depth to groundwater is generally 6 to 9 m (19.7 to 29.5 ft) but is as little as 1.5 m (4.9 ft) in the area of Bear Creek Valley near Highway 95.

Aquifers at ORR include a surficial soil and regolith unit and bedrock aquifers. The surficial aquifer consists of manmade fill, alluvium, and weathered bedrock. Bedrock aquifers occur in carbonates and low-yield sandstones, siltstones, and shales.

There are no Class I sole-source aquifers that lie beneath ORR. All aquifers are considered Class II aquifers (current potential sources of drinking water). Because of the abundance of surface water and its proximity to the points of use, very little groundwater is used at ORR. Only one water supply well exists on ORR; it provides a supplemental water supply to an aquatics laboratory during extended droughts.

Recharge occurs over most of the area but is most effective where overburdened soils are thin or permeable. In the area near Bear Creek Valley, recharge into the carbonate rocks occurs mainly along Chestnut Ridge (OR DOE 1992c:5-5). Shallow groundwater generally flows from the recharge areas to the center of Bear Creek Valley and discharges into Bear Creek and its tributaries.

Groundwater Quality. Groundwater samples are collected quarterly from a representative number of the more than 1,000 monitoring wells throughout ORR. Groundwater samples collected from the monitoring wells are analyzed for a standard suite of parameters and constituents, including trace metals, volatile organic compounds (VOCs), radioactive materials, and pH. Background groundwater quality at ORR is generally good in the near surface aquifer zones and poor in the bedrock aquifer at depths greater than 300 m (984 ft) due to high total dissolved solids.

Groundwater in Bear Creek Valley near Y-12 has been contaminated by hazardous chemicals and radionuclides (mostly uranium) from past weapons production process activities. The contaminated sources include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities (OR DOE 1994c:7-11,7-16,7-33-7-36).

Groundwater Availability, Use, and Rights. Industrial and drinking water supplies in the area are primarily taken from surface water sources. However, single-family wells are common in adjacent rural areas not served by the public water supply system. Most of the residential supply wells in the immediate area of ORR are south of the Clinch River (OR DOE 1992c:1-15). Most wells used for potable water are located in the deeper principal carbonate aquifer (305 m [1,000 ft]), while the groundwater contamination at Y-12 is primarily found at a depth of approximately 84 m (276 ft).

Groundwater rights in the State of Tennessee are traditionally associated with the Reasonable Use Doctrine (VDL 1990a:725). Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights reasonably in relation to the similar rights of others.

4.2.2.5 *Geology and Soils*

Geology. ORR lies in the Valley and Ridge province of east-central Tennessee. The topography consists of alternating valleys and ridges that have a northeast-southwest trend, with most ORR facilities occupying the valleys. Y-12 is in the Bear Creek Valley. Bear Creek Valley and the adjacent Pine and Chestnut Ridges are underlain by rocks composed of siltstone, silty limestone, and shale with some sandstone. The present topography of the valleys is the result of stream erosion of the softer shales and limestones. The ridges are underlain by the more resistant sandstones and dolomites.

ORR is cut by many inactive faults formed during the late Paleozoic Era. The Oak Ridge area lies at the boundary between seismic Zones 1 and 2 (appendix figure A.1-1). Since the New Madrid earthquakes of 1811 to 1812, at least 26 other earthquakes with a modified Mercalli intensity of III to VI have been felt in the Oak Ridge area. Most of these seismic events have occurred in the Valley and Ridge province. The nearest seismic event occurred in 1930, 8 km (5 mi) from ORR. It had a modified Mercalli intensity of V at the site (OR EG&G 1991a: 3-4). The magnitude of the largest recorded earthquake in eastern Tennessee was 4.6 on the Richter scale. This earthquake occurred in 1973 in Maryville, TN, 34 km (21 mi) southeast of ORR, and had an estimated modified Mercalli intensity of V to VI in the Oak Ridge area (DOE 1996h:4.55). There is no volcanic hazard at ORR. The area has not experienced volcanism within the last 230 million years. Therefore, future volcanism is not expected (DOE 1995i:4-200).

Soils. Bear Creek Valley lies on well to moderately well-drained soils underlain by shale, siltstone, and sandstone. Developed portions of the valley are designated as urban land. Soil erosion from past land uses has ranged from slight to severe. Erosion potential is very high in those areas with slopes greater than 25 percent that have been severely eroded in the past. Erosion potential is lowest in nearly flat-lying permeable soils that have a loamy texture (ORNL 1988b:69). Additionally, wind erosion is slight, shrink-swell potential is low to moderate, and the soils are acceptable for standard construction techniques. There are no prime farmlands on ORR (DOE 1995i:4-188).

4.2.2.6 *Biotic Resources*

The following section describes biotic resources at ORR including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. A list of the threatened and endangered species that may be found on or in the vicinity of ORR is presented in appendix C.

Terrestrial Resources. Plant communities at ORR are characteristic of the intermountain regions of central and southern Appalachia. Approximately 10 percent of ORR has been developed since it was withdrawn from public access; the remainder of the site has reverted to or been planted with natural vegetation (OR DOE 1989a:3-5). The vegetation of ORR has been categorized into seven plant communities (figure 4.2.2.6-1). Pine and pine-hardwood forest and oak-hickory forest are the most extensive plant communities on ORR, while northern hardwood forest and hemlock-white pine-hardwood forest are the least common forest community types. Nine-hundred eighty-three species, subspecies, and varieties of plants have been identified on ORR (OR NERP 1993b:2).

Animal species found on ORR include 26 species of amphibians, 33 species of reptiles, 169 species of birds, and 39 species of mammals (OR NERP nda:10-17). Animals commonly found on ORR include the American toad (*Bufo americanus*), eastern garter snake (*Thamnophis sirtalis*), Carolina chickadee (*Parus carolinensis*), northern cardinal (*Cardinalis cardinalis*), white-footed mouse (*Peromyscus leucopus*), and raccoon (*Procyon lotor*). Although the whitetail deer (*Odocoileus virginianus*) is the only species hunted onsite (OR DOE 1991c:4-6), other game animals are also present. Raptors, such as the northern harrier (*Circus cyaneus*) and great horned owl (*Bubo virginianus*), and carnivores, such as the gray fox (*Urocyon cinereoargenteus*) and mink (*Mustela vison*), are ecologically important groups on ORR. A variety of migratory birds has been found at ORR. Migrating birds present onsite, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act* .

Terrestrial habitat within the Y-12 area is dominated by buildings, parking lots, and lawns; thus, little natural vegetation is present. A few small forested areas do exist within the plant boundary along the slope of Chestnut Ridge. Fauna within the Y-12 area are limited by the lack of large areas of natural habitat (OR DOE 1994d:5-13).

Wetlands. Wetlands on ORR include emergent, scrub/shrub, forested wetlands associated with embayments of the Melton Hill and Watts Bar Reservoirs, riparian areas bordering major streams and their tributaries, old farm ponds, and groundwater seeps. Well-developed communities of emergent wetland plants in the shallow embayments of the two reservoirs typically intergrade into forested wetland plant communities, which extend upstream through riparian areas associated with streams and their tributaries. Old farm ponds on ORR vary in size and support diverse plant communities and fauna. Although most riparian wetlands on ORR are forested, areas within utility rights-of-way, such as those in Bear Creek and Melton Valleys, support emergent wetland vegetation (OR NERP 1991a:18,26,41). Two small wetland areas are located near the west end of Y-12 (OR DOE 1994d:5-14). Y-12 is drained by Bear Creek and East Fork Poplar Creek; wetlands occur along portions of both streams.

Aquatic Resources. Aquatic habitat on or adjacent to ORR ranges from small, free-flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction. These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small perennial streams. Aquatic areas within ORR also include seasonal and intermittent streams.

Sixty-four fish species have been collected on or adjacent to ORR. The minnow family has the largest number of species and is numerically dominant in most streams (ORNL 1988c:O-43). Fish species representative of the Clinch River in the vicinity of ORR are shad and herring (*Clupeidae*), common carp (*Cyprinus carpio*), catfish (*Ictaluridae*), bluegill (*Lepomis macrochirus*), crappie (*Pomoxis spp* .), and drum (*Aplodinotus grunniens*) (ORNL 1981b:138-139). The most important fish species taken commercially in the ORR area are common carp and catfish. Commercial fishing is permitted on the Clinch River downstream from Melton Hill Dam (TN WRA 1995a:1-5). Recreational species consist of crappie, largemouth bass (*Micropterus salmoides*), sauger (*Stizostedion canadense*), sunfish (*Lepomis spp* .), and catfish. Sport fishing is not permitted within ORR.

Y-12 is drained by Bear Creek and East Fork Poplar Creek. While both streams contain adequate physical habitat to maintain and propagate aquatic life throughout their length, species abundance and diversity within both streams have been affected by past Y-12 operation (OR DOE 1994d:5-13).

Threatened and Endangered Species. Eighty-four Federal- and state-listed threatened, endangered, and other special status species may be found on and in the vicinity of ORR (appendix table C-1). Twenty-six of these species have been identified on the site, 17 of which are Federal- and/or state-listed as threatened or endangered. The bald eagle (*Haliaeetus leucocephalus*) is the only Federal-listed species observed on the site (i.e., foraging on Melton Hill and Watts Bar Lakes). The additional state-listed species observed include 14 plant, 1 hawk, and 1 salamander species. No critical habitat for threatened or endangered species, as defined in the Endangered Species Act (50 CFR 17.11; 50 CFR 17.12), exists on ORR.

Y-12 does not contain any special status species (OR DOE 1994d:5-14). However, Bear Creek, which drains the western portion of the plant area, contains the Tennessee dace (*Phoxinus tennesseensis*).

4.2.2.7 *Cultural and Paleontological Resources*

Prehistoric Resources. More than 20 cultural resources surveys have been conducted on ORR. About 90 percent of ORR has received at least reconnaissance-level studies; however, less than 5 percent of ORR has been intensively surveyed. Most cultural resources studies have occurred along the Clinch River and adjacent tributaries. Prehistoric sites recorded at ORR include villages, burial mounds, camps, quarries, chipping stations, limited activity locations, and shell scatters. To date, over 45 prehistoric sites have been recorded at ORR, 13 of which may be considered potentially eligible for the NRHP. Most of these sites however have not yet been evaluated.

One site (40RE86), which is located on the Clinch River near K-25, has been determined to be eligible for inclusion on the NRHP. No NRHP-eligible prehistoric sites have been identified at Y-12. One site (40AN6), a lithic scatter, was identified near Scarboro Road east of Y-12, outside the fences. A field review of Y-12 indicated that much of the area had been disturbed and that the potential for NRHP-eligible prehistoric sites was low. Additional prehistoric sites may be identified in the unsurveyed portions of ORR. On May 6, 1994, a Programmatic Agreement concerning the management of historical and cultural properties at ORR was executed among the Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation. This agreement was administered to satisfy DOE's responsibilities regarding sections 106 and 110 of the National Historic Preservation Act, and requires DOE to develop a cultural resources management plan for ORR and to conduct cultural resources surveys as required.

Historic Resources. Historic resources identified at ORR include both archaeological remains and standing structures. Documented log, wood frame, or fieldstone structures include cabins, barns, churches, gravehouses, springhouses, storage sheds, smokehouses, log cribs, privies, henhouses, and garages. Archaeological remains consist primarily of foundations, roads, and trash scatters. Sixty-nine pre-1942 cemeteries were located within the original ORR site (OR Robinson 1950a:130). Because the size of the reservation has been reduced, today there are 32 known cemeteries within ORR. More than 240 historic resources have been recorded at ORR, and 38 of those sites may be considered potentially NRHP eligible.

All structures at ORR have been surveyed for historic significance, and all pre-World War II structures have been evaluated for NRHP eligibility. Freel's Cabin and two church structures, George Jones Memorial Baptist Church and the New Bethel Baptist Church, are listed on the NRHP. These structures date from before the establishment of the Manhattan Project. NRHP sites associated with the Manhattan Project include the Graphite Reactor at ORNL, listed on the NRHP as a National Historic Landmark, and three traffic checkpoints, Bear Creek Road, Bethel Valley Road, and Oak Ridge Turnpike Checking stations. None of these sites is located at Y-12. Many other buildings and facilities at ORR are associated with the Manhattan Project and may be potentially eligible for the NRHP.

Historic building surveys were completed during fiscal year 1994 at K-25 and ORNL. A similar survey was completed at Y-12 in fiscal year 1995. The final document should be finished in fiscal year 1996. Based on this survey, approximately 100 buildings at Y-12 may be NRHP eligible. The secondary and case fabrication alternative involves modifications to 17 buildings at Y-12 (appendix section A-3.2.1). Through consultation with the Tennessee SHPO, Buildings 9215, 9401-3, 9706-2, 9996, 9998, and 9212 have been determined NRHP eligible as contributing properties to the proposed Y-12 Plant National Register Historic District. In addition, Building 9710-2 has been determined to be NRHP eligible. The remaining buildings involved do not possess architectural or historical significance to meet National Register Criteria and therefore are not considered to be contributing properties to the proposed historic district. Additional historic sites may be anticipated in the unsurveyed portions of ORR.

Native American Resources. The Overhill Cherokee occupied portions of the Tennessee, Hiwassee, Clinch, and Little Tennessee River Valleys by the 1700s. Overhill Cherokee villages consisted of a large townhouse, a summer pavilion, and a plaza. Residences had both summer and winter structures. Subsistence was based on hunting, gathering, and horticulture. Most of the Cherokee people were relocated to the Oklahoma territory in 1838; some Cherokee later returned to the area from Oklahoma. Resources that may be sensitive to Native American groups include remains of prehistoric and historic villages, ceremonial lodges, cemeteries, burials, and traditional plant gathering areas. No Native American resources have been identified at Y-12. The Eastern Band of the Cherokee has been consulted concerning activities at ORR.

Paleontological Resources. The majority of geological units with surface exposures at ORR contain paleontological materials. All paleontological materials consist of invertebrate remains, and these assemblages have relatively low research potential (NRC 1987c:122).

4.2.2.8 *Socioeconomics*

Socioeconomic characteristics addressed at ORR include employment and regional economy, population and housing, and public finance. Statistics for employment and regional economy are presented for the regional economic area that encompasses 15 counties in Tennessee around ORR. Statistics for population and housing, and public finance are presented for the ROI, a four-county area in which 91.3 percent of all ORR employees reside: Anderson County (33.1 percent), Knox County (36 percent), Loudon County (5.6 percent), and Roane County (16.6 percent) (appendix table D.1-1). Figure 4.2.2.8-1 presents a map of the counties and selected cities composing the ORR regional economic area and ROI. Supporting data is presented in appendix D.

Regional Economy Characteristics. Selected employment and regional economy statistics for the ORR regional economic area are summarized in figure 4.2.2.8-2. Between 1980 and 1990, the civilian labor force in the regional economic area increased from 355,353 to 412,803 persons, a 16-percent increase (an annual average increase of 1.6 percent). In 1994, unemployment in the regional economic area was 4.9 percent, about the same as for Tennessee (4.8 percent). The region's per capita income of $17,652 in 1993 was approximately 4.3 percent less than the statewide per capita income of $18,439.

As shown in figure 4.2.2.8-2, the composition of the regional economic area economy parallels that of the statewide economy of Tennessee. During 1993, the service sector constituted over 26 percent of the region's total employment, followed by retail trade (19 percent) and manufacturing (18 percent). For the entire state, the service sector comprised 26 percent of total employment, manufacturing comprised 19 percent, and retail trade, 17 percent.

Population and Housing. Between 1980 and 1992, the ROI population increased from 464,018 to 499,444. This was an increase of about 7.6 percent (an annual average increase of less than 1 percent). Within the ROI, Loudon County experienced the greatest population increase at 16.4 percent (an annual average increase of a little over 0.7 percent), while Roane County's population decreased by about 0.7 percent (much less than 1 percent annually).

Between 1980 and 1990, the total number of housing units in the ROI increased from 181,299 to 206,067. The 13.8-percent increase (1.4-percent annual average increase) in housing units between 1980 and 1990 was slightly less than the annual average increase for the entire state. The total number of housing units in the ROI for 1992 was estimated to be 213,500. The 1990 ROI homeowner and rental vacancy rates were 1.7 and 8.5 percent, respectively. These rates were comparable to the statewide rates. Population and housing trends are summarized in figure 4.2.2.8-3 p.2.

Public Finance. Financial characteristics of the local jurisdictions in the ORR ROI that are most likely to be affected by the proposed action are presented in this section. The data reflect total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. Funding for schools in the ROI is provided by the county or city in which they are located. Major revenue and expenditure fund categories for counties and cities are presented in appendix table D.2.3-1. Figure 4.2.2.8-2 summarizes 1994 local governments' revenues and expenditures. Fund balances, which are dollars carried over from previous years, are not included in figure 4.2.2.8-2. All jurisdictions assessed had positive fund balances.

4.2.2.9 *Radiation and Hazardous Chemical Environment*

The following section provides a description of the radiation and hazardous chemical environment at ORR. Also included are discussions of health effects studies, a brief accident history, and emergency preparedness considerations.

Radiation Environment. Major sources of background radiation exposure to individuals in the vicinity of ORR are shown in table 4.2.2.9-1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to ORR operations.

Radionuclides released into the environment from ORR operations provide another source of radiation exposure to individuals in the vicinity of ORR. The radionuclides and quantities released from operations in 1993 are listed in the Oak Ridge Reservation Environmental Report for 1993 (ES/ESH-47). The doses to the public resulting from these releases and direct radiation are presented in table 4.2.2.9-2. These doses fall within radiological limits (DOE Order 5400.5, Radiation Protection of the Public and the Environment) and are small in comparison to background radiation. The releases listed in the 1993 report were used in developing the reference environment (No Action) radiological releases at ORR in 2005 (section 4.2.3.9).

Based on a dose-to-risk conversion factor of 500 cancer deaths per 1 million person-rem ($5x10^{-4}$ fatal cancer per person-rem) to the public (appendix E), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from ORR operations in 1993 is estimated to be approximately $1.5x10^{-6}$. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of ORR operations is less than 2 chances in 1 million. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Based on the same conversion factor, 0.014 excess fatal cancers are projected in the population living within 80 km (50 mi) of ORR from normal operation in 1993. To place this number in perspective, it can be compared with the numbers of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers from all causes expected to occur during 1993 was 1,760 for the population living within 80 km (50 mi) of ORR. This number of expected fatal cancers is much higher than the estimated 0.014 fatal cancers that could result from ORR operations in 1993. Workers at ORR receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.2.2.9-3 presents the average, maximum, and total occupational doses to ORR workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a dose-to-risk conversion factor of 400 fatal cancers per 1 million person-rem ($4x10^{-4}$ fatal cancers per person-rem) among workers (appendix E), the number of excess fatal cancers to workers from operations in 1992 is estimated to be 0.027. A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Oak Ridge Reservation Annual Site Environmental Report for 1993* (ES/ESH-47). The concentrations of radioactivity in various environmental media (e.g., air, water, and soil) in the site region (onsite and offsite) are also presented in the same report.

Table 4.2.2.9-1.-- ***Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Oak Ridge Reservation Operations***

Source	Committed Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic and cosmogenic radiation [13]	27
External terrestrial radiation [13]	28
Internal terrestrial radiation [14]	40
Radon in homes (inhaled) [14]	200
Other Background Radiation [14]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	360

Table 4.2.2.9-2.-- ***Doses to the General Public from Normal Operation at Oak Ridge Reservation, 1993 (Committed Effective Dose Equivalent)***

	Atmospheric Releases		Liquid Releases		Total	
Affected Environment	**Standard**[15]	**Actual**	**Standarda**	**Actual**	**Standard**[15]	**Actual**
Maximally exposed individual (mrem)	10	1.4	4	0.6[16]	100	3.0[17]
Population within 80 kilometers[18] (person-rem)	None	26	None	2.0	100	28.0
Average individual within 80 kilometers[19] (mrem)	None	0.030	None	2.3x10 -*3*	None	0.032

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are presented in previous sections of this PEIS, particularly sections 4.2.2.3 and 4.2.2.4.

Adverse health impacts to the public can be minimized through administrative and design controls to decrease hazardous chemical releases to the environment and achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements). The effectiveness of these controls is verified by using monitoring information and inspecting mitigation measures. Health impacts to the public may occur during normal operation via inhalation of air containing hazardous chemicals released to the atmosphere by ORR operations. Risks to public health from ingesting contaminated drinking water or direct exposure are also potential pathways.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in section 4.2.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are compared with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in appendix E.

Exposure pathways to ORR workers during normal operation may include inhaling the workplace atmosphere, drinking ORR potable water, and other possible contacts with hazardous materials associated with work assignments. The potential health impacts vary from facility to facility and from worker to worker, and there is not enough information available to allow a meaningful estimation and summation of these impacts. However, workers are protected from workplace-specific hazards through appropriate training, protective equipment, monitoring, and management controls. Workers are also protected by ORR's adherence to OSHA and EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals in the workplace. Appropriate monitoring, which reflects the frequency and amounts of chemicals used in the operation processes, ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm; therefore, workers' health conditions at ORR are expected to be substantially better than required by the standards.

Table 4.2.2.9-3.-- ***Doses to the Onsite Worker from Normal Operation at Oak Ridge Reservation, 1992***

	Onsite Releases and Direct Radiation	
Affected Environment	**Standard**[20]	**Actual** [21]
Average worker (mrem)	None	4.0

Maximally exposed worker (mrem)	5,000	2,000
Total workers (person-rem)	None	68

Health Effects Studies. Two epidemiologic studies were conducted to determine whether or not ORR contributed to any excess cancers in the communities surrounding the facility. One study found no excess cancer mortality in the population living in counties surrounding ORR when compared to the control populations located in other nearby counties and elsewhere in the United States. The other study found a slight increase in several types of cancers in the counties near ORR, but none of the increases were statistically significant.

More epidemiologic studies have been conducted to assess the health effects of the population working at ORR than at any other site reviewed for this PEIS. Increased cancer mortalities have been reported and linked to specific job categories, age, and length of employment, as well as the levels of radiation exposure. For a more detailed description of the studies reviewed and the findings, refer to appendix section E.4.

Accident History. There have been no accidents with a measurable impact on the offsite population during nearly 50 years of Y-12 operation at ORR. The most noteworthy accident in Y-12 history was the 1958 criticality accident. The impact from this accident resulted in radiation sickness for a few ORR employees. In 1989, there was a one-time accidental release of xylene into ORR's sewer system with no adverse offsite impacts. Accidental releases of anhydrous hydrogen fluoride occurred in 1986, 1988, and 1992, with few onsite and negligible offsite impacts. The hydrogen fluoride system where these accidents occurred is being modified to reduce the probability of future releases and to minimize the potential consequences if a release does occur (ORR 1992a:6).

Emergency Preparedness. Each DOE site has established an emergency management program. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

DOE has overall responsibility for emergency planning and operations at ORR; however, DOE has delegated primary authority for event response to the operating contractor. Although the contractor's primary response is onsite, it does provide offsite assistance, if requested, under the terms of existing mutual aid agreements. If a hazardous materials event with offsite impacts occurs at a DOE ORR facility, elected officials and local governments are responsible for the state's response efforts. The Governor's Executive Order No. 4 established the Tennessee Emergency Management Agency as the agency responsible for coordinating state emergency services. When a hazardous materials event occurring at DOE facilities is beyond the capability of local government and assistance is requested, the Tennessee Emergency Management Agency Director may direct state agencies to provide assistance to the local governments. To accomplish this task and ensure prompt initiation of emergency response actions, the director may activate the State Emergency Operations Center and

Field Coordination Center. City or county officials may activate local emergency operations centers in accordance with existing emergency plans.

4.2.2.10 *Waste Management*

This section outlines the major environmental regulatory structure and ongoing waste management activities for ORR. A more detailed discussion of the ongoing waste management operations is provided in appendix section H.2.1.

DOE is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR and is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed upon milestones. These agreements have been reviewed to assure the proposed actions are allowable under the terms of these agreements.

EPA placed ORR on the National Priorities List (NPL) on November 21, 1989. DOE, EPA Region IV, and the Tennessee Department of Environment and Conservation completed a Federal Facility Agreement effective January 1, 1992, coordinating ORR inactive site assessment and remedial action. Portions of the Federal Facility Agreement are applicable to operating waste management systems. Existing actions being conducted under the *Resource Conservation and Recovery Act (RCRA)* and applicable state laws minimize duplication, expedite response actions, and achieve a comprehensive remediation of the site.

ORR manages a small quantity of spent nuclear fuel and five broad waste categories: TRU, low-level, mixed, hazardous, and nonhazardous. Because there is no spent nuclear fuel or TRU waste associated with any of the proposed activities at ORR, there is no discussion in this PEIS of spent nuclear fuel or TRU waste generation and management at ORR.

Low-Level Waste. LLW generated at Y-12 and K-25 is primarily contaminated with uranium; whereas, at ORNL, LLW consists primarily of mixed fission products. During 1993, Y-12, ORNL, and K-25 generated approximately 1,030 m^3 (272,000 gallon [gal]), 1,540 m^3 (407,000 gal), and 6 m^3 (1,540 gal) of liquid LLW, respectively (OR MMES 1995c:5-12). At Y-12, the Central Pollution Control Facility treats and discharges nonnitrate dilute wastewater, acidic and caustic waste, and plating rinse waters. This facility can also perform pretreatment of nitrate bearing waste streams. The West End Treatment Facility processes nitrate bearing wastewater consisting of nitric acid, nitrate bearing rinse waters, waste coolants, and bio-nitrification sludge. At ORNL, liquid LLW is collected in storage tanks and routed through underground transfer lines to central evaporators for concentration. The concentrate is sent to the Milton Valley storage tanks for storage and the condensate is sent to the Process Waste Treatment Plant for further treatment prior to further management actions.

During 1993, Y-12, ORNL, and K-25 generated approximately 2,400 m^3 (3,130 cubic yards [yd3]), 1,720 m^3 (2,250 yd3), and 1,540 m^3 (2,030 yd3) of solid LLW, respectively (OR MMES 1995c:5-12). Solid LLW consists primarily of radioactively contaminated construction debris, wood, paper, asbestos, trapping media, personal protection equipment, and process equipment. In addition, Y-12, ORNL, and K-25 also generated 2,335 m^3, 0.3 m^3, and 42 m^3 of contaminated scrap metal, respectively. Depleted and natural uranium machine chips, after oxidation to a stable uranium oxide, are transported to the depleted uranium oxide storage vaults. Uranium sawfines are blended with uranium oxide and placed in the oxide vaults as a short-term storage method. The only LLW disposal facility on ORR is located at ORNL; however, it only accepts LLW generated at ORNL. The declining disposal capacity has created a significant increase in storage requirements. Currently, LLW is shipped to commercial treatment facilities for volume reduction (incineration or supercompaction) or recycle (metal smelting). The resulting residuals are returned to K-25 for storage and shipment to a disposal site.

The management of LLW at ORR has been affected by three recent events: declines in ORR disposal capacity, changes in regulatory and operational conditions, and evolution of the radioactive waste disposal-class concept. The previous strategy classified LLW according to its isotopic content, concentration, and the performance of a disposal facility. In some instances, these classifications are used to describe the type of LLW or a disposal technology. For example, L-I refers to low concentration LLW or a landfill disposal facility, while L-II refers to low-to-moderate concentration LLW or a tumulus disposal facility. A revised classification system has been proposed. Exempt LLW would have contaminant levels sufficiently low to be disposed of in a sanitary or industrial landfill with state concurrence. Disposable LLW would be suitable for disposal at ORR as determined by facility performance assessments. Offsite LLW would be waste which would not meet the criteria of exempt or disposable. The long-range strategy is to rely on the combination of onsite and offsite facilities. Plans for a replacement onsite disposal facility will continue to be pursued with the most likely candidate site for a tumulus disposal facility being Bear Creek Valley. That portion of the LLW that cannot be disposed of onsite consistent with DOE Order 5820.2A, Radioactive Waste Management, will be stored until disposal offsite becomes available.

Mixed Low-Level Waste . RCRA mixed, radioactive land disposal-restricted waste is in storage at Y-12, ORNL, and K-25. Because prolonged storage of these wastes exceeded the 1-year limit imposed by RCRA, ORR entered into a Federal Facility Compliance Agreement for RCRA land disposal restriction wastes with EPA on June 12, 1992. The Federal Facility Compliance Agreement recognizes that DOE will continue to generate and store such mixed wastes subject to land disposal restrictions. A Tennessee Department of Environment and Commissioner's Order was issued on September 26, 1995, that requires DOE to comply with the site treatment plan that was developed pursuant to the Federal Facility Compliance Act of 1992. The plan contains milestones and target dates for DOE to characterize and treat its inventory of mixed wastes.

In 1993, Y-12, ORNL, and K-25 generated 334,016 kilograms (kg) (736,372 pounds [lb]), 176,925 kg (390,049 lb), and 928,948 kg (2,047,959 lb) of mixed LLW, respectively (OR MMES 1995c:7-7). Liquid mixed wastes at Y-12 consist primarily of nonnitrate bearing wastewaters, contaminated groundwaters, nitrate-bearing wastes, cyanide wastes, contaminated waste oils, acidic wastes, caustic wastes, and contaminated solvents. Solid wastes include both RCRA- and TSCA-mixed wastes. The

Central Pollution Control Facility and Plating Rinsewater Treatment Facility treat the nonnitrate bearing wastewaters; whereas, the West End Treatment Facility treats nitrate bearing wastes. Other treatment facilities include the Groundwater Treatment Facility, Waste Coolant Processing Facility, Cyanide Treatment Unit, Uranium Treatment Unit, and Biodenitrification Unit.

Mixed waste at K-25 includes liquids, sludges, and soil contaminated with hazardous and PCB constituents (including waste, oils, spent solvents, paints, and cyanide- or sulfide-bearing reactive wastes), and corrosive and toxic wastes from laboratory processes. Treatment facilities at K-25 include the Central Neutralization Facility and the TSCA Incinerator. The primary waste streams treated at the Central Neutralization Facility include the scrubber effluent from the TSCA Incinerator and process wastewaters from the K-1501 Steam Plant. The K-25 TSCA incinerator has a design capacity to incinerate 907 kg/hour (hr) (2,000 lb/hr) of mixed liquid waste and up to 454 kg/hr (1,000 lb/hr) of solids and sludge (91 kg/hr [200 lb/hr] maximum sludge content). The TSCA incinerator is capable of incinerating both TSCA- and RCRA-mixed waste. DOE guidance currently does not allow incineration of solids or sludges. Because of permit limits (i.e., TSCA, RCRA, and the State of Tennessee), the incinerator is not running at full capacity. In 1993, approximately 2,309 m *3* (610,000 gal) of mixed liquid waste was incinerated (OR MMES 1995c:7-9).

ORNL has no facilities specifically designed for the treatment of mixed wastes. Generators currently neutralize many corrosives before discharge to process drains. Organic mixed wastes are scheduled to be treated at the TSCA Incinerator.

Uranium-contaminated PCB wastes (mixed wastes) are being stored in excess of the 1-year limit imposed by TSCA because of the lack of treatment and disposal capacities. DOE and EPA have signed a Federal Facility Compliance Agreement, effective February 20, 1992, to bring the K-25 site associated with the Uranium Enrichment Program into compliance with TSCA regulations for use, storage, and disposal of PCBs. It also addressed the approximately 10,000 pieces of nonradioactive PCB-containing dielectric equipment associated with the shutdown of diffusion plant operations. An additional Federal Facility Compliance Agreement related to TSCA compliance is currently being discussed by DOE and EPA for ORR.

Hazardous Waste. RCRA-regulated wastes are generated by ORR in laboratory research, electroplating operations, painting operations, descaling, demineralizer regeneration, and photographic processes. Certain other wastes (e.g., spent photographic processing solutions) are processed onsite into a nonhazardous state. Those wastes that are safe to transport and are certified as having no radioactivity added are shipped offsite to RCRA-permitted commercial treatment or disposal facilities. Small amounts of reactive chemical explosives that would be dangerous to transport offsite, such as aged picric acid, are processed onsite in the Chemical Detonation Facility at ORNL.

Y-12 generated approximately 9,920 m^3 (13,000 yd3) of hazardous waste in 1993 (OR MMES 1995c:6-4). Of this amount approximately 8,840 m^3 (11,600 yd3) was liquid hazardous waste that was managed as mixed LLW and treated at the Plating Rinsewater Treatment Facility and the Steam Plant Wastewater Treatment Facility. The solid waste was treated offsite. Liquid and solid hazardous waste streams include steam plant wastewaters for treatment, mineral oil contaminated with PCBs, and sludges. All hazardous waste generated at K-25, including all wastes subject to RCRA and TSCA regulations, is managed as mixed LLW.

At ORNL approximately 23,800 m^3 (31,200 yd3) of liquid hazardous waste was generated in 1993. Bulk nonnitrate acids previously neutralized at the Nonradiological Wastewater Treatment Plant are now sent to the Central Neutralization Facility. No treatment is performed for the approximately 354 m^3 (464 yd3) of solid hazardous waste at ORNL (OR MMES 1995c:6-5). Some waste is sent to K-25 for storage or incineration, while the remainder (non-RCRA) is sent to a landfill at Y-12. Hazardous waste at K-25 is managed as mixed waste. Hazardous waste is collected and stored until it can be certified under the "no rad added" policy, at which time it is shipped offsite.

Nonhazardous Waste. Nonhazardous wastes are generated from ORR maintenance and utilities. For example, the steam plant produces a nonhazardous sludge. Scrap metals are discarded from maintenance and renovation activities and are recycled, when appropriate. Construction and demolition projects also produce nonhazardous industrial wastes. All nonradioactive medical wastes are autoclaved to render them noninfectious and are sent to the Y-12 sanitary landfill. Remedial action projects also produce wastes requiring proper management. The State of Tennessee-permitted landfill (Construction Demolition Landfill VI) receives nonhazardous industrial materials such as fly ash and construction debris. Asbestos and general refuse are managed in the Industrial and Sanitary Landfill V located at Y-12.

Approximately 52,800 m^3 (69,100 yd3) of solid industrial and sanitary wastes were generated on ORR in 1993 (OR MMES 1995c:8-4). Y-12 is the single largest generator of this waste category with 43,900 m^3 (57,600 yd3). ORNL and K-25 generated approximately 11 and 6 percent, respectively, of the total nonhazardous waste.

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1 Federal standard.

2 Value is maximum for 24-hour period.

3 No monitoring data available, baseline concentration assumed less than applicable standard.

4 State standard.

5 Annual average. *f* No standard. 40 CFR 50; OR DOE 1993a; TN DEC 1994a; TN DHE 1991a.

6 For comparison only.

7 National Primary Drinking Water Regulations (40 CFR 141).

8 Proposed National Primary Drinking Water Regulations, Radionuclides (56 FR 33050).

9 DOE Derived Concentration Guides for water (DOE Order 5400.5). Values are based on a committed effective dose equivalent of 100 millirems (mrem) per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guides.

10 Minimum of uranium isotopes.

11 A tilde (~) indicates that estimated values and/or detection limits were used in the calculation.

12 National Secondary Drinking Water Regulations (40 CFR 143).
NA - not applicable; NST - no sample taken; parentheses () indicate standard error of the mean.
OR DOE 1994f.

13 OR DOE 1994c.

14 NCRP 1987a. Value for radon is an average for the United States.

15 The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem per year limit from airborne emissions is required by the CAA, the 4 mrem per year limit is required by the *SDWA* , and the total dose of 100 mrem per year is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268).

16 Includes a dose of 0.20 mrem from drinking water.

17 Includes an annual direct radiation dose of 1 mrem to an individual at Poplar Creek or the Clinch River shoreline.

18 In 1993, this population was approximately 880,000.

19 Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.
OR DOE 1994c..

20 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

21 DOE 1993n:7. The number of badged workers in 1992 was approximately 17,000.

4.5 Pantex Plant

Pantex was established in 1951 and currently occupies approximately 4,119 ha (10,177 acres) of DOE-owned land near Amarillo, TX. The current DP mission at Pantex is to assemble and disassemble nuclear weapons; perform HE manufacturing; perform weapons repair, modification, and disposal; conduct stockpile evaluation and testing; and provide interim storage for plutonium. Section 3.2.5 provides a description of all the DOE missions and support facilities at Pantex. The location of Pantex is illustrated in figure 4.5-1, and the principal facilities and zones at Pantex are shown in figure 4.5-2.

4.5.1 Description of Alternatives

No Action. Pantex would continue to perform the missions described in section 3.2.5.

Stockpile Management Alternatives. The A/D and the high explosives (HE) fabrication missions could be downsized and consolidated and remain at Pantex. If the A/D mission remains at Pantex, the nonintrusive modification pit reuse mission and the option of storing the strategic reserve of pits could be located there. In addition, if Y-12 does not retain the secondary and case fabrication mission, the storage of the strategic reserve of secondaries could be located at Pantex.

The HE fabrication mission could be phased out at Pantex and transferred to either LANL, LLNL, or both. In the event that the HE fabrication mission was transferred, those facilities associated with this mission would be phased out and Pantex downsized to accommodate just the A/D mission. The nonintrusive modification pit reuse and strategic storage options would also be located at Pantex.

The A/D mission could either stay at Pantex without the HE fabrication mission or it could be phased out at Pantex and transferred to NTS. If the A/D mission was also transferred, then all of the DP missions at Pantex would be phased out and the entire plant could be turned over to EM for disposition.

Stockpile Stewardship Alternatives. There are no stockpile stewardship alternatives that include Pantex.

4.5.2 Affected Environment

4.5.2.1 *Land Resources*

Pantex is located within Carson County in the Panhandle region of Texas, 27 km (17 mi) east-northeast of downtown Amarillo. Pantex covers 6,466 ha (15,978 acres) of land, of which 4,119 ha (10,177 acres) are owned by the Federal Government, and 2,347 ha (5,800 acres) immediately south of the main plant area are leased from Texas Tech for use as a safety and security buffer zone. DOE-owned land at the plant facility includes 3,683 ha (9,100 acres) in the main plant area and 436 ha

(1,077 acres) around Pantex Lake, 4 km (2.5 mi) northeast of the main plant area. The undeveloped land at Pantex Lake is held by DOE to retain water rights. All owned and leased buildings on the Pantex site are administered, managed, and controlled by DOE. Generalized land uses at Pantex and in the vicinity are shown in figure 4.5.2.1-1.

Industrial operations at Pantex are currently located on approximately 809 ha (2,000 acres) of DOE-owned property, excluding the Burning Ground, firing sites, and other outlying areas. The Burning Ground and firing sites occupy approximately 198 ha (489 acres).

Texas Tech Agriculture Research operations use DOE-leased land that is not actively used by Pantex operations for agricultural use. Agricultural activities generally consist of dry farming and livestock grazing. A limited amount of crop irrigation occurs. Except for the playas, the Natural Resources Conservation Service (formerly the Soil Conservation Service) considers these lands prime farmland when irrigated. Texas Tech land also contains four dwelling units located approximately 5 km (3 mi) southwest of the weapons A/D and HE production core.

The land surrounding Pantex is rural private property. The closest offsite residences are approximately 31 m (102 ft) west of the plant boundary along Farm-to-Market Road 683. Most of the surrounding land is prime farmland when irrigated, with the exception of the area northwest of the plant site, which is rangeland. The majority of the surrounding land is cultivated. The packing plant of Iowa Beef Packers, Inc., is the only industrial facility within 3 km (2 mi) of the plant.

Four low-altitude Federal airways used by the Amarillo International Airport for aircraft landings and takeoffs cross or come near Pantex. The runway is located approximately 11 km (7 mi) southwest of the site boundary.

It is anticipated that future residential development in the area will occur toward the southwest, away from the plant. The East Planning Area of the city, which extends to within 3.2 km (2 mi) of the plant site, has historically been one of the slower growing residential areas. Because of the presence of the airport, an important industrial use in this area, the Amarillo Comprehensive Plan encourages compatible use rather than residential use. The largest residential area, located approximately 8 km (5 mi) southwest of the plant boundary, is the site of the former Amarillo Air Force Base housing, which has been converted to rental housing.

Table 4.5.2.2-1.-- ***Baseline Characteristics for Pantex Plant***

Characteristics	Current Value
Land	
Area (ha)	4,119
Roads (km)	76

Railroads (km)	27
Electrical	
Energy consumption[1] (MWh/yr)	84,420
Peak load (MWe)[2]	13.6
Fuel	
Natural gas[3] (m^3/yr)	14,600,000
Liquid (L/yr)	1,775,720
Coal (t/yr)	0
Steam[4]	
Generation (kg/hr)	59,524

4.5.2.2 *Site Infrastructure*

Section 3.2.5 describes the current missions at Pantex. To support these missions, infrastructure exists as shown in table 4.5.2.2-1.

4.5.2.3 *Air Quality*

This section describes existing air quality including a review of the meteorology and climatology in the vicinity of Pantex. More detailed discussions of the air quality methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.3.5.

Meteorology and Climatology. The climate at Pantex and in the surrounding region is characterized as semi-arid with hot summers and relatively cold winters. The average annual temperature in the Amarillo region is 13.8 °C (56.9 °F); average daily temperatures vary from a mean daily minimum of -5.7 °C (21.8 °F) in January to a mean daily maximum of 32.8 °C (91.1 °F) in July. The annual average precipitation is approximately 49.7 cm (19.6 in). Prevailing wind directions at Pantex are from the south to southwest. The annual average wind speed is 6.0 m/s (13.5 mph) (NOAA 1994c:3).

Ambient Air Quality. Pantex is located within the Amarillo-Lubbock Intrastate AQCR 211, which is currently designated as "attainment" or "unclassified" by EPA (40 CFR 81.344) with respect to the NAAQS for criteria pollutants (40 CFR 50). Appendix table B.3.1-1 lists the NAAQS for these criteria pollutants. These standards have been adopted by the State of Texas (TX ACB 1993a). There are no Prevention of Significant Deterioration (40 CFR 52.21) Class I areas within 100 km (62.1 mi) of Pantex.

The primary emission sources of criteria pollutants at Pantex are the steam plant boilers, the explosives burning operation, and diesel and gasoline engines. Potential emission sources of hazardous/toxic air pollutants include the HE Synthesis Facility, the explosives burning operation, miscellaneous laboratories, and other small operations. With the exception of open burning of HE at the Burning Ground, most stationary points of nonradioactive atmospheric releases are from fume hoods and building exhaust systems with HEPA filters.

Table 4.5.2.3-1 presents the baseline ambient air concentrations for criteria pollutants and other pollutants of concern at Pantex. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Table 4.5.2.3-1.-- ***Comparison of Baseline Ambient Air Concentrations wiTD Most Stringent Applicable Regulations and Guidelines at Pantex Plant, 1993***

Pollutant	Averaging Time	Most Stringent Regulation or Guideline (g/m^3)	Baseline Concentration (g/m^3)
Criteria Pollutant			
Carbon monoxide	8-hour	10,000[5]	161
	1-hour	40,000[5]	924
Lead	Calendar quarter	1.5[5]	0.01
Nitrogen dioxide	Annual	100[5]	0.90
Ozone	1-hour	235[5]	[6]
Particulate matter	Annual	50[5]	8.73
	24-hour	150[5]	88.5
Sulfur dioxide	Annual	80[5]	<0.01
	24-hour	365[5]	<0.01
	3-hour	1,300[5]	<0.01
	30-minute	1,045[7]	<0.01
Mandated by Texas			
Hydrogen fluoride	30-day	0.8[7]	<0.27
	7-day	1.6[7]	<0.27
	12-hour	2.9[7]	0.27
	24-hour	3.7[7]	0.38

	3-hour	4.9[7]	1.52
Hydrogen sulfide	30-minute	111[7]	[6]
Sulfuric acid	24-hour	15[7]	[6]
	1-hour	50[7]	[6]
Total suspended particulates	3-hour	200[7]	[6]
	1-hour	400[7]	[6]
Hazardous and Other Toxic Compounds			
Alcohols	30-minute[8]	100[7]	195
	Annual	[9]	0.70
Benzene	30-minute[8]	30[7]	19.40
	Annual	3[7]	0.05
Carbon disulfide	30-minute[8]	30[7]	22.60
	Annual	3[7]	0.09
Carbon tetrachloride	30-minute[8]	126[7]	19.7
	Annual	13[7]	0.08
Chlorobenzene	30-minute[8]	460[7]	19.5
	Annual	46[7]	0.08
1,1,1-ChloroeTDane	30-minute[8]	500[7]	127
	Annual	50[7]	0.53
Chromium	30-minute[8]	1[7]	0.10
	Annual	0.1[7]	0.002
Cresol	30-minute[8]	5[7]	0.41
	Annual	[9]	0.002
Cresylic acid	30-minute[8]	5[7]	0.51
	Annual	[9]	0.002
Dibenzofuran	30-minute[8]	[9]	0.001

	Annual	[9]	0.00002
Ester glycol eTDers	30-minute[8]	[9]	35.9
	Annual	[9]	0.15
ETDyl benzene	30-minute[8]	2,000[9]	31.1
	Annual	434[7]	0.13
ETDylene dichloride	30-minute[8]	40[7]	9.58
	Annual	4[7]	0.04
Formaldehyde	30-minute[8]	15[7]	0.37
	Annual	1.5[7]	0.004
Hydrogen chloride	30-minute[8]	75[7]	5.98
	Annual	0.1[7]	0.09
Ketones	30-minute[8]	[9]	33.4
	Annual	[9]	0.14
Mercury	30-minute[8]	0.5[7]	0
	Annual	0.05[7]	0
MeTDanol	30-minute[8]	[9]	245
	Annual	[9]	0.58
MeTDyl cyanide	30-minute[8]	[9]	0
	Annual	[9]	0
MeTDyl eTDyl ketone	30-minute[8]	3,900[7]	1,400
	Annual	590[7]	5.10
MeTDyl isobutyl ketone	30-minute[8]	2,050[7]	4.45
	Annual	205[7]	0.02
MeTDylene chloride	30-minute[8]	260[7]	180
	Annual	26[7]	0.74
NaphTDalene	30-minute[8]	440[7]	0.005

	Annual	50[7]	0.0001
2-Nitropropane	30-minute[8]	50[7]	8.55
	Annual	5[7]	0.04
Nitrobenzene	30-minute[8]	24[7]	0.51
	Annual	5[7]	0.002
Phenol	30-minute[8]	154[7]	0.03
	Annual	19[7]	0.0006
Tetrachloroethylene	30-minute[8]	340[7]	17.6
	Annual	34[7]	0.07
Toluene	30-minute[8]	1880[7]	568
	Annual	188[7]	1.73
1,1,2-Trichloroethane	30-minute[8]	550[7]	17.3
	Annual	55[7]	0.08
Trichloroethylene	30-minute[8]	*1350*[7]	51.1
	Annual	135[7]	0.21
Triethylamine	30-minute[8]	40[7]	1.08
	Annual	4[7]	0.002
Xylene	30-minute[8]	3700[7]	145
	Annual	434[7]	0.47

4.5.2.4 *Water Resources*

This section describes the surface and groundwater resources at Pantex.

Surface Water. There are no streams or rivers at Pantex, and all site water requirements are currently met by groundwater. All surface water drains to playas, natural closed depressions that collect runoff to form ephemeral lakes. There are six playas associated with Pantex. Playas 1 through 3 are located on the main site, Playas 4 and 5 are located south and southwest, respectively, of the main site, and Pantex Lake (the sixth playa) is located approximately 4 km (2.5 mi) northeast of the main site (figure 4.5.2.4-1).

Playa 1 receives continuous wastewater discharges from the Pantex Wastewater Treatment Facility. Treated industrial wastewater discharges from buildings, and stormwater runoff are directed to Playas 1, 2, and 4. Playa 3 receives stormwater runoff from the Pantex Burning Ground. Playa 5 has received wastewater from numerous sources other than Pantex. Past Pantex activities included discharge of treated effluents to Pantex Lake. There are also a number of playas adjacent to Pantex that receive drainage from perimeter portions of the site. Playas provide a source of groundwater recharge through infiltration, although the rate of recharge is unknown. A study to determine this infiltration rate is currently being conducted (PX DOE 1996b:4-55).

Because there are no onsite or nearby flowing streams, floodplains exist only in association with the playas. The U.S. Army Corps of Engineers delineated 100- and 500-year floodplains and concluded that the only incidence of flooding would occur at Playa 3. The 500-year flood runoff at Playa 3 would overflow out of the drainage basin creating shallow (less than 30 cm [1 ft]) flooding of the drainage basins for Playas 1 and 2. This limited flooding would not affect the operations of Pantex (PX DOE 1996b:4-57).

Surface Water Quality. Surface water monitoring is conducted at all five playas at the main plant and Pantex Lake as well as at Bushland Playa, an offsite control playa (50 km [30 mi] west of Pantex) used for comparative purposes. Bushland Playa was dry during 1994. With the exception of a June 1994 high water level in Playa 1, due to a rainfall event, the Texas Natural Resources Conservation Commission's annual wastewater inspection in 1993 and 1994 did not note any deficiencies with permit requirements; however, the plant reported 16 excursions of the pH limitation during 1993. A treatment to adjust the effluent pH was installed in September 1993.

Surface Water Rights and Permits. Pantex submitted an NPDES permit application for industrial discharge on November 5, 1990, and a stormwater discharge permit application in October 1991. EPA classified the playa lakes as jurisdictional wetlands and not "waters of the U.S." and therefore did not issue either permit. EPA requested on February 16, 1994, that Pantex resubmit modified NPDES permit applications for industrial discharge to Playas 1, 2, and 4. The application was submitted to EPA on August 26, 1994. A Notice of Intent to discharge stormwaters associated with nonconstruction industrial activities into Playas 1, 2, 3, and 4 via outfalls 007 through 030 was submitted to EPA on September 30, 1994. A stormwater permit was issued by EPA in February 1995. A draft NPDES industrial discharge permit was issued on December 31, 1994. Comments followed the issuance of the permit, and additional information was requested. A revised draft NPDES permit was issued on August 12, 1995; issuance of a final permit is still pending (PX DOE 1996b:4-61).

Treated domestic and industrial wastewater from Pantex is discharged into Playas 1 and 2 under the Texas Natural Resource Conservation Commission Wastewater No-Discharge Permit No. 02296. This permit was issued on May 19, 1980, and renewed and modified on May 3, 1988. This permit allows wastewater disposal by evaporation and onsite irrigation on Texas Tech University farmland. A modified renewal application was submitted on December 26, 1990. This application was protested, and the existing permit expired on May 6, 1993, without renewal. A settlement was reached on November 6, 1995, between Pantex and the local citizens. Issuance of the final permit is still pending. Until a decision is made by the Texas Natural Resource Conservation Commission, the plant continues to operate under the terms and conditions of the expired permit (PX DOE 1996b:4-61).

Water rights in Texas fall under the Doctrine of Prior Appropriations. Under this doctrine, the user who first appropriated water for a beneficial use has priority to use available water supply over a user claiming rights at a later time. Courts also recognize riparian rights legally granted from Spanish-American Agreements. The Texas Natural Resources Conservation Commission is the administrator for water rights and is the permit-issuing authority.

Groundwater. Pantex is located on the Texas High Plains aquifer system, which is the southernmost extension of a regional aquifer that extends from Texas to South Dakota (PX WDB 1993a:1). The two principal water-bearing units beneath Pantex and adjacent areas are the Ogallala aquifer and the underlying Dockum Group aquifer (PX DOE 1983a). Deep wells in the northeast corner of Pantex, completed at depths of 183 to 259 m (600 to 850 ft) into the Ogallala Formation, have provided the water supply at Pantex for over 40 years. A discontinuous perched aquifer is present at 66 to 88 m (217 to 290 ft) below ground surface; it is best defined under the eastern portion of Pantex, particularly under Zones 11 and 12. The perched groundwater is capable of yielding 2 to 5 gallons per minute, but is not used as a source for drinking water for any plant operations (PX DOE 1996b:4-65).

The Ogallala aquifer beneath Pantex has not been classified by EPA; however, it is the only source of drinking water at Pantex. Depth to water in the Ogallala aquifer ranges from 104 m (341 ft) at the southern boundary of Pantex to 140 m (459 ft) at the northern boundary. The saturated thickness of the Ogallala Formation ranges from 15 m (49.2 ft) to more than 120 m (394 ft) and in some areas is capable of producing yields in excess of 4,000 L per minute (1,050 gal per minute). Estimates of annual recharge rates to the Ogallala aquifer vary from 0.02 to 4.1 cm/yr (0.0079 to 1.6 in/yr) (PX DOE 1996b:4-69) based on earlier studies that investigated slow regional infiltration of precipitation and recent studies that explored percolation of water through playa lakes and leakage from the Dockum Group aquifer into the Ogallala aquifer (PX WDB 1993a:2).

The withdrawal of water from the Ogallala aquifer continues to exceed recharge, causing water levels to decline in the Pantex area at a rate of approximately 0.6 to 2 m/yr (1.97 to 6.56 ft/yr). From 1980 to 1990, the city of Amarillo well field north of Pantex experienced up to 20 m (60 ft) of water-level decline, causing a depression in the groundwater surface northeast of Pantex (PX WDB 1993a:11). In 1990, the recoverable volume of water in storage and available for use in the Ogallala aquifer was estimated at 5.15×10^{14} L (1.36×10^{14} gal) (PX DOE 1996b:4-71). Figure 4.5.2.4-1 shows the groundwater surface of the Ogallala aquifer beneath Pantex.

Groundwater Quality. Pantex's groundwater monitoring program includes monitoring wells and onsite Ogallala production wells distributed throughout the facility. Wells located in the vicinity of the plant are shown in figure 4.5.2.4-1. Groundwater samples collected from the wells are analyzed for a standard suite of parameters and constituents, including volatile organics, semi-volatile organics, pesticides, herbicides, trace metals, radionuclides (gross alpha and gross beta), and field parameters (total dissolved solids and pH). Limited metal concentrations have been found in some of the groundwater samples from the wells monitoring the Ogallala aquifer, including iron which was above the drinking water regulation.

Table 4.5.2.4-1 shows the most recent groundwater analytical data from the Ogallala aquifer. Past groundwater samples from the perched zone have been found to contain a variety of constituents that are either above background levels or drinking water standards or are not naturally occurring. These include 1,2-dichloroethane; chromium; iron; total dissolved solids; and trichloroethane. Table 4.5.2.4-2 shows the groundwater quality from three wells completed in the perched zone.

Groundwater Availability, Use, and Rights. Five production wells in the northeast corner of Pantex serve the plant's industrial and potable water needs. During the 1994 water year, the plant pumped 836 million L (221 million gal) of water from the Ogallala aquifer, while the city of Amarillo pumped 23,900 million L (6,320 million gal) from its Carson County well field located immediately north and northeast of the plant (PX DOE 1996b:4-77). The capacity of Pantex well field is approximately 1,990 MLY (526 MGY). Pantex Lake, located adjacent to the Amarillo water-well field, is available for drilling additional water wells if needed for future Pantex operations.

Groundwater is controlled by the individual landowner in Texas. The Texas Department of Health and the Texas Water Development Board are the two state agencies with major involvement in groundwater fact finding, data gathering, and analysis. Local groundwater management is the responsibility of local jurisdictions through Groundwater Management Districts. The Pantex facility is located in Panhandle Groundwater District 3, which has the authority to require permits and limit the quantity of water pumped. Presently, the Panhandle Groundwater District does not limit the quantity of water pumped.

Table 4.5.2.4-1.-- ***Groundwater Quality Monitoring of TDe Ogallala Aquifer Wells at Pantex Plant, 1994***

Parameter	**Unit of Measure**	**Water Quality Criteria and Standards**[10]	**Well Number OM-39**	**Well Number OM-40**
Radiological				
Alpha (gross)	pCi/L	15 [11]	<MDA-1.0	<MDA-1.0
Beta (gross)	pCi/L	50 [12]	<MDA-1.0 (0.8)	<MDA-1.0
Tritium	pCi/L	80,000 [13]	<MDA-50	<MDA-100 (70)

Uranium -234	pCi/L	20 [12]	0.8-5.5 (1.1)	3.5-5.3 (0.5)
Uranium -238	pCi/L	24 [12]	0.9-2.7 (0.4)	2-2.7 (0.2)
Nonradiological				
Barium	mg/L	2 .0[11]	0.12-0.19	0.14-0.17
Chromium	mg/L	0.1[11]	0.005	<0.005-0.007
Copper	mg/L	1.0[14]	<0.005	<0.005-0.01
1,2-DichloroeTDane	mg/L	0.005[11]	<0.005	<0.005
HMX	mg/L	NA	<0.020	<0.020
Iron	mg/L	0 .3[14]	0.06-1.49	0.15-0.28
Lead	mg/L	0 .015[11]	<0.005	<0.005
Nitrate	mg/L	10 [11]	0.77-2.19	1.24-1.77
pH	pH units	6 .5-8.5[14]	7.2-7.6	6.7-7.5
RDX	mg/L	NA	<0.020	<0.020
Sulfate	mg/L	250 [14]	16-26	18-22
Total dissolved solids	mg/L	500 [14]	210-310	220-360
Total organic carbons	mg/L	NA	<1.0-1	<1-2
Total organic halogens	mg/L	NA	<3-23	<3-6
TrichloroeTDylene	mg/L	0 .005[11]	<0.005	<0.005
Zinc	mg/L	5 [14]	0.221-1.9	0.033-0.048

Table 4.5.2.4-2.-- ***Groundwater Quality Monitoring of TDe Perched Zone Wells at Pantex Plant,***

1994

Parameter	Unit of Measure	Water Quality Criteria and Standards[15]	Well Number PM-44	Well Number PM-45	Well Number PM-20
Radiological					
Alpha (gross)	pCi/L	15 [16]	<MDA	<MDA-1	<MDA-1
Beta (gross)	pCi/L	50 [17]	<MDA-3	<MDA-2	<MDA-1
					(0.8)
Tritium	pCi/L	80,000 [18]	<MDA-100	<MDA-40	<MDA-160
				(350)	(900)
Uranium-234	pCi/L	20 [18]	1.8-2.8	4.3-5.5	2.6-3.8
			(0.3)	(0.4)	(0.3)
Uranium-238	pCi/L	24[18]	0.81-1.7	2.2-3	1.5-2.3
			(0.2)	(0.3)	(0.2)
Nonradiological					
Barium	mg/L	2 [16]	0.13-0.15	0.22-0.25	0.16-0.23
Chromium	mg/L	0 .1[16]	<0.005-0.007	<0.005-0.01	0.53-1.95
Copper	mg/L	1 .0[19]	<0.005-0.006	<0.005-0.005	<0.005-0.006
1,2-DichloroeTDane	mg/L	0 .005[16]	<0.005	<0.005	<0.005
HMX	mg/L	NA	<0.020	<0.020	<0.020-0.07
Iron	mg/L	0 .3[19]	0.01-0.09	0.02-0.08	0.2-3.55
Lead	mg/L	0 .015[16]	<0.005	<0.005	<0.005

Nitrate	mg/L	10 [16]	<0.01-4.12	1.02-3.19	1.5-4.8
pH	pH units	6 .5-8.5[19]	7.3-7.6	6.9-7.3	7.2-7.9
RDX	mg/L	NA	<0.020	<0.020	<0.020-1.1
Sulfate	mg/L	250 [19]	12	25-28	24-40
Total dissolved solids	mg/L	500 [19]	180-230	370-460	280-500
Total organic carbons	mg/L	NA	<1-2	<1-3	<1-1
Total organic halogens	mg/L	NA	<5-8	6-13	69-95
TrichloroeTDane	mg/L	0 .2[16]	<0.005	<0.005-0.01	<0.005-0.15
Zinc	mg/L	5 [19]	0.011-0.038	0.006-0.032	<0.005-0.017

4.5.2.5 *Geology and Soils*

Geology. Pantex is located on the southern High Plains of the Texas panhandle. The topography at Pantex consists of flat to gently rolling plains. There are no unique landforms, and the only distinctive features are playas that are spaced more or less uniformly over the site. The playas are about 500 to 1,000 m (1,640 to 3,280 ft) across with clay bottoms and depths to 9 m (30 ft).

The site itself is underlain by the Blackwater Draw Formation. At Pantex this geologic formation consists of a sequence of buried soils with an upper unit of mostly silt, clay, and caliche and a 12- to 23-m (40- to 75-ft) thick lower unit of silty sand with caliche. The Ogallala Formation, one of two principal water-bearing units beneath Pantex and adjacent areas, underlies the Blackwater Draw Formation.

The plant is located at the edge of a large Permian fault block, but there is no indication of faulting in the immediate area in the last 250 million years. Pantex lies on the boundary between seismic Zones 0 and 1 (figure A.1-1). Since 1906, only nine earthquakes of Richter magnitude 3.0 or greater have been recorded in the more seismically active Amarillo Uplift region 20 km (12 mi) northeast of Pantex. Seismicity in the Palo Duro Basin and at Pantex is low. There is no volcanic hazard at Pantex (DOE 1995i:4-298).

In the High Plains area, salt dissolution in Permian formations is an active process which can lead to sinkholes and fractures. Such surficial expressions have not been identified in Carson County, where Pantex is located. Sinkholes and fractures have been identified, however, in adjacent Armstrong

County to the south and Hutchinson County to the north (PX DOE 1996b:4-29, 4-31).

Soils. Pantex is underlain by soils of the Pullman-Randall association. These soils are typically deep, very low permeability clay loams and clays. Pullman soils underlie most of the plant area, but Randall soils occur in the vicinity of the playas and depressions. Areas of Estacado, Lofton, and Pep clay loams are found in sloping areas surrounding playa bottoms (PX DOE 1995d:5-3). Water and wind erosion and shrink-swell potential are moderate to severe for most of the soil units (PX USDA 1962a:1,2; PX USDA 1980a:31,32). However, the soils are acceptable for standard construction techniques. DOE-leased land at Pantex that is used for agricultural purposes by Texas Tech is considered prime farmland when irrigated (DOE 1995i:4-282).

4.5.2.6 *Biotic Resources*

The following section describes biotic resources at Pantex including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. A list of threatened and endangered species that may be found on or in the vicinity of Pantex is presented in appendix C.

Terrestrial Resources. Pantex is located within a treeless portion of the High Plains that is classified as mixed prairie. The primary vegetation of the High Plains includes short-grasses (buffalo-grass [Buchloe dactyloides] and blue grama [Bouteloua gracilis]) and mid-grasses (little bluestem [Schizachyrium scoparium], sideoats grama [Bouteloua curtipendula], and western wheatgrass [Agropyron smithii]) (PX DOE 1991a:2). Approximately 23 percent of the site, including land leased from Texas Tech University, has been developed. Much of the remainder of the site has been disturbed by past agricultural practices and is being managed as native and improved pasture, or is being cultivated by the university or its tenant farmers (PX DOE 1983a:3-20,3-23). Small areas of relatively undisturbed vegetation exist around playas. Some protection for native habitat is also provided at Pantex where plant operations preclude agricultural activities. Vegetation within these areas consists primarily of grasses and herbs, although barrel cactus *(Ferocactus sp.)* is also present (PX DOE 1995d;5-3, 5-4). Plant communities on the site have not been mapped. A total of 229 plant species has been identified at Pantex (PX DOE 1993c:2).

Terrestrial wildlife species identified on Pantex include 7 amphibians, 8 reptiles, 43 birds, and 19 mammals (PX DOE 1994c:4-5; PX DOE 1994d:7-11). Common animal species known to exist in the vicinity of Pantex include the upland chorus frog (Pseudacris triseriata), common bullsnake (Piturophis melanoleucus), western meadowlark (Sturnella neglecta), mourning dove (Zenaida macroura), black-tailed jackrabbit (Lepus californicus), and black-tailed prairie dog (Cynomys ludovicianus). Among the game animals existing onsite are cottontails (Sylvilagus spp.), scaled quail (Callipepla squamata), northern bobwhite *(Colinus virginianus)* , mourning dove, and numerous waterfowl species (PX DOE 1994b:2,3; PX DOE 1994d:8,11). Hunting is not permitted at Pantex. Common raptors on Pantex include the Swainson's hawk (Buteo swainsoni) and burrowing owl (Athene cunicularia). Carnivores present include the American badger (Taxidea taxus) and coyote (Canis latrans). A variety of migratory birds has been found at Pantex. Migratory birds and their nests and eggs, are protected by the Migratory Bird Treaty Act. Eagles are similarly protected by the Bald and Golden Eagle Protection Act.

Wetlands. Wetlands at Pantex are associated with the five playa basins existing on the site and Pantex Lake (also a playa), located approximately 4 km (2.5 mi) northeast of the site. The National Wetland Inventory map identifies Playas 1 through 5 and part of Pantex Lake as wetlands. Playas 1, 2, and 3 are classified by the USFWS as palustrine (nontidal wetlands dominated by trees, shrubs, and emergent vegetation) systems. The larger Playas, 4 and 5, and Pantex Lake are classified as lacustrine (lakes, ponds, and other enclosed open waters at least 8 ha [20 acres] in extent and not dominated by trees, shrubs, or emergent vegetation) systems. Playas 1, 2, and 4 currently receive treated industrial discharges and stormwater runoff, while Playa 3 receives only stormwater runoff. Playa 5 and the Pantex Lake do not receive site discharges. National Wetland Inventory maps identify a number of smaller palustrine wetlands, approximately 4 ha (10 acres) or less, located on the western and southwestern parts of Pantex in areas that are largely grazed or farmed. Situated along the Central Flyway Migratory Route, the Pantex playas are important to migratory birds and provide valuable habitat for nesting and wintering birds, as well.

Aquatic Resources. Aquatic habitat at Pantex is limited to four ephemeral playas, one permanent playa, and several ditches. Although the playas and ditches located on the Pantex site proper may provide habitat for amphibians and macroinvertebrates, they do not support any fish populations. However, a small pond associated with Pantex Lake does support a small population of minnows (Cyprinidae) (PX DOE 1996b:4-139).

Threatened and Endangered Species. Ten Federal- or state-listed threatened, endangered, and other special status species may be found on and in the vicinity of Pantex (appendix table C-3). Five of these species have records of occurrence on the site, four of which are Federal- and/or state-listed as threatened or endangered. The Federal-listed bald eagle (Haliaeetus leucocephalus) is a winter resident that has been observed foraging at playas on the site each year, while the whooping crane (Grus americana) is considered a very infrequent migrant, last observed in 1990. The state-listed Texas horned-lizard *(Phrynosoma cornutum)* resides on site, while the white-faced ibis (Plegadis chihi) may forage at site playas. The Federal candidate swift fox (*Vulpes velox*) has also been observed onsite. No critical habitat for threatened and endangered species, as defined in the Endangered Species Act (50 CFR 17.11; 50 CFR 17.12), exists on Pantex.

4.5.2.7 *Cultural and Paleontological Resources*

Prehistoric Resources. Archaeological surveys at Pantex have systematically covered approximately one-half of the facility. To date, 63 prehistoric sites have been recorded on DOE and Texas Tech University property. Prehistoric site types identified at Pantex include small temporary campsites and limited activity locations characterized by surface scatters of artifacts. Some of the sites contain heat-altered rock that suggests food processing. Consistent with a Pantex prehistoric site location model, these prehistoric campsites tend to be clustered near the Pantex playa drainages. In this model, prehistoric sites would be located only within 0.4 km (0.25 mi) of playas or their drainages. Of 22 prehistoric sites tested, only one, a late prehistoric bison kill site north of Pantex Lake, has been determined potentially eligible for the NRHP. To date, no activity is planned that would affect this potentially significant site. Other identified sites are thought to be ineligible based on their lack of contextual integrity. A cultural resources management plan is being developed for Pantex. Implementation of this plan is scheduled for 1997. An interim programmatic agreement is in place to ensure regulatory compliance, and potential adverse impacts are evaluated on a case-by-case basis.

Historic Resources. The Pantex facility was originally constructed in 1942 as a World War II bomb-loading plant on land claimed from local farmers. Remains of eight of these farmsteads have been recorded as historic archaeological sites; these sites have minimal integrity and are highly unlikely to be eligible for the NRHP.

The entire Pantex site has been surveyed for World War II-era structures and foundations, and all such properties have been systematically recorded. The Texas SHPO has listed 45 of these structures as potentially eligible for the NRHP. The Cold War historic context has not yet been fully defined for Pantex. When completed, it is probable that a number of plant structures will be determined NRHP eligible.

Native American Resources. Native Americans known to have traditional interests in Pantex include the Comanche Tribe of Oklahoma, the Kiowa Tribe of Oklahoma, the Apache Tribe of Oklahoma, the Mescalero Apache Tribe, the Jicarilla Apache Tribe, the Cheyenne-Arapaho Tribe of Oklahoma, the Wichita and Affiliated Tribes, the Caddo Tribe of Oklahoma, the Delaware Tribe of Western Oklahoma, and the Fort Sill Apache Tribe. DOE is performing a historic treaties search and a public outreach program to involve Native American stakeholders in decisionmaking related to the use of plant land and the protection of cultural resources. Traditional cultural properties have not been identified at Pantex, but the remains of temporary historic campsites and hunting locations are possible.

Paleontological Resources. The surficial geology of the Pantex area consists of silts, clays, and sands of the Blackwater Draw Formation. In other areas of the High Plains, this formation contains Late Pleistocene vertebrate remains, including bison, camel, horse, mammoth, and mastodon, with occasional and significant evidence of their use by early humans. Evidence of woolly mammoths has been found north of Pantex near the Canadian River.

4.5.2.8 *Socioeconomics*

Socioeconomic characteristics addressed at Pantex include employment, regional economy, population, housing, and public finance. Statistics for employment and regional economy are presented for the regional economic area that encompasses 32 counties surrounding Pantex in Texas and New Mexico. Statistics for population, housing, and public finance are presented for the ROI, a four-county area in which approximately 96 percent of all Pantex employees reside: Armstrong County (1 percent), Carson County (11 percent), Potter County (34 percent), and Randall County (50 percent). Site employment at Pantex totalled 3,555 in 1994 and is projected to decrease to 1,644 by 2005. Figure 4.5.2.8-1 presents a map of the counties and selected cities composing the Pantex regional economic area and ROI. Supporting data are shown in appendix D.

Regional Economy Characteristics. Selected employment and regional economy statistics for the

Pantex regional economic area are summarized in figure 4.5.2.8-2 *(not available electronically)*. The civilian labor force in the regional economic area grew approximately 9 percent between 1980 and 1990 (about 1 percent annually). Total employment in the region was 219,504 in 1994. In 1994, unemployment in the regional economic area was 4.8 percent, significantly lower than 6.4 and 6.3 percent unemployment in Texas and New Mexico, respectively. The 1993 per capita income in the regional economic area was $19,310, approximately 1.5 percent higher than the per capita income in Texas ($19,023) and 19 percent higher than New Mexico's per capita income of $16,346.

As shown in figure 4.5.2.8-2 *(not available electronically)*, the Pantex regional economic area, Texas, and New Mexico have similar employment patterns. The service sector accounts for the largest share of total employment in both Texas and New Mexico (28 percent in both states), as well as in the region (22 percent). Manufacturing, however, accounts for a greater share of employment in Texas (11 percent) than in the region (9 percent) or New Mexico (6 percent).

Population and Housing. The ROI population, which totalled 200,052 in 1992, increased by approximately 10 percent (less than 1 percent annually) between 1980 and 1992, less than half the growth rate of Texas during the same period. Furthermore, population growth was uneven among the ROI counties; Randall County grew about 22 percent (an annual rate of almost 2 percent) while the populations of Carson and Armstrong Counties decreased slightly.

Increases in the number of housing units averaged approximately 1 percent annually in the ROI from 1980 to 1990, less than the almost 3 percent annual increase for Texas. Within the ROI, the number of housing units increased at a rate of almost 3 percent in Randall County, while the number of units decreased slightly in both Carson and Potter Counties. Homeowner and rental vacancy rates in the Pantex ROI in 1990 were comparable to those in Texas. Population and housing statistics for the ROI are summarized in figure 4.5.2.8-3.

Public Finance. Financial characteristics of the local jurisdictions in the Pantex ROI that are most likely to be affected by the proposed action are presented in this section. The data reflect total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.2.3-6 and D.2.3-7. Figure 4.5.2.8-4 *(not available electronically)* summarizes local governments' revenues and expenditures. Fund balances, which are dollars carried over from previous years, are not included in figure 4.5.2.8-4 *(not available electronically)*. All jurisdictions assessed had positive fund balances.

4.5.2.9 *Radiation and Hazardous Chemical Environment*

The following section provides a description of the radiation and hazardous chemical environment at Pantex. Also included are discussions of health effects studies, emergency preparedness considerations, and a brief accident history.

Radiation Environment. Major sources of background radiation exposure to individuals in the vicinity of Pantex are shown in table 4.5.2.9-1. All annual doses to individuals from background radiation are expected to remain constant over time. The incremental total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to Pantex operations.

Table 4.5.2.9-1.-- ***Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Pantex Plant Operations***

Source	Committed Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic and external terrestrial cosmogenic radiation[20]	95
Internal terrestrial radiation[21]	39
Radon in homes (inhaled)[21]	200
Other Background Radiationb	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and Industrial Products	10
Total	399

Releases of radionuclides to the environment from Pantex operations provide another source of radiation exposure to people in the vicinity of Pantex. The radionuclides and quantities released from Pantex operations in 1994 are listed in the 1994 Environmental Report for Pantex Plant (DOE/AL/65030-9506). The doses to the public resulting from these releases are given in table 4.5.2.9-2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1994 report were used in the development of the reference environment (No Action) radiological releases at Pantex in 2005 (section 4.5.3.9).

Based on a dose-to-risk conversion factor of 500 cancer deaths per 1 million person-rem ($5x10^{-4}$ fatal cancer per person-rem) to the public (appendix E), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from Pantex operations in 1994 is estimated to be approximately 2.9x10-11. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of Pantex operations is less than 3 chances in 100 billion. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Based on the same conversion factor, $7.0x10^{-8}$ excess fatal cancersare projected in the population living within 80 km (50 mi) of Pantex from normal operation in 1994. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this mortality rate, the number of fatal cancers from all causes expected to occur during 1994 in the population living within 80 km (50 mi) of Pantex was 550. This number of expected fatal cancers is much higher than the estimated $7.0x10^{-8}$ fatal cancers that could result from Pantex operations in 1994.

Table 4.5.2.9-2.-- ***Doses to the General Public from Normal Operation at Pantex Plant, 1994 (Committed Effective Dose Equivalent)***

	Atmospheric Releases		**Liquid Releases**		**Total**	
Affected Environment	**Standard**[22]	**Actual**	**Standard**[22]	**Actual**	**Standard**[22]	**Actual**
Maximally exposed individual (mrem)	10	$5.8x10^{-5}$	4	0.0	100	$5.8x10^{-5}$
Population within 80 kilometers [23] (person-rem)	None	$1.4x10^{-4}$	None	0.0	100	$1.4x10^{-4}$
Average individual within 80 kilometers [24] (mrem)	None	$5.0x10^{-7}$	None	0.0	None	$5.0x10^{-7}$

Table 4.5.2.9-3.-- ***Doses to the Onsite Worker from Normal Operation at Pantex Plant, 1994***

Onsite Releases and Direct Radiation

Affected Environment	Standard[25]	Actual[26]
Average worker (mrem)	None	10
Maximally exposed worker (mrem)	5,000	660
Total workers (person-rem)	None	30

Workers at Pantex receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.5.2.9-3 includes the average, maximum, and total occupational doses to Pantex workers from operations in 1994. These doses fall within radiological limits (10 CFR 835). Based on a dose-to-risk conversion factor of 400 fatal cancers per 1 million person-rem (4×10^{-4} fatal cancers per person-rem) among workers (appendix E), the number of excess fatal cancers to Pantex workers from operations in 1994 is estimated to be 0.012.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the Pantex Plant Site Report for Calendar Year 1994. In addition, the concentrations of radioactivity in various environmental media (e.g., air, water, and soil) in the onsite and offsite site regions are presented in the same reference. Pantex operations contribute only small amounts of radioactivity to all these media.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in sections 4.5.2.3 and 4.5.2.4.

Adverse health impacts to the public can be minimized through administrative and design controls to decrease hazardous chemical releases to the environment and to achieve compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operation at Pantex via inhalation of air containing hazardous chemicals released to the atmosphere by Pantex operations. Risks to the public health from ingestion of contaminated drinking water or by direct exposure are also potential pathways.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in section 4.5.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. All annual concentrations are compared with applicable guidelines and regulations. Information about estimating health impacts from hazardous/toxic chemicals is presented in appendix E.

Exposure pathways to Pantex workers during normal operation may include inhaling the workplace atmosphere, drinking Pantex potable water, and possible other contact with hazardous materials associated with particular work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Pantex workers are also protected by adherence to OSHA and EPA occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operating processes, ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at Pantex are expected to be substantially better than required by standards.

Health Effects Studies. Only one mortality study and one cancer incidence epidemiological study of the general population in communities surrounding Pantex has been performed, and only one study of workers has been done. Significant increases in prostate cancer mortalities among males in Potter and Randall Counties and leukemia mortalities among Carson County males were observed between 1981 and 1992. The analysis on excess cancer incidence found no statistically significant excesses in males. Workers were reported to show a nonstatistically significant excess of brain cancer and leukemia in the one study conducted, but the small number of cases could be attributed to chance alone. For a more detailed description of the studies reviewed and the findings, refer to appendix section E.4.5.

Accident History. There have been no plutonium-dispersing detonation accidents during nuclear weapons operations at Pantex. In 1989, during a weapon disassembly and retirement operation, a release of tritium in the assembly cell occurred. As a result, four workers received negligible doses and a fifth worker received a dose of 1.4 mrem.

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response to accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with planning, preparedness, and response.

Pantex has an emergency management plan, with guidance on implementation provided by a series of Emergency Preparedness Procedures manuals, to protect life and property within the facility, the health and welfare of surrounding areas, and the defense interests of the Nation during any credible emergency situation. Formal mutual assistance agreements have been made with Federal, State of

Texas, and local governments. Federal agreements include Interagency Agreements with the Federal Bureau of Investigation for security-based events requiring its efforts, Veteran's Administration for maintenance of an Emergency Radiation Treatment Facility, LLNL for plume modeling information and data from the Atmospheric Release Advisory Center, and the U.S. Army for Explosives Ordnance Disposal. The DOE/State of Texas Agreement-in-Principle contains both DOE and State activities to mutually improve and integrate both Pantex and State of Texas emergency preparedness programs for potential Pantex-generated emergencies. Memoranda of Understanding among the city of Amarillo, Carson County, and Randall County are in place for mutual assistance and aid in the event of a Pantex-generated emergency. Under accident conditions, an emergency coordinating team of DOE and Pantex contractor management personnel would initiate the Pantex Emergency Plan and coordinate all onsite actions.

If offsite areas could be affected, the Texas Department of Public Safety would be notified immediately, and would make emergency announcements to the public and local governmental agencies in accordance with Annex R of the State of Texas Emergency Management Plan. Pantex has radiological assistance teams with a total of 46 personnel who are equipped and trained to respond to an accident involving radioactive contamination either onsite or offsite.

In addition, the Joint Nuclear Accident Coordination Center in Albuquerque, NM, can be called upon should the need arise. This would mobilize radiation emergency response teams from DOE, DOD, and other participating Federal agencies.

4.5.2.10 *Waste Management*

This section outlines the major environmental regulatory structure and ongoing waste management activities for Pantex. A more detailed discussion of the ongoing waste management operation is provided in appendix section **H.2.4** .

DOE is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at Pantex. The activities DOE is engaged in to bring its operations into full regulatory compliance are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties. These agreements have been reviewed to assure the proposed actions are allowable under the terms of these agreements.

EPA Region 6 on July 29, 1991, proposed Pantex for listing on the NPL of Superfund cleanup sites. Independent evaluations questioned this proposed listing and DOE dissented on the proposal. In September 1991, DOE submitted to EPA its technical comments regarding the proposed listing. EPA placed Pantex on the NPL on May 31, 1994. The DOE Amarillo Area office is currently negotiating a tri-party Federal Facility Agreement with the EPA and the State of Texas. Currently all environmental restoration activities are conducted in compliance with an RCRA permit issued in April 1991. Environmental restoration activities are expected to be completed in 2000.

Pantex's waste management goals are to avoid waste generation or minimize the volume of waste generated to the extent that is technologically and economically practicable, reduce the hazard of waste through substitution or process modification, minimize contamination of existing or proposed real property and facilities, minimize exposure and associated risks to human health and the environment to as low as reasonably achievable levels, and ensure safe, efficient, and compliant long-term management of all wastes. Pantex manages four broad waste categories: low-level, mixed, hazardous, and nonhazardous. Pantex does not generate or manage spent nuclear fuel or HLW. Pantex does not generate TRU waste as a result of normal operation. In the unlikely event that any TRU waste is generated, it would be stabilized and packaged in an appropriate container until shipment to a DOE-approved storage site. A discussion of the waste management operations associated with the remaining categories follows.

Low-Level Waste. LLW generated at Pantex consists of radioactive waste materials associated with weapons A/D, such as protective clothing, cleaning materials, filters, and other similar materials. In 1994, Pantex generated 33 m^3 (8,720 gal) of liquid and 122 m^3 (160 yd3) of solid LLW (PX 1995a:2). Liquid LLW is being stored onsite awaiting a treatment process. Compactible wastes are processed at Pantex's Solid Waste Compaction Facility and staged along with the noncompactible wastes for shipment to a DOE-approved disposal site and/or a commercial vendor. Pantex's LLW is currently shipped to NTS for disposal.

Mixed Low-Level Waste. Mixed LLW is generated during various production, maintenance, modification, and dismantlement functions. For 1994, Pantex generated approximately 1 m^3 (264 gal) of liquid and 15 m^3 (20 yd3) of solid mixed LLW (PX 1995a:2). These wastes consist primarily of small quantities of material such as radioactively contaminated solvents and wipes contaminated by organic solvents and radioactive scrap metal. Mixed LLW is currently stored onsite in RCRA-permitted facilities. Pantex has received exemptions to DOE Order 5820.2A, Radioactive Waste Management for mixed waste shipments to two RCRA-permitted commercial facilities. Pantex developed the *Pantex Plant Compliance Plan* to provide mixed waste treatment capability for all mixed waste streams in accordance with the *Federal Facility Compliance Act* of 1992. This plan was approved by the Texas Natural Resources Conservation Commission and adopted through an Agreed Order on September 27, 1995. The Agreed Order signed by the State of Texas on October 2, 1995, requires implementation of this plan.

Hazardous Waste. Pantex received an RCRA Part B hazardous waste permit from EPA and the Texas Natural Resources Conservation Commission on April 25, 1991. This permit authorizes Pantex to manage hazardous and industrial solid wastes listed in the permit. The permit also requires Pantex to notify the Texas Natural Resources Conservation Commission of the discovery of any release of hazardous waste or hazardous constituents that may have occurred from any solid waste management unit. The hazardous waste permit specifically excluded the 17 RCRA units at the HE Burning Ground that are currently operated under interim status with a written grant of authority for air emissions from the Texas Natural Resources Conservation Commission. Pantex has submitted a request to the Texas Natural Resources Conservation Commission for an RCRA Part B permit modification to add these units at the Burning Ground. A decision on this modification has not been reached.

Most of the hazardous waste generated by Pantex results from HE operations; however, electroplating and photographic and various other operations also generate additional hazardous waste streams. In 1994, Pantex generated 16 m^3 (4,230 gal) of solvent-contaminated wastewater, explosives-contaminated wastewater, and spent organic solvents contaminated with explosives. Solid hazardous wastes included approximately 177 m^3 (232 yd^3) of RCRA-regulated and 8 m^3 (10 yd^3) of TSCA-regulated wastes (PX 1995a:2). HE, HE support material, HE-contaminated materials, and HE-contaminated solid wastes are burned under controlled conditions at Pantex's Burning Ground. Ash, debris, and residue resulting from this burning are transported offsite for approved disposal at a commercial RCRA-permitted facility. All other hazardous waste generated at Pantex, including various chemicals, solvents, heavy metals, and other hazardous constituents, are manifested and shipped offsite by DOT-certified transporters for recycling or disposal at a commercial RCRA-permitted facility.

Nonhazardous Waste. Nonhazardous solid and liquid sanitary wastes are generated at Pantex. An estimated 476,000 m^3 (125,700,000 gal) of sewage wastewater and 4,190 m^3 (1,107,000 gal) of other wastewater was generated in 1994 (PX 1995a:2). Sewage and some pretreated industrial wastewater are treated by the sanitary sewage wastewater treatment system. The liquid effluent from the system is discharged into a playa, where it then either evaporates or filtrates into the ground. Liquid industrial waste is also treated in a tank system that removes metals from plating solutions and then neutralizes this solution. The effluent from this process is discharged to a playa, which is permitted by the Texas Natural Resources Conservation Commission. Stormwater discharges are regulated by a NPDES permit. A proposed upgrade to the sanitary wastewater sewer treatment system would permit all industrial wastewater and sewage to be treated at one location.

Nonhazardous solid waste generated onsite consists primarily of paper, cardboard, construction waste, and cafeteria waste. For 1994, Pantex generated approximately 824,400 kg (1,817,500 lb) of solid sanitary waste (PX 1995a:2). Seventy percent of the solid sanitary waste was disposed of at the City of Amarillo Landfill. The remainder was shipped offsite to other treatment/disposal facilities. In addition, 47,400 m^3 (62,000 yd^3) of construction debris were generated (PX 1995a:2). Only construction wastes are disposed of onsite. Prior to late 1989, sanitary waste was disposed of onsite. Since then, sanitary waste has been transported to the City of Amarillo Landfill for disposal. Waste asbestos is sent to an offsite permitted landfill.

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1 System capacity is 201,480 MWh/yr.

2 System capacity is 22.5 MWe.

3 System capacity is 289,000,000 m**3** /yr.

4 System capacity is 68,040 kg/hr. PX 1996e:1; PX DOE 1995g; PX DOE 1996b.

5 Federal standard.

6 No monitoring data available; baseline concentration assumed less than applicable standard.

7 State standard. The effects screening levels are used in evaluation of hazardous and other toxic compounds.

8 1-hour predicted concentrations were used for 30-minute standard.

9 No standard. Source: 40 CFR 50; PX DOE 1996b; TX ACB 1987a; TX NRCC 1992a; TX NRCC 1995a.

10 For comparison only.

11 National Primary Drinking Water Regulations (40 CFR 141).

12 Proposed National Primary Drinking Water Regulation; Radionuclides (56 FR 33050).

13 DOE Derived Concentration Guides for water (DOE Order 5400.5). Number used is 4 percent of Derived Concentration Guides.

14 National Secondary Drinking Water Regulations (40 CFR 143). NA - not applicable; <MDA indicates the results were less than the minimum detectable activity of the radionuclide counting system; parentheses () indicate standard deviation from the mean. If no parentheses are given for the radionuclide, then a mean could not be be calculated. PX DOE 1995d.

15 For comparison only, except for those parameters with the Texas State water quality criteria.

16 National Primary Drinking Water Regulations (40 CFR 141).

17 Proposed National Primary Drinking Water Regulation; Radionuclides (56 FR 33050).

18 DOE Derived Concentration Guides for water (DOE Order 5400.5). Number used is 4 percent of Derived Concentration Guides.

19 National Secondary Drinking Water Regulations (40 CFR 143). NA - not applicable; <MDA indicates the results were been that the minimum detectable activity of the radionuclide counting system; parentheses ( ) indicate standard deviation from the mean, if no parentheses are given for the radionuclide, then a mean could not be be calculated. PX DOE 1995d.

20 PX DOE 1995d.

21 NCRP 1987a. Value for radon is an average for the United States.

22 The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the *SDWA* , and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268).

23 In 1994, this population was approximately 275,000.

24 Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site. Source: PX DOE 1995d.

25 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

26 PX DOE 1995d. The number of badged workers in 1994 was approximately 2,980.

4.6.3 Environmental Impacts

4.6.3.1 Land Use

No Action. Under No Action, DOE would continue current and planned activities at LANL as described in section 3.2.6. No additional land use impacts are anticipated at LANL beyond the effects of the existing and future activities that are independent of the proposed action.

Management Alternatives

Pit Fabrication. The existing plutonium facility at LANL would be modified to support this alternative. Additional land would not be used to implement the new mission. The proposed activity would be compatible and consistent with land use plans and policies. Impacts to land use are not expected.

Secondary and Case Fabrication. The secondary and case fabrication alternative at LANL would use existing facilities, equipment, and infrastructure to support production requirements for the secondary fabrication mission. Only minimal modifications to existing facilities at LANL would be required. Additional land would not be used to implement the new mission. These activities would be compatible and consistent with land use plans and policies. Impacts to land use are not expected.

High Explosives Fabrication. The proposed HE fabrication activities would be conducted in existing LANL facilities. No new facilities or structures would be required to support HE fabrication. Additional land would not be used to implement the mission. The proposed activity would be compatible and consistent with land use plans and policies. Impacts to land use are not expected.

Nonnuclear Fabrication. LANL would use existing facilities to support nonnuclear fabrication activities. Additional land would not be used to implement the mission. The proposed activity would be compatible and consistent with land use plans and policies. Impacts to land use are not expected.

Sensitivity Analysis . LANL would be able to accommodate the high and low case production operations for all management alternatives with base case production facilities. No land-use impacts are expected.

Stewardship Alternatives

Proposed National Ignition Facility. The proposed location of NIF at LANL is within TA-58. An estimated 4 ha (10 acres) of land for buildings, walkways, building access, and buffer space would be required to construct and operate NIF. The land required for the proposed NIF would represent approximately 1 percent of the land currently available for development within LANL. However, 4 ha (10 acres) represents an extremely small proportion of LANL's total land area of 111 km^2 (43 mi^2). The proposed NIF is compatible and consistent with land-use plans for this area. No impacts to LANL land-use plans or policies are expected.

Proposed Atlas Facility. The proposed Atlas Facility would include existing buildings located in a developed area within TA-35 at LANL. Modification activities would involve renovating the existing buildings for use in performing pulsed-power experiments. The area is currently used for similar types of activities. The proposed Atlas Facility activity would be compatible and consistent with land use plans for the area. Impacts to LANL land-use plans and policies are not expected.

Combined Program Impacts. Of the six potential Stockpile Stewardship and Management Program alternatives proposed for LANL, existing facilities would be modified for five of the alternatives. No additional land would be used to implement the mission. The proposed NIF would require clearing 4 ha (10 acres) of undeveloped land for buildings, walkways, and buffer space. The total land use impact from placing all potential Program alternatives at LANL would be the use of 4 ha (10 acres) of undeveloped land in TA-58 for the new NIF mission.

Potential Mitigation Measures . No mitigation measures for stockpile stewardship and management alternatives at LANL are anticipated.

4.6.3.2 Site Infrastructure

This section discusses site infrastructure at LANL for No Action and the modifications needed for actions due to construction and operation of stockpile stewardship and management facilities. A comparison of site infrastructure and facility resource needs for No Action and the proposed alternatives is presented in table 4.6.3.2-1.

No Action. This alternative continues the management missions, described in section 3.2.6, of limited pit fabrication and selected nonnuclear fabrication, and the stewardship R&D missions. As stated in section 1.6.2, the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility is considered part of No Action. Impacts on site infrastructure would be minimal since the Pulsed High Energy Radiation Machine Emitting X-Rays (PHERMEX) Facility would be phased out as the DARHT Facility becomes operational. As shown in table 4.6.3.2-1, the site infrastructure would continue to adequately supply facility requirements.

Management Alternatives

Pit Fabrication. As shown in table 4.6.3.2-1, site infrastructure would require slight facility improvements to meet pit fabrication requirements. Only a slight increase over No Action requirements in electrical energy and natural gas use is expected. No other impacts to site infrastructure are expected.

Secondary and Case Fabrication. Site infrastructure would require slight facility improvements to meet secondary and case fabrication requirements. Table 4.6.3.2-1 shows the total site requirement with secondary and case fabrication and the change from No Action. Impacts to site infrastructure include a 9-percent increase in electrical energy use over No Action requirements. The electric power pool has sufficient capacity margins to accommodate the secondary and case fabrication mission. There would also be an increase in liquid fuel use.

High Explosives Fabrication. Site infrastructure would require minor facility improvements to meet HE fabrication requirements. Impacts to site infrastructure include an increase in liquid fuel use over No Action requirements. An 8-percent increase in natural gas use would occur, but there would be only a slight increase in electrical energy use over No Action requirements. This analysis assumes the entire HE mission is relocated to LANL. If it is shared with LLNL, the impact would be proportionately less.

Nonnuclear Fabrication. Minor site infrastructure facility improvements would be needed to meet nonnuclear fabrication requirements. As shown in table 4.6.3.2-1, only a slight increase in energy use is expected. No other impacts to site infrastructure are expected.

Sensitivity Analysis . No change in site infrastructure impacts are expected for the high and low production case for pit, secondary and case, and HE fabrication. For nonnuclear fabrication, the high production case would require using additional facilities, namely Buildings 300 and 301 at S-Site. Also, additional capital equipment would need to be added to increase processing, storage, and inventory control capability. No additional site infrastructure changes would be needed to meet the low production case.

Stewardship Alternatives

Proposed National Ignition Facility. As shown in table 4.6.3.2-1, site infrastructure would require slight facility improvements to meet the proposed NIF requirements. Impacts to site infrastructure include a 11-percent increase in electrical energy use, a 22-percent increase in peak electrical loads, and a 2-percent increase in natural gas use over No Action requirements. The electric power pool has sufficient capacity margins to accommodate the proposed NIF.

Table 4.6.3.2-1.-- Site Infrastructure Requirements and Changes for Stockpile Stewardship and Management Alternatives at Los Alamos National Laboratory

	Electrical		Fuel		
Alternative	Energy (MWh/ yr)	Peak Load (MWe)	Liquid (L/ yr)	Gas (m^3 / yr)	Coal (t/ yr)
Current Resources	381,425	87	0	43,414,560	NA
No Action (2005)					
Total site requirement	381,425	87	0	43,414,560	NA
Change from current resources	0	0	0	0	NA
Nonnuclear Fabrication					
Total site requirement	381,950	87.2	0	43,414,900	NA
Change from No Action	525	0.23	0	340	NA
Pit Fabrication					
Total site requirement	386,905	87.7	0	43,445,460	NA

Change from No Action	5,480	0.7	0	30,900	NA
Secondary and Case Fabrication					
Total site requirement	417,425	92	100,000	43,414,560	NA
Change from No Action	36,000	5	100,000	0	NA
High Explosives Fabrication					
Total site requirement	387,025	88	94,600	47,064,560	NA
Change from No Action	5,600	1	94,600	3,650,000	NA
National Ignition Facility					
Total site requirement	423,425	107	2,800	44,224,560	NA
Change from No Action	42,000	20	2,800	810,000	NA
Atlas Facility					
Total site requirement	386,785	87	0	43,414,560	NA
Change from No Action	5,360	0[1]	0	0	NA
Combined Program Impacts					
Total site requirement	476,390	113.9	197,400	47,905,800	NA
Change from No Action	94,965	26.9	197,400	4,491,240	NA

Proposed Atlas Facility. The LANL site infrastructure would require minor facility improvements to meet the proposed Atlas Facility requirements. Table 4.6.3.2-1 shows the expected change in site requirements to support the Atlas Facility. Impacts to site infrastructure include no increase in peak electrical load requirements due to utilization of existing generators currently used for other experiments and only a slight increase in electrical energy use over No Action requirements. No other impacts to site infrastructure are expected.

Combined Program Impacts. If all of the alternatives applicable to LANL were to be located there, the combined impacts would exceed current site infrastructure resources. The largest impact would be a 25-percent increase in electrical energy use with an associated 31-percent increase in peak electrical load. Natural gas use would increase by 10 percent. Consumption of liquid fuel, which is currently used for standby power only and shows no amount in table 4.6.3.2-1, would increase to about 197,400 L per year.

Potential Mitigation Measures. No mitigation measures are anticipated.

4.6.3.3 Air Quality

No Action. No Action air quality utilizes estimated air emissions data from operations at LANL in 2005, assuming continuation of current site missions, to calculate pollutant concentrations at or beyond the LANL site boundary. Included in the criteria and toxic/hazardous emissions from LANL are those emissions estimated for operation of the DARHT Facility currently under construction. The emission rates for criteria and toxic/hazardous pollutants for No Action are presented in appendix table B.3.6-1. Table 4.6.3.3-1 presents the No Action pollutant concentrations calculated from the 2005 emission rates. In this table, pollutant concentrations are compared with applicable Federal and state regulations and guidelines. Concentrations are expected to remain within these standards.

Table 4.6.3.3-1.-- Estimated Concentrations of Pollutants from No Action and Stockpile Stewardship and Management Alternatives at Los Alamos National Laboratory

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines (mg/m^3)	2005 No Action (mg/m^3)	Pit Fabrication (mg/m^3)	Secondary and Case Fabrication (mg/m^3)	High Explosives Fabrication (mg/m^3)	Nonnuclear Fabrication (mg/m^3)	Atlas Facility (mg/m^3)	National Ignition Facility (mg/m^3)	Combined Program Impacts (mg/m^3)

Criteria Pollutant										
Carbon monoxide	8-hour	7,689[2]	115	116.81	138.97	139.17	115	115	117.45	165.59
	1-hour	11,578[2]	630	639.90	761.46	762.51	630	630	643.44	907.41
Lead	Calendar quarter	1.5[3]	0.00002	0.00002	0.01	0.00002	0.00002	0.00002	0.00002	0.01
Nitrogen dioxide	Annual	73[2]	3.84	3.84	16.82	6.36	3.84	3.84	4.05	19.55
	24-hour	145[2]	2	2	233.12	46.8	2	2	5.77	278.69
Ozone	1-hour	235[3]	139	139	139	139	139	139	139	139
Particulate matter	Annual	50[3]	8.01	8.01	8.04	8.04	8.01	8.01	8.03	8.09
	24-hour	150[3]	24.3	24.3	24.89	24.84	24.3	24.3	24.66	25.79
Sulfur dioxide	Annual	40[2]	1.3	1.3	6.63	1.3	1.3	1.3	1.3	6.63
	24-hour	202[2]	0.006	0.006	94.83	0.006	0.006	0.006	0.09	94.96
	3-hour	1,300[3]	0.03	0.03	467.43	0.03	0.03	0.03	0.40	467.8
Mandated by New Mexico										
Hydrogen sulfide	1-hour	11[2]	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4]
Total reduced sulfur	30-minute	3[2]	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4]
Total suspended particulates	Annual	60[2]	8	8.06	8.03	8.03	8	8	8.02	8.08
	30-day	90[2]	<21	<21	<21.59	<21.54	<21	<21	<21.36	<22.49
	7-day	110[2]	<21	<21	<21.59	<21.54	<21	<21	<21.36	<22.49
	24-hour	150[2]	21	21	21.59	21.54	21	21	21.36	22.49
Hazardous and Other Toxic Compounds										
Acetic acid	8-hour	250[2]	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87
Ammonia	8-hour	180[2]	4.27	4.27	4.27	6.69	4.27	4.27	4.27	6.69
2-Butoxyethanol	8-hour	1,200[2]	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Chlorine	8-hour	[5]	0.07	1.89	0.07	0.07	0.07	0.07	0.07	1.89
Chloroform	8-hour	500[2]	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61
Ethyl acetate	8-hour	14,000[2]	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Ethylene glycol	8-hour	[5]	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Formaldehyde	8-hour	15[2]	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24

Heavy metals	8-hour	5	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
p Heptane (N-heptane)	8-hour	5	9.06	9.06	9.06	9.06	9.06	9.06	9.06	9.06
Hexane (N-hexane)	8-hour	5	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Hpydrogen chloride	8-hour	5	3.41	3.41	3.41	4.01	3.41	3.41	3.41	4.06
Hydrogen fluoride	8-hour	5	1.29	1.29	1.29	1.54	1.29	1.29	1.29	1.54
Isopropyl alcohol	8-hour	9,800[2]	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88
Kerosene	8-hour	5	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
Methpyl alcohol	8-hour	5	3.14	3.46	3.14	3.14	3.14	3.14	3.14	3.14
Methyl ethyl ketone	8-hour	5	9.95	9.95	9.95	10.08	9.95	9.95	9.95	10.08
Methylene chloride	8-hour	5	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90
Nickel	8-hour	10[2]	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Nitric acid	8-hour	50[2]	3.53	3.53	3.53	3.53	3.53	3.53	3.53	3.53
Nitrogen oxide	8-hour	5	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
Non methane hydrocarbons	8-hour	5	15.83	15.83	15.83	15.83	15.83	15.83	15.83	15.83
Propane sultone	8-hour	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Stoddard solvent	8-hour	5,250[2]	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
Toluene	8-hour	5	13.26	13.26	13.26	13.38	13.26	13.26	13.26	13.38
Tungsten (as W) (insoluble)	8-hour	50[2]	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
1,1,2-Trichloroethane	8-hour	5	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95
Trichloroethylene	8-hour	5	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
VM&P naphtha	8-hour	13,500[2]	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27
Welding fumes	8-hour	5	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
Xylene	8-hour	5	9.41	9.41	9.41	9.41	9.41	9.41	9.41	9.41

Management Alternatives

Pit Fabrication. Operation of the Pit Fabrication Facility would generate criteria and toxic/hazardous pollutants resulting from the combustion of fossil fuels for space heating and manufacturing processes. The emissions consist of particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, and VOCs. Emission rates of criteria and toxic/hazardous pollutants for annual operation of the Pit Fabrication Facility are presented in appendix table B.3.6-1. Table 4.6.3.3-1 presents the concentrations of criteria and toxic/hazardous pollutants resulting from No Action and those generated from operation of the Pit Fabrication Facility. Concentrations of pollutants resulting from operation of this facility added to No Action concentrations are expected to remain within Federal and state regulations.

Secondary and Case Fabrication. The Secondary and Case Fabrication Facility would generate criteria and toxic/hazardous emissions resulting from operation of the plant boiler, component manufacturing, and chemical processes. Reasonably available control technology would be used to minimize pollutant emissions. This would include using HEPA filters to contain particulate emissions and providing liquid scrubbing prior to HEPA filtration to remove chemical vapors such as nitric acid. Emission rates for criteria and toxic/hazardous pollutants for the secondary and case fabrication mission are presented in appendix table B.3.6-1. Table 4.6.3.3-1 presents the concentrations of criteria and toxic/hazardous pollutants resulting from No Action and those generated from operation of the secondary and case fabrication mission. The resulting concentrations of criteria and toxic/hazardous pollutants are expected to remain within Federal and state regulations and guidelines. Modeled estimates for the 24-hour concentration of nitrogen dioxide, however, are above the applicable standard.

High Explosives Fabrication. Gaseous emissions of criteria and toxic/hazardous air pollutants would be generated from HE fabrication. These emissions would result from open burn/open detonation of nonradioactive scrap HE and HE-contaminated waste, plant boiler operation, cleaning operations using solvents, and formulation and synthesis operations. Emission rates for criteria and toxic/hazardous pollutants for HE fabrication are presented in appendix table B.3.6-1. Table 4.6.3.3-1 presents the concentrations of criteria and toxic/hazardous pollutants resulting from No Action and those generated from HE fabrication. The resulting concentrations of criteria and toxic/hazardous pollutants are expected to be within Federal and state regulations and guidelines.

Nonnuclear Fabrication. Aerial emissions of combustion by-products from the slight increase in process steam usage would result in an increase of 159 kg (350 lb) of VOCs. This emission rate is based upon the increase of natural gas combustion needed to generate an additional 1 million British thermal units of energy. Pollutant emissions of combustion by-products for steam and gas heating systems for normal building operations are not considered, as the facilities are existing and no increases in emissions would occur as a result of the proposed activity. Table 4.6.3.3-1 presents the concentrations of criteria and toxic/hazardous pollutants resulting from No Action and nonnuclear fabrication. Concentrations of pollutants resulting from operation of nonnuclear fabrication added to No Action concentrations are expected to remain within Federal and state regulations.

Sensitivity Analysis. Impacts to air quality from either the low or high case scenario of the program alternative would result in higher and lower concentrations of criteria and toxic/hazardous pollutants for the high and low case, respectively. The concentrations of pollutants for the high case pit fabrication, HE, and nonnuclear fabrication missions are expected to be within applicable Federal and state regulations and guidelines. The 24-hour concentration of nitrogen dioxide for the high case secondary and case fabrication mission is above applicable standards and guidelines.

Stewardship Alternatives

Proposed National Ignition Facility. Operation of the proposed NIF would generate criteria and toxic/hazardous pollutants resulting from the combustion of boiler fuel for heating, operation of diesel generators, and solvent cleaning processes. The emissions consist of particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, and VOCs. Boiler fuel is assumed to be natural gas. Emission rates of criteria and toxic/hazardous pollutants for annual operation of the proposed NIF are presented in appendix table B.3.6-1. Table 4.6.3.3-1 presents the concentrations of criteria and toxic/hazardous pollutants resulting from No Action and those generated from operation of the proposed NIF. Concentrations of pollutants resulting from operation of the proposed NIF added to No Action concentrations are expected to remain within Federal and state regulations.

Proposed Atlas Facility. Operation of the Atlas Facility would not typically generate criteria pollutants; however, for purposes of this analysis it is anticipated that small amounts of lead or other similar heavy metals might be released as a volatilized metal from the target chamber following certain occasional experiments. Toxic/hazardous emissions would be generated by the Atlas Facility following each experiment due to the evaporation of solvents used to clean the inside of the target chamber. The quantity of air emissions resulting from each experiment are small and therefore require no facility air filtration or scrubbers. Emission rates of criteria and toxic/hazardous pollutants for annual operation of the proposed Atlas Facility are presented in appendix table B.3.6-1. Table 4.6.3.3-1 presents the concentrations of criteria and toxic/hazardous pollutants resulting from No Action and those generated from operation of the proposed Atlas Facility. Concentrations of pollutants resulting from operation of the proposed Atlas Facility added to No Action concentrations are expected to remain within Federal and state regulations.

Combined Program Impacts. The combined Program impacts to air quality, assuming that each of the proposed stewardship and management alternatives are located at LANL, are presented in table 4.6.3.3-1. The table presents total program concentrations of criteria and toxic/hazardous pollutants derived by adding the contribution from each alternative. The contribution to air pollutants was determined for each alternative independently from each of the other alternatives. Therefore, adding the respective contributions presents a conservative estimate of the combined impacts to air quality since the maximum pollutant concentration for each alternative would not occur at the same time or location at or beyond the site boundary.

Using this conservative estimate of the combined impacts to air quality at LANL, the data indicate that the 24-hour concentration of nitrogen dioxide may result in a concentration above the applicable State of New Mexico ambient air quality standard. All other criteria and/or toxic/hazardous air pollutants are expected to be within applicable standards.

Potential Mitigation Measures. The use of reasonably available control technology may contribute to the reduction of concentrations of nitrogen dioxide.

4.6.3.4 Water Resources

Environmental impacts associated with the construction and operation of the potential stockpile stewardship and management facilities at LANL could affect surface and groundwater resources. All water required for construction or operation would be supplied from groundwater. The proposed sites for the new or modified facilities would be outside the 100- and 500-year floodplains. A description of the activities that would continue at LANL is provided in section 3.2.6. Table 4.6.3.4-1 presents existing surface water and groundwater resources and the potential changes to water resources at LANL resulting from the proposed alternatives. The total site water resources requirements for each alternative including No Action are displayed in this table. Combined program impacts if all alternatives were implemented at LANL are also listed.

Surface Water

No Action. Since there would be no construction under No Action, no additional construction water would be required or discharged. Current wastewater discharge would remain at 693 MLY in the No Action year 2005.

Management Alternatives

Pit Fabrication. Existing facilities would be modified at TA-55 to accept the pit fabrication mission. Modification activities would take place in TAs atop mesas and would not be affected by a 500-year flood. No surface water would be withdrawn for stockpile stewardship and management activities. Impacts to surface water resources associated with runoff and wastewater discharged during the modification phase would be negligible.

Table 4.6.3.4-1.-- Potential Changes to Water Resources from Stockpile Stewardship and Management Alternatives at Los Alamos National Laboratory

Affected Resource Indicator	No Action Single-Shift Operation 2005	Pit Fabrication Three-Shift Operation	Secondary and Case Fabrication Three-Shift Operation	High Explosives Fabrication Three-Shift Operation	Nonnuclear Fabrication Three-Shift Operation	National Ignition Facility	Atlas Facility	Combined Program Impacts
Construction								
Water Availability and Use								
Water source	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Total site water operation requirement[6] (MLY)	0[7]	5,760	5,761	5,760	5,760	5,763	5,760	5,764
Percent change from No Action water use (5,760 MLY)	NA	0	0.02	0	0	0.05	0	0.07
Water Quality								
Wastewater discharge to surface waters[8]	0[7]	693	693.9	693	693	693.4	693	694.3
Percent change from No Action wastewater discharges (693 MLY)	NA	0	0.13	0	0	0.06	0	0.18
Operation								

Water Availability and Use								
Water source	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Total site water operation requirement (MLY)	5,760	5790	5,815	5,773	5,808	5,912	5,760	6,059
Percent change from No Action water use (5,760 MLY)	NA	0.5	1	0.2	0.8	2.6	0	5.2
Percent change from current use (5,519 MLY)	4.4	4.9	5.4	4.6	5.2	7.1	4.4	9.8
Percent of groundwater allotment (6,800 MLY)	85	85	86	85	85	87	85	89
Water Quality								
Wastewater discharge to surface waters[8]	693	705	713	706	694	711	693	757
Percent change from No Action wastewater discharge (693 MLY)	NA	1.8	2.9	1.8	0.08	2.6	0	9.2
Percent change from current wastewater discharge (693 MLY)	0	1.8	2.9	1.8	0.08	2.6	0	9.2
Floodplain								
Actions in 100-year floodplain	NA	None	None	None	None	None	None	None
Actions in 500-year floodplain	NA	None	None	None	None	None	None	None

During operation, sanitary and other liquid wastes would be treated at the Los Alamos Sanitary Treatment Facility. Treated wastewater would then be discharged to the canyons. The additional sanitary wastewater generated by the processes would be approximately 12.3 MLY (3.2 MGY). This represents an increase of approximately 1.8 percent over the projected sanitary wastewater generation rate of 693 MLY (183 MGY).

Secondary and Case Fabrication. During operation, nonhazardous sanitary liquid wastes would be disposed of by a sanitary collection system. Sanitary process and support liquids are sent by drain to the sanitary wastewater treatment plant (TA-46) and treated similarly to municipal sewage. The additional sanitary wastewater generated by the processes would be approximately 20.4 MLY (5.4 MGY). This represents an increase of approximately 2.9 percent over the projected sanitary wastewater generation rate of 693 MLY (183 MGY). No additional impacts to surface water are anticipated.

While brief downpours can cause local flash flooding, especially in canyons, streams, and other low spots, most of the LANL TAs, including TA-55, are located atop the finger mesas near drainage ditches and are not subject to flooding.

High Explosives Fabrication. During modification activities, no additional sanitary liquid waste or other liquid wastes would be generated. During operation, sanitary liquid and other liquid wastes would be treated at the Los Alamos Sanitary Treatment Facility before being discharged to the canyons. The HE fabrication processes would generate approximately 12.8 MLY (3.38 MGY) of additional sanitary wastewater. This represents an increase of approximately 1.8 percent over the projected sanitary wastewater generation rate of 693 MLY (183 MGY). Treated effluent would be monitored to comply with NPDES-permitted and other applicable discharge requirements. No adverse impacts to surface water or surface water quality are expected.

All proposed HE facilities and buildings at the Los Alamos HE Facility are located above the critical flood elevation of the potential flood source (i.e., river, dam, levee, and precipitation).

Nonnuclear Fabrication. An additional 0.005 MLY (0.001 MGY) of wastewater would be discharged during construction. Sanitary and other liquid wastes would be treated at the Los Alamos Sanitary Treatment Facility and then discharged to the canyons. The processes associated with nonnuclear fabrication would generate approximately 0.57 MLY (0.151 MGY) of additional sanitary wastewater. This represents approximately a 0.08-percent increase in the annual projected sanitary wastewater generation rate of 693 MLY (183 MGY). Treated effluent would be monitored to comply with NPDES permits and with applicable discharge requirements. No adverse impacts to surface water or surface water quality are expected.

Stewardship Alternatives

Proposed National Ignition Facility. The proposed NIF is expected to generate an additional 17.8 MLY (4.7 MGY) of sanitary wastewater. This amount would represent a 2.6-percent increase in the annual projected sanitary wastewater generation rate of 693 MLY (183 MGY). Consolidation of LANL's sewer system was completed in 1994 to bring all treatment systems into compliance with Federal and state regulations. Capacity of the consolidated sewer system would be sufficient to meet project requirements.

Because the canyons south and north of the NIF location are more than 20 m (65.6 ft) deep, the 100-year floodplain is contained within the canyons. Because of the depth of the canyons, impacts from a 500-year flood event are unlikely.

Proposed Atlas Facility. Existing buildings at TA-35 would be renovated for the proposed Atlas Facility. During modification activities and operations, a minimal amount of wastewater would be generated. Current wastewater capacities would be able to meet the additional requirements for the Atlas Facility. Additional information regarding the Atlas Facility at LANL is presented in appendix K. No additional wastewater would be discharged to surface water during construction, modification, or operation activities.

Groundwater

No Action. Water supply at LANL is provided by three DOE-owned well fields. Springs in the area produce approximately 1 percent of the water supply. Approximately 5,760 MLY (1,522 MGY) of water is produced.

Since there would be no construction or modifications under No Action, no additional groundwater for construction would be required. Baseline conditions and operations, described in section 4.6.2.4, would continue, and groundwater withdrawal would remain at 5,760 MLY (1,522 MGY) in 2005. No additional impacts to groundwater quality are anticipated since there are no direct discharges to groundwater.

Management Alternatives

Pit Fabrication. Water requirements for both the building modification activities and operation phase would be supplied from local groundwater sources. Minimal water would be needed during the building modification activities.

During operation, an additional 30.2 MLY (7.98 MGY) of water would be required to support pit fabrication activities, which is a 0.52-percent increase over the No Action groundwater withdrawal of 5,760 MLY (1,522 MGY). The projected water requirements for modification activities and operation would not constitute significant increases in the total amount of groundwater currently withdrawn by LANL and would not affect water supply in the area. The additional amount would still be below the LANL maximum allotment of 6,800 MLY (1,796 MGY).

Secondary and Case Fabrication. Approximately 1 MLY (0.26 MGY) of groundwater would be required for construction and modification activities.

Operation of the secondary and case fabrication facilities would require approximately 55 MLY (14.5 MGY), which is less than a 1-percent increase over the projected groundwater withdrawal of 5,760 MLY (1,522 MGY). The projected water requirements during operation would not constitute significant increases in the total amount of groundwater currently withdrawn by LANL and would not affect water supply in the area. The additional amount would still be below the LANL maximum allotment of 6,800 MLY (1,796 MGY).

High Explosives Fabrication. No additional groundwater would be needed for HE fabrication building modification activities. During modification, no wastewater would be discharged to groundwater. Adverse impacts to groundwater are not expected.

Operation of the HE fabrication facilities would require approximately 13 MLY (3.4 MGY), which is an increase of less than 1 percent over the projected groundwater withdrawal of 5,760 MLY (1,522 MGY). The projected water requirements during operation would not constitute significant increases in the total amount of groundwater currently withdrawn by LANL and would not affect water supply in the area. The additional amount of water would still be below the LANL maximum allotment of 6,800 MLY (1,796 MGY).

Nonnuclear Fabrication. Approximately 0.004 MLY of additional groundwater would be needed for building modification activities for nonnuclear fabrication. Operation of the nonnuclear fabrication facilities would require approximately 48.3 MLY (12.76 MGY), which is a 0.8-percent increase in the projected groundwater use of 5,760 MLY (1,522 MGY). The projected water requirements during operation would not constitute significant increases in the total amount of groundwater currently withdrawn by LANL, and would not affect water supply in the area.

Groundwater Quality. No process wastes from the proposed management alternatives would be discharged directly to the groundwater, and all treated wastewater discharges to the canyons would be monitored to comply with NPDES permit and other applicable discharge requirements. Given normal safeguards and precautions, no adverse impacts to groundwater quality are expected.

Sensitivity Analysis. The effluent discharges to surface waters resulting from the high stockpile case are expected to be similar or slightly greater than the volumes generated by the surge three-shift operation alternatives. The low case scenario would discharge a slightly larger volume of treated effluent compared to the No Action volume. Additional impacts to surface water quality would be negligible. Groundwater quality is not expected to be impacted by the low or high case production scenario at LANL.

Stewardship Alternatives

Proposed National Ignition Facility. During the proposed NIF's 5-year construction period, approximately 3 MLY (0.8 MGY) of water would be required. This amount is a 0.05-percent increase in the (2005) projected groundwater withdrawal of 5,760 MLY (1,522 MGY). Operation of the proposed NIF would require approximately 152 MLY (40.2 MGY), of which 17.8 MLY (4.7 MGY) would be for domestic use. This amount is a 2.6-percent increase in the projected groundwater withdrawal of 5,760 MLY (1,522 MGY). The projected water requirements during operation would not constitute significant increases in the total amount of groundwater projected to be withdrawn by LANL and would not affect water supply in the area. This additional amount would still be below the LANL maximum allotment of 6,800 MLY (1,800 MGY).

Proposed Atlas Facility. Existing buildings at TA-35 would require renovation for the proposed Atlas Facility. During modification activities and operation, a minimal amount of water would be required. Current water capacities would be able to meet the additional requirements for the proposed Atlas Facility. Additional information regarding the Atlas Facility at LANL is presented in appendix K.

Groundwater Quality. No process wastes from the proposed stewardship alternative would be discharged directly to the groundwater, and all treated wastewater discharges to the canyons would be monitored to comply with NPDES permit and other applicable discharge requirements. Given normal safeguards and precautions, no adverse impacts to groundwater quality are expected.

Combined Program Impacts. The combined Program impacts to water resources if each proposed alternative were implemented at LANL are shown in table 4.6.3.4-1. A negligible amount of water would be required for modification activities. Approximately 6,059 MLY (1,600 MGY) of groundwater would be required to operate the facilities; this represents a 5.2-percent increase in projected groundwater use and 89 percent of the current groundwater allotment at LANL. Wastewater discharges during construction and operation of the facilities would total approximately 0.6 MLY (0.2 MGY) and 64 MLY (17 MGY), respectively. All wastewater would be discharged to surface waters and would be monitored to comply with NPDES permit and other applicable discharge requirements. Given normal safeguards and precautions, no adverse impacts to surface water or groundwater quality are expected.

Potential Mitigation Measures. Because appropriate erosion and runoff management measures would be implemented during construction to comply with NPDES stormwater management regulations, no mitigation measures should be necessary. Stormwater measures include erosion control measures such as silt fences, dikes, and sediment traps to divert runoff away from disturbed areas and stabilization practices that cover soils with materials such as riprap or mulch in order to prevent direct exposure of soils to runoff.

4.6.3.5 Geology and Soils

The proposed alternatives for LANL would have no adverse impact on the geological resources described in section 4.6.2.5. Although a moderate seismic risk exists at LANL, this would be considered during design, construction, and operation of any new functions. The existing seismic risk does not preclude safe implementation and operation of the new functions. The LANL stockpile management alternatives and the proposed Atlas Facility would use existing structures within their current footprints. There would be a nominal amount of area required for equipment staging, material laydown, and parking. Existing facility space or developed areas would be used for these activities. Modification activities, with the exception of the erection of seismic reinforcement, would be within the existing building structures. There is sufficient parking for construction workers in lots adjacent to work areas.

The proposed NIF would require additional acreage, but would not adversely affect geological resources. Control measures would be used to minimize any soil erosion. Potential changes to geology and soils associated with the proposed alternatives at LANL are discussed below.

No Action. Under No Action, DOE would continue current and planned activities at LANL. Any impacts to geology and soils would be independent of and unaffected by the proposed action.

Management Alternatives

Pit Fabrication. All new functions would be accommodated within existing structures; therefore, modification and operation activities would not affect geological conditions. Soil disturbance is not expected. The properties and conditions of the soils underlying the proposed site place no limitations on modification activities and operation. Soils would not adversely affect the safe operation of project facilities.

During implementation and operation of the new functions, seismic activity in the area could pose a potential hazard to the facilities and personnel at LANL. Modifications of site facilities to accommodate new pit fabrication functions would take into account the moderate seismic risk in the LANL area. All facilities would be designed for earthquake-generated ground acceleration in accordance with DOE O 420.1 and accompanying safety guides. Secondary effects from seismic activities, such as soil liquefaction or landslides, are not expected because of the depth of groundwater and relatively stable topography on top of the mesas. Hazards resulting from the return of volcanism during implementation or operation are unlikely (see section 4.6.2.5). Potential health impacts from accidents associated with geological hazards are discussed in section 4.6.3.9.

Secondary and Case Fabrication. Impacts to geology and soils from secondary and case fabrication at LANL would be similar to those described above for pit fabrication.

High Explosives Fabrication. Impacts to geology and soils from HE fabrication at LANL would be similar to those described above for pit fabrication.

Nonnuclear Fabrication. Impacts to geology and soils from nonnuclear fabrication at LANL would be similar to those described above for pit fabrication.

Sensitivity Analysis . The high or low case operation scenario for the proposed stockpile management alternatives at LANL would not affect geology or soils.

Stewardship Alternatives

Proposed National Ignition Facility. The construction and operation of the proposed NIF at LANL would not adversely affect geological resources. NIF would require the clearing of an estimated 4 ha (10 acres) of land for buildings, walkways, building access, and buffer space. Soil impacts during construction would be short term and minor with appropriate erosion and sediment control measures. Net soil disturbance during operation would be less than for construction because areas temporarily used for equipment and material laydown would be restored. Seismic risks would be taken into account during construction and operation of the proposed NIF (see appendix I).

Proposed Atlas Facility. The design, installation, and operation of the Atlas Facility in existing buildings at LANL would have no impact on geological resources. Seismic risks would be taken into account during design, implementation, and operation of the Atlas Facility (see appendix K).

Potential Mitigation Measures. No mitigation measures for stockpile stewardship and management alternatives at LANL are anticipated.

4.6.3.6 Biotic Resources

The following sections address impacts to terrestrial resources, wetlands, aquatic resources, and threatened and endangered species at LANL. Although most alternatives would not impact these resources, the proposed NIF would result in a loss of terrestrial habitat and possible impacts to threatened and endangered species.

No Action. Under No Action, the limited replacement pit fabrication, selected nonnuclear fabrication, and stewardship R&D missions described in section 3.2.6 would continue at LANL. There would be no changes to current biotic resource conditions at the site as described in section 4.6.2.6.

Management Alternatives

Pit Fabrication. The pit fabrication and intrusive and nonintrusive modification pit reuse mission at LANL would utilize existing facilities within the boundaries of a number of the site's TAs. No new construction would be required and wastewater would be released through existing NPDES-permitted discharges. The operation of pit manufacturing facilities at LANL is not expected to impact biotic resources.

Secondary and Case Fabrication. The secondary and case fabrication mission, would take place in existing structures located within a number of the site's TAs. No new construction would be required and wastewater would be released through existing NPDES permitted discharges. The operation of the secondary and case fabrication mission facilities at LANL is not expected to impact biotic resources.

High Explosives Fabrication. The HE fabrication mission would take place in existing structures located within a number of the site's TAs. No new construction would be required and wastewater would be released through existing NPDES-permitted discharges. The operation of HE fabrication mission facilities at LANL is not expected to impact biotic resources.

Nonnuclear Fabrication. Nonnuclear fabrication mission elements that would be moved to LANL would be located in existing buildings within a number of the site's TAs. No new construction would be required and wastewater would be released through existing NPDES-permitted discharges. The relocation of the nonnuclear fabrication mission to LANL is not expected to impact biotic resources.

Sensitivity Analysis. Implementation of either a low or high case workload for the stockpile management alternatives would not affect biological resources at LANL.

Stewardship Alternatives

Proposed National Ignition Facility

Terrestrial Resources. The proposed NIF would be located within TA-58, an undeveloped area containing ponderosa pine. Construction of new facilities would result in the disturbance of approximately 4 ha (10 acres) of habitat. This would cause a fragmentation of the wooded habitat present on the site. Proper erosion and sediment control measures would reduce the potential for disturbance of habitat adjacent to the construction area. During construction, animal species within the disturbed area would be either destroyed or displaced depending upon whether they were able to move from the area.

During construction and operation, fencing around the proposed NIF could cause a localized constraint on the movement of the resident elk herd in the area of the site. Wildlife may also be disturbed by the increased level of human activity associated with the project.

Wetlands. Construction and operation of the proposed NIF is not expected to affect wetlands since this resource is not located on or near the proposed site.

Aquatic Resources. Construction and operation of the proposed NIF is not expected to affect aquatic resources since this resource is not located on or near the proposed site.

Threatened and Endangered Species. The construction of the proposed NIF at LANL would disturb a small amount of habitat suitable for several special status species which potentially exist onsite. If present, less mobile species such as the New Mexican meadow jumping mouse *(Zapus hudsonius luteus)* and plant species could be lost during construction. Construction could also disturb potential foraging or nesting habitat for the Mexican spotted owl (Strix occidentalis lucida), gray vireo *(Vireo vicinior)* , southwestern willow flycatcher *(Empidonox traillii extimus)* , and spotted bat *(Euderma maculata)* . Some species such as the spotted owl may be further disturbed by the increased level of human activity (i.e., noise and lighting) associated with the project. Informal consultation under the Endangered Species Act may be necessary regarding the Mexican spotted owl.

Proposed Atlas Facility. The proposed Atlas Facility would be located at TA-35, located near the center of Pajarito Mesa, which is immediately north and east of Pajarito Canyon. The facility would be placed in existing TA-35 buildings, with the exception of a limited number of associated structures (e.g., storage tanks and a concrete pad), which would be constructed adjacent to existing buildings. No natural habitat would be disturbed and runoff volumes would not change appreciably from present levels; thus, impacts to biotic resources from construction and operation of the proposed Atlas Facility would not be expected.

Potential Mitigation Measures. Limiting the area to be disturbed, revegetating with native species, and implementing a soil erosion and sediment control plan would help to lessen short- and long-term impacts to terrestrial species and habitats. Disturbance to wildlife living in areas adjacent to new facilities may be minimized by preventing workers from entering undisturbed areas. It may be necessary to survey the site for the nests of migratory birds prior to construction and to avoid clearing operations during the breeding season. If any threatened or endangered species exist on the site, specific mitigation measures would be developed in conjunction with the USFWS.

4.6.3.7 Cultural and Paleontological Resources

For the discussion of impacts, the term cultural resources includes prehistoric, historic, and Native American resources. Cultural and paleontological resources may be affected directly through ground disturbance, building modification, visual intrusion of the project to the historic setting or environmental context of historic sites, visual and audio intrusions to Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism. Cultural resources surveys have been conducted in portions of the involved TAs. Some NRHP-eligible prehistoric and historic resources may be affected by the proposed actions. Site-specific surveys and evaluations would be conducted in conjunction with the *National Historic Preservation Act* and tiered NEPA documents. No impacts to Native American resources are anticipated. Geological strata at LANL are not known to be fossiliferous.

No Action. Under No Action, DOE would continue existing and planned missions at LANL as described in section 3.2.6. Any impacts to cultural or paleontological resources would be independent of and unaffected by the proposed action.

Management Alternatives

Pit Fabrication. Pit fabrication and intrusive modification pit reuse would necessitate reconfiguring and upgrading existing facilities within TAs -3, -8, -35, -50, -54, and -55. A nominal area would be required for equipment staging, material laydown, and parking during the modification of the facilities. All of TA-35 has been surveyed, and no cultural resources were identified. Portions of TAs -3, -8, -50, -54, and -55 have been surveyed and contain NRHP-eligible prehistoric and/or historic resources. Additional prehistoric and historic resources may exist on unsurveyed portions of the involved TAs. NRHP-eligible resources would be identified through project-specific inventories and evaluations, and any project-related effects would be addressed in tiered NEPA documentation. Impacts to Native American resources are not expected as a result of the alternative but would be identified through consultation with the potentially affected tribes. None of the geological formations at LANL are known to be fossiliferous.

Secondary and Case Fabrication. Replacing secondary and case fabrication would use existing facilities within the boundaries of TAs -3, -8, -50, -54, and -55. Some of these buildings would need modifications. A nominal area within existing buildings and developed areas would be required for equipment staging, material laydown, and parking during the facilities modification. Portions of each of the involved TAs have been surveyed and contain NRHP-eligible prehistoric and/or historic resources. Some additional NRHP-eligible sites may exist in unsurveyed portions of the involved TAs. Some prehistoric and historic resources may be affected by the proposed action. NRHP-eligible resources would be identified through project-specific surveys, inventories, and evaluations, and any project-related effects would be addressed in tiered NEPA documentation. Impacts to Native American resources are not expected but would be identified through consultation with potentially affected tribes. None of the geological formations at LANL are known to be fossiliferous.

High Explosives Fabrication. HE fabrication would take place in TAs -9, -16, -28, and -37. Only minimal new equipment is needed; no facility construction or modification is necessary to conduct the HE fabrication mission at LANL. No impacts to cultural or paleontological resources are anticipated. Sharing this mission with LLNL would have no impact on cultural and paleontological resources at LANL.

Nonnuclear Fabrication. Nonnuclear fabrication would use existing facilities within TAs -3, -16, -22, and -35. Additional equipment and building modifications would be necessary. These modifications largely involve electrical upgrades, and no ground disturbance is expected. Impacts to prehistoric, Native American, or paleontological resources are not anticipated. Some of the facilities to be modified under this alternative have been declared eligible for inclusion in the NRHP. Any project-related effects to historic resources would be addressed in tiered NEPA and *National Historic Preservation Act* documentation.

Sensitivity Analysis. The high and low case scenarios for the proposed stockpile management alternatives at LANL would have the same impacts to cultural and paleontological resources as the base case production facilities.

Stewardship Alternatives

Proposed National Ignition Facility. Surveys indicate that no prehistoric or historic archaeological sites or structures exist on the proposed NIF location in TA-58. Paleontological remains are unlikely to exist in the proposed location because the Pajarito Plateau, comprised of Pleistocene volcanic tuffs and the Bandelier Formation, does not contain fossiliferous deposits. No Native American resources have been identified to date in the proposed location but some may be identified through consultation with the potentially affected tribes.

Proposed Atlas Facility. Existing buildings in TA-35 would be renovated to implement the proposed Atlas Facility. Some additional land would be required for the placement of concrete pads, storage tanks, and transportable office and diagnostic space. All of TA-35 has been surveyed for cultural resources and none were identified. All of the involved buildings were constructed in either 1980 or 1990 (appendix K) and are not NRHP eligible. No impacts to Native American or paleontological resources are expected.

Potential Mitigation Measures. If NRHP-eligible sites cannot be avoided though project design or siting, and the facility would cause adverse impacts, then a Memorandum of Agreement would need to be negotiated among DOE, the New Mexico SHPO, and the Advisory Council on Historic Preservation. The Memorandum of Agreement would formalize mitigation measures agreed to by these consulting parties. Mitigation measures could include describing and implementing intensive inventory and evaluation studies, data recovery plans, site treatments, and monitoring programs. The appropriate level of data recovery for mitigation would be determined through consultation with the New Mexico SHPO and the Advisory Council on Historic Preservation in accordance with Section 106 of the *National Historic Preservation Act* . Mitigation measures for specific NRHP-eligible sites would be identified during tiered NEPA documentation.

If Native American resources could not be avoided through project design or siting, then acceptable mitigation measures to reduce project impacts on them would be determined in consultation with the affected Native American groups. In accordance with the Native American Graves Protection and Repatriation Act and the American Indian Religious Freedom Act, such mitigations may include, but would not be limited to, appropriately relocating human remains, planting vegetation screens to reduce visual or noise intrusion, increasing access to traditional use areas during operation, or transplanting or harvesting important Native American plant resources.

4.6.3.8 Socioeconomics

No Action. Under No Action, the existing missions at LANL as described in section 3.2.6 would continue with no new employment or in-migration of workers. Projections for regional economy and employment rates, population and housing changes, and public finance characteristics are presented in appendix D.

By 2002, the DAHRT Facility would be operational at LANL. A total of 80 jobs would be generated as a result of operation of this facility. This increase in workers has been considered in the No Action analysis for LANL.

Regional Economy and Employment. Total employment in the regional economic area is projected to grow slightly less than 2 percent annually between 1995 and 2000, reaching approximately 122,700 in the latter year. Long-range projections show employment growth averaging slightly more than 1 percent annually between 1995 and 2000 and then slowing to less than 1 percent between 2021 and 2030, reaching approximately 164,400 persons. Site employment at LANL is expected to total 6,546 in 2005. The unemployment rate in the regional economic area was 6.2 percent in 1994 and is expected to remain at this level into the near future. Per capita income is projected to increase from approximately $18,314 in 1995 to $26,801 in 2030.

Population and Housing. Annual ROI county and city population and housing growth is projected to be less than 2 percent over the period 1995 to 2005 and then is expected to slow to about 1 percent in the period 2006 to 2030. Annual increases between 2006 and 2030 are expected to be a little more than 1 percent. Population in the ROI is projected to increase from 167,400 in 1995 to 245,100 by 2030. The total number of housing units in the ROI is projected to increase from 70,100 in 1995 to 102,700 in 2030.

Public Finance. Between 2000 and 2005, all ROI county, city, and school district total revenues are projected to increase at an annual average of less than 1.6 percent. Total expenditures are projected to increase at an annual average of less than 1.5 percent during the same period. These rates of increase should continue until 2030.

Management Alternatives

Pit Fabrication

Regional Economy and Employment. Modification-related activities for the Pit Fabrication Facility would require 138 direct workers during the peak construction year and would generate approximately an additional 90 indirect jobs in the regional economic area. As a result of the modification activities, total employment for the LANL regional economic area would increase by much less than 1 percent. This increase would reduce the unemployment rate from 6.2 percent under the No Action alternative to approximately 6 percent. Per capita income for the LANL regional economic area would increase very slightly over No Action projections.

Operation employment at LANL would begin phasing in as the modification phase nears completion. Operation of the facility in the base case surge mode would generate 260 new direct jobs, but would generate no indirect jobs because there are no closely related industries in the regional economic area. As a result of the operation of the facility, total employment for the LANL regional economic area would increase by much less than 1 percent. This increase would reduce regional unemployment from the 6.2 percent No Action estimate to approximately 6.0 percent. Per capita income for the LANL regional economic area would increase by much less than 1 percent over No Action projections. Changes in employment and per capita income resulting from the operation of the Pit Fabrication Facility are shown in figure 4.6.3.8-1.

Population and Housing. Population in the LANL ROI during peak construction would not increase over No Action projections. Available workers in the regional economic area and ROI would be sufficient to fill all of the direct and indirect jobs generated by the modification activities for the facility.

There would not be enough available workers to fill all of the direct operation jobs. Approximately 20 workers would in-migrate to fill positions at the Pit Fabrication Facility. The ROI population over No Action for full operation at LANL is shown in figure 4.6.3.8-2. Vacant housing in the ROI is sufficient to house the in-migrating workers and their families.

Public Finance. Modification of the Pit Fabrication Facility would not require in-migrating workers. Therefore, changes to local finances compared to No Action projections would be attributed to income increases and would be negligible.

Changes in revenues and expenditures compared to No Action projections due to operation of the facility at LANL are shown in figure 4.6.3.8-3. In 2005 the percent increase in total ROI revenues and expenditures over No Action projections would be negligible with the exception of the Los Alamos school district which would be expected to experience increases of approximately 1 percent.

Secondary and Case Fabrication

Regional Economy and Employment. Modification-related activities for the Secondary and Case Fabrication Facility would generate a total of 55 direct jobs during the peak construction year and would generate an additional 36 indirect jobs in the regional economic area. As a result of the modification activities, total employment for the LANL regional economic area would increase by less than 1 percent. This increase would reduce regional unemployment from the 6.2 percent No Action estimate to approximately 6.1 percent. Per capita income for the LANL regional economic area would increase very slightly over No Action projections as a result of modification activities for the Secondary and Case Fabrication Facility.

Facility operation-related employment at LANL would begin phasing in as the modification phase nears completion. Operation of the facility in the base case surge mode would require 321 new direct workers but would generate few additional indirect jobs in the regional economic area because there are no closely related industries in the regional economic area. As a result of the operation of the facility, total employment for the LANL regional economic area would increase by less than 1 percent. This increase would reduce regional unemployment from the 6.2 percent No Action estimates to approximately 6.0 percent. Per capita income for the LANL regional economic area would increase by less than 1 percent over No Action projections. Changes in employment and per capita income resulting from the operation of the Secondary and Case Fabrication Facility are shown in figure 4.6.3.8-1.

Population and Housing. Population in the LANL ROI during construction or operation of the Secondary and Case Fabrication Facility would not increase over No Action projections. Available workers in the regional economic area and ROI would be sufficient to fill all of the jobs generated by construction and operation of the facility.

Public Finance. Construction and operation of the Secondary and Case Fabrication Facility would not require in-migrating workers. Therefore, changes to local finances compared to No Action projections would be due to income increases and would be negligible.

High Explosives Fabrication

Regional Economy and Employment. Modification-related activities for the facility would require 46 direct workers during the peak construction year and would generate an additional 30 indirect jobs in the regional economic area. As a result of the modification activities, total employment for the LANL regional economic area would increase by less than 1 percent. Unemployment would decrease from the 6.2 percent No Action estimates to approximately 6.1 percent. Per capita income for the LANL regional economic area would increase very slightly over No Action projections as a result of modification activities for the HE Facility.

Facility operation-related employment at LANL would begin phasing in as the modification phase nears completion. Operation of the facility in the base case surge mode would require 67 new direct workers but would generate only a few indirect jobs because there are no closely related industries in the regional economic area. As a result of the operation of the HE Facility, total employment for the LANL regional economic area would increase by much less than 1 percent. The No Action regional unemployment of 6.2 percent would decrease to 6.1 percent. Per capita income for the LANL regional economic area would increase slightly over No Action projections. Changes in employment and per capita income resulting from the operation of the HE Facility are shown in figure 4.6.3.8-1.

Population and Housing. Population in the LANL ROI during peak construction would not increase over No Action projections. Available workers in the regional economic area and ROI would be sufficient to fill all of the direct and indirect jobs generated by construction of the HE Facility.

There would not be enough available workers in the regional economic area and ROI to fill all of the jobs generated by operation of the facility. Approximately 10 additional workers would have to in-migrate into the ROI to fill the new direct jobs. Population in the LANL ROI during full operation would increase by approximately 30 people over No Action projections. The ROI population over No Action for full operation at LANL is shown in figure 4.6.3.8-2. No additional housing units would be needed to meet such a small population increase.

Public Finance. Modification of the HE Facility would not require in-migrating workers. Therefore, changes to local finances compared to No Action projections would be due to income increases and would be negligible.

Changes in revenues and expenditures compared to No Action projections due to operation of the HE Facility at LANL are shown in figure 4.6.3.8-4. In 2005, the percent increase in total ROI revenues and expenditures over No Action projections would be negligible.

Nonnuclear Fabrication

Regional Economy and Employment. Modification-related activities for the facility would require a total of six workers during the peak construction year and would generate an additional four indirect jobs in the regional economic area. As a result of the modification activities, total employment and per capita income would not noticeably increase. The unemployment rate would remain unchanged.

Facility operation-related employment at LANL would begin phasing in as the modification phase nears completion. Operation of the facility in the base case surge mode would require 194 new direct workers and would generate approximately 46 indirect jobs in the regional economic area. As a result of the operation of the facility, total employment for the LANL regional economic area would increase by less than 1 percent. Unemployment would decrease from 6.2 percent under the No Action alternative to 6.0 percent. Per capita income for the LANL regional economic area would increase by less than 1 percent over No Action projections. Changes in employment and per capita income resulting from the operation of the Nonnuclear Fabrication Facility are shown in figure 4.6.3.8-1.

Population and Housing. Population in the LANL ROI during peak construction and full operation would not increase over No Action projections. There would be enough workers available in the regional economic area and ROI to fill all of the direct and indirect jobs generated by the modification and operation of the Nonnuclear Fabrication Facility.

Public Finance. Construction and operation of the Nonnuclear Fabrication Facility would not require in-migrating workers. Therefore, changes to local finances compared to No Action projections would be due to income increases and would be negligible.

Partial Nonnuclear Fabrication. LANL may not receive the entire nonnuclear mission. Reservoirs and/or plastics may be excluded from the mission. If this occurs, the full operation employment increment would range from 57 to 232 direct jobs. For these options, in-migration would not be required. Socioeconomic effects on regional economy, employment, population, and housing would be less than for the full nonnuclear mission. These changes would be minimal.

Sensitivity Analysis . There would be no change in the number of construction workers required to complete any of the facilities for LANL (pit manufacturing, secondary and case fabrication, HE or nonnuclear fabrication) for either the high or low case. Operation of any of the facilities for the high case level would require fewer workers than would the base case surge operation. For the low case, worker requirements would decrease further causing slightly smaller increases in regional economy, population and housing, and public finance than occurred in either the base case surge or high case levels. These changes would be negligible.

Stewardship Alternatives

Proposed National Ignition Facility. The following is a summary of the socioeconomic effects of construction of the proposed NIF at LANL. See appendix I for a more detailed, project-specific discussion.

Regional Economy and Employment. Construction of NIF would require 270 construction workers during the peak year of construction and would generate approximately 860 additional indirect jobs in the regional economic area. Employment for operation would begin phasing in as the construction phase nears completion. Operation of the facility would require 330 direct workers and would generate 270 additional indirect jobs in the regional economic area. Construction and operation of NIF would have only minimal affects on the regional economy and employment.

Population and Housing. Both construction and operation of the facility would require workers and their families to in-migrate to the ROI. This in-migration would cause a slight increase in the population of the ROI. Vacant housing in the ROI is sufficient to handle these increases.

Public Finance. Both revenues and expenditures would increase as a result of the construction and operation of NIF. Increases due to construction would peak in 1998 and then decline as construction nears completion in 2002. Increases due to operation of the facility would peak in 2003 and continue through the duration of NIF operations.

Proposed Atlas Facility. The Atlas Facility at LANL would not have any identified socioeconomic impact over No Action.

Combined Program Impacts. If the pit fabrication, secondary and case fabrication, HE, and nonnuclear fabrication missions and the NIF were all located at LANL, the resulting benefits to the regional economy would be greater than from any one mission. Increases in total employment would be about 1 percent while per capita income would increase less than 1 percent. There would be sufficient available labor in the projected labor force to fill any construction-related employment requirements, but not enough to fill operation-related employment requirements. Approximately 1,349 people (workers and their families) would in-migrate into the LANL ROI to fill the available operation jobs. Although there would be a small population increase in the ROI, vacant housing would not be sufficient to house all in-migrating workers during full operation. Approximately 250 houses would need to be constructed over the No Action estimates. However, based on past building rates, new construction would be able to meet this demand. As shown in figure 4.6.3.8-5, the increase in ROI total revenues and expenditures over No Action projections would be approximately 0.7 and 0.6 percent, respectively. The Los Alamos School District would experience the greatest revenue and expenditure increases at approximately 3.1 percent.

Potential Mitigation Measures. No mitigation measures are anticipated for the stockpile stewardship and management alternatives at LANL.

4.6.3.9 Radiation and Hazardous Chemical Environment

This section describes the radiological and hazardous chemical releases and their associated impacts which could result from No Action and proposed alternatives at LANL. Within this section, impacts resulting from the base case scenario are quantitatively discussed, and a sensitivity analysis of the high and low case scenarios is qualitatively discussed.

Summaries of the prevailing radiological impacts at LANL to the public and to workers associated with normal operation are presented in tables 4.6.3.9-1 and 4.6.3.9-2, respectively; accident radiological impacts are presented in figure 4.6.3.9-1 and tables 4.6.3.9-3 through 4.6.3.9-7. The impact assessment methodology is described in section 4.1.9, and further supplementary methodological information is presented in appendixes E and F.

Normal Operation There would be no radiological releases during the construction or modification of any facilities to support the Stockpile Stewardship and Management Program. However, limited hazardous chemical releases (e.g., small spills of diesel fuel from equipment refueling) may occur due to construction activities for the base case scenario and may increase slightly for the high case scenario. The concentration of these releases is expected to be well within the regulated exposure limits and would not result in any adverse health effects.

Water from processes containing hazardous chemicals is not discharged directly into surface water or groundwater that serves as potable water. Process water that may contain hazardous chemicals is treated before discharge. Furthermore, discharges of wastewater through NPDES-permitted outfalls which can be attributed to the activities associated with normal operations and operations of the stockpile stewardship and management alternatives at LANL are expected to be below NPDES limits. Water quality would not be adversely affected. Thus, the primary pathway considered for the public and the onsite worker is the air pathway.

For normal operation at LANL, all possible hazardous chemicals were examined for further analysis based on their toxicity, concentration, and frequency of use. The HI is a summation of the HQ for all chemicals. The HQ is the value used as an assessment of noncancer toxic effects of chemicals (e.g., kidney or liver dysfunction). It is independent of cancer risk, which is calculated only for those chemicals identified as carcinogens. The HI was calculated for the No Action chemicals and all alternative chemicals proposed to be added (the increment) at the site to yield cumulative levels for the site. An HI of 1.0 indicates that all noncancer exposure values meet OSHA standards; if the cancer risk is 1x10-*6* (the default value, not a regulatory standard), no further analysis is indicated. A cancer risk of 1x10-*6* is considered acceptable by EPA (40 CFR 300.430) because this incidence of cancers cannot be distinguished from the cancer risk for an individual member of the population. Information pertaining to OSHA-regulated exposure limits and toxicity profiles for all hazardous chemicals described in this PEIS may be found in the *Chemical Health Effects Technical Reference* (TTI 1996b).

No Action

Radiological Impacts. Radiological impacts to the public resulting from the No Action alternative are presented in table 4.6.3.9-1. These impacts are representative of the aggregated total which is estimated to exist from all future baseline operational contributions (including pit fabrication R&D). Total impacts are provided to compare with applicable regulations governing total site operations. To place doses to the public from the No Action alternative into perspective, comparisons are made to natural background radiation. As shown in table 4.6.3.9-1, the total dose to the maximally exposed member of the public from annual total site operations is within radiological limits and would be 6.5 mrem for the No Action alternative. The annual population dose within 80 km (50 mi) in 2030 would be 2.7 person-rem.

Total site doses to onsite workers from normal operation for the No Action alternative are presented in table 4.6.3.9-2. The estimated annual dose to the entire facility workforce for this alternative would be 196 person-rem. The presented noninvolved worker impacts were not modeled due to the unavailability of certain site-specific information.

Potential radiological impacts to the public and workers in tables 4.6.3.9-1 and 4.6.3.9-2 include the addition of the phased containment option (preferred alternative) representing the DARHT Facility and the phaseout of the PHERMEX Facility at LANL. Based on the radiological impacts associated with normal operation under the No Action alternative, all resulting doses would be within radiological limits and are well below levels of natural background radiation. The associated risks of adverse health effects to the public and to workers would be small.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from normal operation under No Action at LANL are presented below. Analyses to support the values presented in this section are provided in appendix table E.3.4-13. This PEIS does not purport to provide the level of detail needed to go beyond a conservative screening process for hazardous chemicals. As such, the analysis in this PEIS for the No Action alternative should not be relied upon as a basis for judging the sites as having a hazardous health concern of alternatives among sites. The model used to calculate HI and cancer risk in this PEIS only establishes a baseline for comparison of alternatives among sites. The baseline is then used to determine the extent to which each alternative adds or subtracts from the No Action HI and cancer risk to the public at each site.

The HI for the maximally exposed individual of the public at LANL resulting from normal operation under the No Action alternative would be 3.01x10^{-2} , and the cancer risk would be 5.15x10^{-6} . The HI for the onsite worker would be 4.65x10^{-2} and the cancer risk would be 1.54x10^{-4} . The HIs for the public and onsite worker are within acceptable health levels.

Cancer risks to the public and to the onsite worker exceed the EPA default value as a result of the emissions of methylene chloride; 1,1,2-

trichloroethane; and trichloroethylene associated with operations under the No Action alternative at LANL.

Mitigation measures such as substituting less toxic solvents or modifying processes are proposed to reduce or eliminate the emissions of all hazardous chemicals due to operations under the No Action alternative with particular attention to methylene chloride; 1,1,2-trichloroethane; and trichloroethylene.

Table 4.6.3.9-1.-- Potential Radiological Impacts to the Public Resulting from Normal Operation of Stockpile Stewardship and Management Alternatives at Los Alamos National Laboratory

	No Action	**Pit Fabrication Three-Shift Operation**	**Secondary and Case Fabrication Three-Shift Operation[9]**	**National Ignition Facility**	**Atlas Facility**	**Combined Program Total[10]**
Affected Environment	**Total Site**	**Total Site[11]**	**Total Site[11]**	**Total Site[11]**	**Total Site[11]**	**Total Site[11]**
Maximally Exposed Individual (Public)						
Atmospheric Release						
Dose[12] (mrem/yr)	5.7	5.7	5.9	5.7	5.7	5.9
Percent of natural background[13]	1.7	1.7	1.7	1.7	1.7	1.7
25-year fatal cancer risk	$7.1x10^{-5}$	$7.1x10^{-5}$	$7.4x10^{-5}$	$7.1x10^{-5}$	$7.1x10^{-5}$	$7.4x10^{-5}$
Liquid Release						
Dose[12] (mrem/yr)	0.80	0.80	0.80	0.80	0.80	0.80
Percent of natural background[13]	0.24	0.24	0.24	0.24	0.24	0.24
25-year fatal cancer risk	$1.0x10^{-5}$	$1.0x10^{-5}$	$1.0x10^{-5}$	$1.0x10^{-5}$	$1.0x10^{-5}$	$1.0x10^{-5}$
Atmospheric and Liquid Releases						
Dose[12] (mrem/yr)	6.5	6.5	6.7	6.5	6.5	6.7
Percent of natural background[13]	1.9	1.9	2.0	1.9	1.9	2.0
25-year fatal cancer risk	$8.1x10^{-5}$	$8.1x10^{-5}$	$8.4x10^{-5}$	$8.1x10^{-5}$	$8.1x10^{-5}$	$8.4x10^{-5}$
Population Within 80 Kilometers						
Atmospheric and Liquid Releases in 2030						
Dose (person-rem)	2.7	2.7	3.2	2.8	2.7	3.3
Percent of natural background[13]	$2.8x10^{-3}$	$2.8x10^{-3}$	$3.4x10^{-3}$	$2.9x10^{-3}$	$2.8x10^{-3}$	$3.5x10^{-3}$
25-year fatal cancers	0.034	0.034	0.040	0.035	0.034	0.041

Table 4.6.3.9-2.-- Potential Radiological Impacts to Workers Resulting from Normal Operation of Stockpile Stewardship and Management Alternatives at Los Alamos National Laboratory

Affected Environment	No Action	Pit Fabrication Three-Shift Operation	Secondary and Case Fabrication Three-Shift Operation[14]	National Ignition Facility	Atlas Facility	Combined Program Total
Involved Workforce[15]						
Average worker dose[16] (mrem/yr)	NA	380	2.2	30	0	NA
25-year fatal cancer risk	NA	$3.8x10^{-3}$	$2.2x10^{-5}$	$3.0x10^{-4}$	0	NA
Total dose (person-rem/ yr)	NA	55.6	0.33	8.0	0	64
Noninvolved Workforce [17]						
Average worker dose[16] (mrem/yr)	34	34	34	34	34	NA
25-year fatal cancer risk	$3.4x10^{-4}$	$3.4x10^{-4}$	$3.4x10^{-4}$	$3.4x10^{-4}$	$3.4x10^{-4}$	NA
Total dose (person-rem/ yr)	196	196	196	196	196	196
Total Site Workforce[18]						
Dose (person-rem/yr)	196	252	196	204	196	260
25-year fatal cancers	2.0	2.5	2.0	2.0	2.0	2.6

Management Alternatives

Pit Fabrication

Radiological Impacts. Radiological impacts to the public resulting from the pit fabrication alternative are presented in table 4.6.3.9-1. These impacts are representative of the aggregate total which is estimated to exist from all future baseline operational LANL contributions and from three-shift base case operations for pit fabrication at the site. Total impacts are provided to compare with applicable regulations governing total site operations. To place doses to the public from this alternative into perspective, comparisons are made to natural background radiation. As shown in table 4.6.3.9-1, the total dose to the maximally exposed member of the public from annual total site operations is within radiological limits and would be 6.5 mrem for this alternative. The annual population dose within 80 km (50 mi) in 2030 would be 2.7 person-rem. The impacts incurred from three-shift base case operations are negligible when compared to those existing for the normal baseline site operations (see table 4.6.3.9-1).

Total site doses to onsite workers from normal operation for the pit fabrication mission are presented in table 4.6.3.9-2. The average annual dose to involved workers for this alternative would be 380 mrem. The dose to the entire facility workforce (involved workforce) would be 55.6 person-rem. As stated in the methodology section 4.1.9, all worker doses were referenced either from alternative-specific working group data reports or from the Radiation Exposures for DOE and DOE Contractor Employees 1992 Database which reports doses for similar types of operations. The presented noninvolved worker impacts were not modeled due to the unavailability of certain site-specific information. There may also be small risks to construction workers who are involved with tasks that are in close proximity to potentially contaminated areas.

Hazardous Chemical Impacts. Hazardous chemical impacts for the public and for the onsite worker resulting from normal operation of the pit fabrication alternative at LANL are presented below. The pit fabrication alternative includes intrusive and nonintrusive modification pit reuse. The HI and cancer risk would remain constant over 25 years of operation provided exposures remain the same. Analyses to support the values presented in this section are provided in appendix table E.3.4-14.

The incremental HI for the maximally exposed member of the public would be $2.10x10^{-4}$, and the incremental cancer risk would be zero as a result of operation of the pit fabrication mission in the year 2005. The incremental HI for the onsite worker would be $1.75x10^{-4}$, and the incremental cancer risk would be zero as a result of operation of the pit fabrication mission in 2005.

The total site operation and the increment associated with the pit fabrication alternative would result in HIs for the public (0.030) and onsite worker (0.047) that are within acceptable health levels. The cancer risks to the public (5.15×10^{-6}) and to the onsite worker (1.54×10^{-4}) slightly exceed the EPA default value of 1×10^{-6} .

Cancer risks to the public and to the onsite worker exceed the EPA default value as a result of the No Action emissions of chloroform; methylene chloride; 1,1,2-trichloroethane; and trichloroethylene. Incremental emissions due to the pit fabrication mission cause only a minimal increase in the HI for the public and onsite worker and, therefore, this alternative is not expected to increase the cancer risk for the public and the onsite worker.

Secondary and Case Fabrication

Radiological Impacts. Radiological impacts for the public resulting from the secondary and case fabrication alternative are presented in table 4.6.3.9-1. These impacts are representative of the aggregate total which is estimated to exist from all future baseline operational LANL contributions and from three-shift base case operation for secondary and case fabrication at the site. Total impacts are provided to compare with applicable regulations governing total site operations. To place doses for the public from this alternative into perspective, comparisons are made to natural background radiation. As shown in table 4.6.3.9-1, the total dose to the maximally exposed member of the public from annual total site operations is within radiological limits and would be 6.7 mrem for this alternative. The annual population dose within 80 km (50 mi) in 2030 would be 3.2 person-rem. The impacts incurred from three-shift base case operations are small when compared to those existing for the normal baseline site operations (see No Action column in table 4.6.3.9-1).

Total site doses to onsite workers from normal operation for the secondary and case fabrication mission are presented in table 4.6.3.9-2. The average annual dose to involved workers for this alternative would be 2.2 mrem. The dose to the entire facility workforce (involved workforce) would be 0.33 person-rem. As stated in the methodology section 4.1.9, all worker doses were referenced from the Radiation Exposures for DOE and DOE Contractor Employees 1992 Database which reports doses for similar types of operations. The presented noninvolved worker impacts were not modeled due to the unavailability of certain site-specific information. There may also be small risks to construction workers who are involved with tasks that are in close proximity to potentially contaminated areas.

Hazardous Chemical Impacts. Hazardous chemical impacts for the public and for the onsite worker resulting from the normal operation of the secondary and case fabrication alternative at LANL are presented below. The HI and cancer risk would remain constant over 25 years of operation provided exposures remain the same. Analyses to support the values presented in this section are provided in appendix table E.3.4-15.

The incremental HI for the maximally exposed member of the public would be 9.43x10-4 and the incremental cancer risk would be zero as a result of operation of the secondary and case fabrication mission in 2005. The incremental HI for the onsite worker would be 7.89x10-4 and the incremental cancer risk would be zero as a result of operation of the secondary and case fabrication mission in 2005.

Total site operations of the secondary and case fabrication mission would result in HIs (HI is applicable only to noncarcinogenic risks) for the public (0.031) and the onsite worker (0.047) that are within acceptable health levels. The cancer risks for the public (5.15×10^{-6}) and the onsite worker (1.54×10^{-4}) slightly exceed the EPA default value of 1x10-6using extremely conservative stack assumptions (i.e., a stack flow of 0.1 ft/sec). Using the same emissions values and average LANL stack flow, the cancer risk values drop by 2 to 3 orders of magnitude (i.e., 100 to 1,000 times lower).

Cancer risks for the public and for the onsite worker exceed the EPA default value as a result of the No Action emissions of methylene chloride; 1,1,2-trichloroethane; and trichloroethylene. When average LANL stack flows are used, the cancer risk for the public and the onsite worker do not exceed the default value for any alternative. Incremental emissions due to the secondary and case fabrication mission cause only a minimal increase in HI (noncarcinogenic risks) for the public and onsite worker and no additional cancer risk for the public and the onsite worker.

High Explosives Fabrication

Radiological Impacts. There are no radiological impacts associated with this alternative.

Hazardous Chemical Impacts. Hazardous chemical impacts for the public and for the onsite worker resulting from normal operation of the HE fabrication alternative at LANL are presented below. The HI and cancer risk would remain constant over 25 years of operation provided exposures remain the same. Analyses to support the values presented in this section are provided in appendix table E.3.4-16.

The incremental HI for the maximally exposed individual of the public would be 3.99x10-3 and the incremental cancer risk would be zero as a result of operation of the HE fabrication mission in 2005. The incremental HI for the onsite worker would be 3.33×10^{-3} and the incremental cancer risk would be zero as a result of operation of the HE fabrication mission in 2005.

Total site operations of the HE fabrication mission would result in HIs for the public (0.034) and the onsite worker (0.05) that are within acceptable health levels. The cancer risks for the public (5.15×10^{-6}) and the onsite worker (1.54×10^{-4}) slightly exceed the EPA default value of

1x10-6. Incremental emissions due to the HE fabrication mission cause only a minimal increase in HI for the public and onsite worker and no additional cancer risk for the public and the onsite worker.

Cancer risks for the public and for the onsite worker exceed the EPA default value as a result of the No Action emissions of chloroform, methylene chloride; 1,1,2-trichloroethane; and trichloroethylene.

Sharing of the HE Fabrication alternative mission with LLNL would be expected to reduce emissions of hazardous chemicals by up to 50 percent. Therefore, HI and cancer risk impacts may be reduced up to 50 percent as a result of HE fabrication mission sharing with LLNL. This would bring the cancer risk to an acceptable level of 1x10-6.

Nonnuclear Fabrication

Radiological Impacts. There are no radiological impacts associated with this alternative.

Hazardous Chemical Impacts. Hazardous chemical impacts for the public and for the onsite worker resulting from normal operation of the nonnuclear fabrication alternative at LANL are presented below. The nonnuclear fabrication alternative includes detonators and the option of adding reservoirs, plastics, or both to this mission. The HI and cancer risk would remain constant over 25 years of operation provided exposures remain the same. Analyses to support the values presented in this section are provided in appendix table E.3.4-17.

The incremental HI to the maximally exposed member of the public would be $2.61\text{x}10^{-5}$ and the incremental cancer risk would be zero as a result of operation of the nonnuclear fabrication mission in 2005. The incremental HI for the onsite worker would be $3.15\text{x}10^{-6}$, and the incremental cancer risk would be zero as a result of operation of the nonnuclear fabrication mission in 2005.

Total site operations and the incremental effect of the nonnuclear fabrication mission would result in HIs for the public (0.03) and the onsite worker (0.047) that are within acceptable health levels. The cancer risks for the public ($5.15\text{x}10^{-6}$) and the onsite worker ($1.54\text{x}10^{-4}$) slightly exceed the EPA default value of 1x10-6.

Cancer risks for the public and for the onsite worker exceed the EPA default value due to the No Action emissions of chloroform methylene chloride; 1,1,2-trichloroethane; and trichloroethylene. Incremental emissions due to the nonnuclear fabrication mission cause only a minimal increase in HI for the public and onsite worker and no additional cancer risk for the public and the onsite worker.

The emissions of hazardous chemicals may not increase, and may slightly decrease if the options of not including reservoirs, plastics, or both in the nonnuclear fabrication alternative is implemented. Therefore, it is not expected that there would be any increase in HI or cancer risk for the public or for the onsite worker by not including reservoirs, plastics, or both in the nonnuclear fabrication alternative at LANL.

Sensitivity Analysis. Radiological impacts may be subject to certain degrees of variance resulting from either high or low case operations. For the high case scenario, impacts to both the public and worker would be similar to the three-shift base case operations. For the low-case scenario, impacts to the total workforce would be expected to fall within the increment (range) projected between that of No Action and the pit fabrication alternative (less than 55.6 person-rem/year increase to the total site workforce). Impacts for the public would be expected to fall within the increment (range) projected between that of No Action and the secondary and case fabrication alternative (less than 0.2 mrem/year to the maximally exposed individual, and less than 0.5 person-rem/year for the population).

Based on the radiological impacts associated with normal operation of this alternative, all resulting doses would be within radiological limits and are well below levels of natural background radiation. The associated risks of adverse health effects for the public and to workers would be small.

Operations under the low case scenario for pit, secondary and case, HE, and nonnuclear fabrication are not expected to increase the emissions of hazardous chemicals at LANL. Since the HIs are well within the acceptable health limits, there are no adverse HI impacts for the public and the onsite worker expected. The low case scenario probably would not contribute to the expected adverse effects of cancer risk for the public and onsite worker.

Operations under the high case scenario for pit and secondary and case fabrication may increase the emissions of hazardous chemicals at LANL. Since the HIs are well within the acceptable health limits, there are no expected adverse HI impacts for the public and the onsite worker. The high case scenario probably would also not increase cancer risk for the public and onsite worker above the EPA default value.

Operations under the high case scenario for HE fabrication may result in up to a two-fold increase in the emissions of hazardous chemicals at LANL. Since the HIs are well within the acceptable health limits, no adverse HI impacts for the public and the onsite worker are expected. The high case scenario probably would not increase the cancer risk for the public and onsite worker above the EPA default value.

Operations under the high case scenario for nonnuclear fabrication may result in up to a three-fold increase in the emissions of hazardous chemicals at LANL. Since the HIs are well within the acceptable health limits, no adverse HI impacts for the public and the onsite worker are expected. The high case scenario may, however, contribute to the adverse effects of cancer risk for the public and onsite worker unless mitigation steps are implemented.

Stewardship Alternatives

Proposed National Ignition Facility

Radiological Impacts. Radiological impacts for the public resulting from normal operation of the proposed NIF for the enhanced option scenario are presented in table 4.6.3.9-1. These impacts are representative of the aggregate total which is estimated to exist from all future baseline operational LANL contributions and from enhanced option operations of the proposed NIF at the site. Total impacts are provided to compare with applicable regulations governing total site operations. To place doses for the public from this alternative into perspective, comparisons are made to natural background radiation. As shown in table 4.6.3.9-1, the total dose to the maximally exposed member of the public from annual total site operations is within radiological limits and would be 6.5 mrem for this alternative. The annual population dose within 80 km (50 mi) in 2030 would be 2.8 person-rem. The impacts incurred from proposed NIF operations are small when compared to those existing for the normal baseline site operations (see No Action column in table 4.6.3.9-1).

Total site doses to onsite workers from normal operation for the proposed NIF are presented in table 4.6.3.9-2. The average annual dose to involved workers for this alternative would be 30 mrem. The dose to the entire facility workforce (involved workforce) would be 8.0 person-rem. The presented noninvolved worker impacts were not modeled due to the unavailability of certain site-specific information. There may also be small risks to construction workers who are involved with tasks that are in close proximity to potentially contaminated areas.

Based on the radiological impacts associated with normal operation of this alternative, all resulting doses would be within radiological limits and are well below levels of natural background radiation. The associated risks of adverse health effects for the public and to workers would be small.

Hazardous Chemical Impacts. No hazardous chemical impacts are expected from operation of the NIF (see appendix I). Therefore, HIs and cancer risks for the public and onsite workers were not calculated nor assessed.

Proposed Atlas Facility

Radiological Impacts. There are no radiological impacts associated with this alternative. Total site doses and impacts characteristic of this alternative are equal to the No Action alternative.

Hazardous Chemical Impacts. Minimal hazardous chemical impacts are expected from operation of the Atlas Facility (see appendix K). Therefore, HIs and cancer risks for the public and onsite workers were not calculated nor assessed.

Combined Program Impacts

Radiological Impacts. Radiological impacts to the public and to workers from the simultaneous operation of all LANL site alternatives (both management and stewardship) would result in very small increases over the No Action or the largest individual alternative. All Program totals would be within radiological limits and are well below levels of natural background radiation. The associated risks of adverse health effects to the public and to workers would be small.

Combined Program impacts due to hazardous chemical emissions from operation of the No Action alternative and the incremental chemical emissions incurred by the management alternatives (pit fabrication, secondary and case fabrication, HE fabrication, and nonnuclear fabrication) would result in a cumulative HI for the public of 0.035 and a cumulative cancer risk of $5.15x10^{-6}$. The cumulative HI for the onsite worker would be 0.051 and the cumulative cancer risk would be $1.54x10^{-4}$.

The cumulative Program HIs (noncarcinogenic effects) for the public and the onsite worker are within acceptable health levels since the HIs do not exceed the value of 1. Concern for potential health effects is heightened when the HI exceeds 1. Cumulative cancer risks for the public and the onsite worker exceed the cancer risk default value of 1x10-6 under No Action when extremely conservative stack parameters are used. When average LANL stack flows are used, the cancer risk for the public and the onsite workers do not exceed this default value for any alternatives. The incremental chemical emissions due to operations associated with all of the management alternatives did not increase the cancer risks.

Potential Mitigation Measures.Radioactive airborne emissions to the general population and onsite exposures to workers could be reduced by implementing the latest technology for process and design improvements. For example, to reduce public exposure from emissions, improved building and work area control methods could be used to remove radioactivity from the releases to the environment. Similarly, the use of remote, automated and robotic production methods are examples of techniques that are being developed which would reduce worker exposure (see section 3.5).

Measures such as substituting less-toxic solvents or modifying processes are proposed to reduce or eliminate the emissions of all hazardous chemicals due to site operations, with particular attention to methylene chloride; 1,1,2-trichloroethane; and trichloroethylene.

Facility Accidents. The proposed actions have the potential for accidents that may impact the health and safety of workers and the public. The potential for and associated consequences of reasonably foreseeable accidents that have been evaluated are summarized in this section and described in more detail in appendix F. The methodology used in the assessment is described in section 4.1.9. A list of documents reviewed for applicable accident data is provided in appendix table F.1.1-1. The potential impacts from accidents, ranging from high-consequence/low-probability to low-consequence/high-probability events, have been evaluated in terms of potential cancer fatalities that may result for noninvolved workers and the public. The risk of cancer fatalities has also been evaluated to provide an overall measure of accident impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities). A figure is also provided showing the risk of latent cancer fatalities in the population within 80 km (50 mi) that may result from accidents for the alternatives. Specifically, the curves in each figure show the probability (vertical axis) that the number of cancer fatalities in the offsite population within 80 km (50 mi) (horizontal axis) will be exceeded. The curves reflect the probability of the accident.

In addition to the potential impacts to noninvolved workers and the offsite population, there are potential impacts to involved workers who would be located in the facilities associated with the proposed action. Quantitative statements of these impacts cannot be made until design details are developed further, at which time the number and location of facility workers protective and mitigating features can be estimated to support accident impact analyses. However, depending on the type of accident, facility workers in close proximity to the point of the accident could receive high levels of exposure to radiation, with potentially fatal impacts.

No Action. Under the No Action alternative, limited pit fabrication, nonnuclear fabrication, and stewardship R&D would continue to be performed at LANL with no changes to facilities and operations. Under existing conditions, potential accidents and their consequences have been addressed in facility safety documentation according to requirements in DOE orders.

Management Alternatives. This section provides accident information on the four management alternatives under consideration at LANL: pit fabrication, secondary and case fabrication, HE fabrication, and nonnuclear fabrication.

Pit Fabrication . A set of potential accidents has been postulated for the pit fabrication and intrusive and nonintrusion modification pit reuse alternative for which there may be releases of radioactive materials or other hazardous effects that may impact onsite workers and the offsite population. The accident impacts of greatest interest are those associated with pit fabrication and/or intrusive modification. Any potential accident impacts associated with nonintrusive modification would be bounded by the intrusive modification activity impacts. The potential accidents analyzed are described in appendix F. The probability distribution showing the range of probable cancer fatalities that may result for the composite set of accidents identified in appendix F is shown in figure 4.6.3.9-1. For example, the probability of a pit fabrication accident causing more than 0.1 cancer fatalities is approximately 10^{-6} per year. The curve reflects the probability of the accidents occurring. The impacts for the composite set of accidents are shown in table 4.6.3.9-3. If an accident were to occur, there would be an estimated 1.2×10^{-4} cancer fatalities in the population within 80 km (50 mi) of the site. A noninvolved worker located 1,000 m (3,281 ft) from the accident would have an increased likelihood of cancer fatality of 6.4×10^{-7} . A maximally exposed individual located at the site boundary would have an increased likelihood of cancer fatality of 4.3×10^{-7} . The risks for the composite set of accidents, reflecting both the probability of the accident occurring and the consequences, are also shown in table 4.6.3.9-3. For the same worker, maximally exposed individual, and population, the risks would be 3.3×10^{-8} , 2.2×10^{-8} , and 6.2×10^{-6} cancer fatalities per year, respectively. There is also a potential for chemical accident impacts as shown in table 4.6.3.9-4.

Secondary and Case Fabrication . A set of potential accidents has been postulated for the secondary and case fabrication alternative for which there may be releases of radioactive materials or other hazardous effects that may impact onsite workers and the offsite population. The potential accidents analyzed are described in appendix F. The probability distribution showing the range of probable cancer fatalities that may result for the composite set of accidents identified in appendix F is shown in figure 4.6.3.9-1. For example, the probability of a secondary and case fabrication accident causing more than one cancer fatality is approximately 10^{-8} per year. The curve reflects the probability of the accidents occurring. The impacts of the composite set of accidents are shown in table 4.6.3.9-3. If an accident were to occur, there would be an estimated 0.02 cancer fatalities in the population within 80 km (50 mi) of the site. A noninvolved worker located 862 m (2,828 ft) from the accident would have an increased likelihood of cancer fatality of 6.8×10^{-5} . For a maximally exposed individual located at the site boundary, there would be an increased likelihood of cancer fatality of 8.4×10^{-5} . The risks for the combined EBA and BEBA composite set of accidents, reflecting both the probability of the accident occurring and the consequences, are also shown in table 4.6.3.9-3. For the same worker, maximally exposed individual and population, the risks would be 4.1×10^{-9} , 5.1×10^{-9} , and 1.2×10^{-6} cancer fatalities per year, respectively. Table 4.6.3.9-3 also shows the impacts for EBAs only and BEBAs only. There is also a potential for chemical accidents and impacts as shown in table 4.6.3.9-5.

Table 4.6.3.9-3.-- Impacts of Accidents for Pit and Secondary and Case Fabrication and Intrusive and Nonintrusive Modification Pit Reuse at Los Alamos National Laboratory

	Pit Fabrication and Intrusive Modification Pit Reuse	Secondary and Case Fabrication

Parameter	EBA	BEBA	EBA and BEBA Combined	EBA	BEBA	EBA and BEBA Combined
Composite Accident Frequency (Per Year)	0.0152	$1.0x10^{-6}$	0.0152	$6.0x10^{-5}$	$5.0x10^{-7}$	$6.0x10^{-5}$
Consequences						
Noninvolved Worker						
Cancer fatality[19]	$6.4x10^{-7}$	$3.8x10^{-5}$	$6.4x10^{-7}$	$6.3x10^{-5}$	$6.2x10^{-4}$	$6.8x10^{-5}$
Risk (cancer fatality per year)	$3.3x10^{-8}$	$3.8x10^{-4}$	$3.3x10^{-8}$	$3.8x10^{-9}$	$3.1x10^{-10}$	$4.1x10^{-9}$
Maximally Exposed Individual						
Cancer fatality[19]	$4.3x10^{-7}$	$2.6x10^{-5}$	$4.3x10^{-7}$	$7.9x10^{-5}$	$7.7x10^{-4}$	$8.4x10^{-5}$
Risk (cancer fatality per year)	$2.2x10^{-8}$	$2.6x10^{-11}$	$2.2x10^{-8}$	$4.7x10^{-9}$	$3.9x10^{-10}$	$5.1x10^{-9}$
Population Within 80 Kilometers[20]						
Cancer fatality[21]	$1.2x10^{-4}$	$7.1x10^{-3}$	$1.2x10^{4}$	0.018	0.18	0.02
Risk (cancer fatalities per year)	$6.2x10^{-6}$	$7.1x10^{-9}$	$6.2x10^{-6}$	$1.1x10^{-6}$	$8.9x10^{-8}$	$1.2x10^{-6}$

Table 4.6.3.9-4.-- Impacts of Chemical Accidents for Pit Fabrication at Los Alamos National Laboratory

					Concentration to:		Potential Impacts of Exceeding:	
Accident Description	**Accident Frequency (Per Year)**	**IDLH**	**TLV-STEL**	**TLV-TWA**	**Noninvolved Worker (mg/ m^3)**	**Individual at Site Boundary (mg/m^3)**	**IDLH Limits[22]**	**TLV Limits[22]**
Confined Release of Nitric Acid	10^{-6} to 10^{-4}				1.1	0.50	Irreversible health effects	Irritations of the eyes, mucous membranes and skin, delayed pulmonary edema, and bronchitis and dental erosion
Concentration[22] (mg/m^3)		260	10	5				
Distances[23] (m)		22	260	390				
Area (m^2)		64	$7.1x10^3$	$1.5x10^4$				
Population[24]		0	0	0				
Unconfined Release of Nitric Acid	10^{-6}				26	12	Irreversible health effects	Irritations of the eyes, mucous membranes and skin; delayed
Concentration[22] (mg/m^3)		260	10	5				

Distances[23] (m)		230	1,900	2,900				pulmonary edema; and bronchitis and dental erosion
Area (m^2)		6.5x10^3	2.9x10^5	6.8x10^5				
Population[24]		0	19	330				

Table 4.6.3.9-5.-- Impacts of Chemical Accidents for Secondary and Case Fabrication at Los Alamos National Laboratory

					Concentrations to:		**Potential Impacts of Exceeding:**	
Accident Description	**Accident Frequency (Per Year)**	**IDLH**	**TLV-STEL**	**TLV-TWA**	**Noninvolved Worker (mg/m^3)**	**Individual at Site Boundary (mg/m^3)**	**IDLH Limits[25]**	**TLV Limits[25]**
Fire and release of lithium oxide	10^{-6} to 10^{-4}				>230	230	Irreversible health effects	Burns to the eyes, skin, mouth, and esophagus; muscular twitches; mental confusion; and blurred vision
Concentration (mg/m^3)		55	-	0.025				
Distance[26] (m)		84 to 2,200		46 to >9x10^4				
Area (m^2)		3.8x10^5		>5.7x10^8				
Population[27]		520		>24,000				
Hydrogen fluoride release	10^{-6} to 10^{-4}				>32	32	Irreversible health effects	Irritation or burning to skin, eyes, nose and throat; pulmonary edema; and bronchitis
Concentration (mg/m^3)		36	5	2.5				
Distance[26] (m)		800	2,800	4,400				
Area (m^2)		5.7x10^4	5.9x10^5	1.4x10^6				
Population [27]		0	820	1,500				
Hydrogen cyanide release	10^{-6} to 10^{-4}				>20	20	Irreversible health effects	Nausea, vomiting, gasping for breath, weakness, and at high levels, asphyxiation and death
Concentration (mg/m^3)		56	5	-				
Distance[26] (m)		460	2,000					
Area (m^2)		2.0x10^4	3.3x10^5					
Population		0	430					

High Explosives Fabrication. A set of potential accidents has been postulated for the HE fabrication alternative for which there may be hazardous effects that may impact onsite workers and the offsite population. The potential accidents analyzed are described in appendix F. The consequences of the accidents are shown in table 4.6.3.9-6.

In addition to the chemical accident impacts, there are the potential physical effects from a catastrophic explosion of the entire contents of a process related building, which would have a probability of occurrence less than the explosion considered above (i.e., less than 1.0x10^{-6} per year). The quantity of HE detonated could range up to 18 t (19.8 tons); the blast pressure could result in death (at up to 40 m [131 ft]), lung damage (at 80 m [262 ft]), thoracic injury (at 130 m [420 ft]), and eardrum rupture (at 160 m [525 ft]), depending on an individual's distance from the accident. Injuries could also be caused by glass breakage and building debris.

Nonnuclear Fabrication. The impacts of potential accidents associated with nonnuclear fabrication activities at LANL were previously addressed in Nonnuclear Consolidation Environmental Assessment (DOE/EA-0792, June 1993) where it was determined that the then current accident profile would not change as a result of the relocation of nonnuclear fabrication functions to LANL. The present proposed action to transfer the nonnuclear fabrication mission to LANL is not expected to change the accident profile that presently exists at the site.

Stewardship Alternatives. Accident information on the two proposed stewardship alternatives under consideration at LANL, the NIF and the Atlas Facility, is provided in this section.

Proposed National Ignition Facility . Studies of potential accidents associated with the proposed NIF have been performed. A bounding accident was postulated based on a preliminary hazard analysis. The bounding accident assumes a severe earthquake of 1 G horizontal ground acceleration occurring during a maximum-credible-yield fusion experiment. Beamlines streaking into the target chamber and building structures other than the target area building would fail during the postulated earthquake. The collapsed beamlines and building structures would provide a pathway for acute atmospheric releases of tritium in the tritium processing system, activated gases in the air, and activated material in the target chamber.

The frequency of this severe earthquake is estimated at $1x10^{-4}$ per year. The joint frequency of the severe earthquake during the maximum-credible-yield fusion experiment would be less than $2x10^{-8}$ per year. The radiological impacts of the accident, presented in table 4.6.3.9-7, were estimated using the GENII computer code.

Proposed Atlas Facility . Studies of potential accidents associated with the proposed Atlas Facility have been performed. The results of the studies indicate that the bounding case accident for a site worker involves electrocution from a high energy power source or mechanical collapse of the overhead crane. Both scenarios have an equal likelihood of occurrence. The impact to a site worker in these scenarios could be death. However, the likelihood of occurrence is less than once in 100 years of operation. The most likely accident that could result in an impact to collocated workers involves exposure to emissions and effluents from a capacitor bank fire. In this scenario, a collocated worker would receive minimal exposure to smoke and sprinkler system water containing mineral oil from a Marx module. The impact to a collocated worker in this scenario would be temporary irritation and discomfort; however, the likelihood of occurrence is less than once in 10,000 years of operation. In the event of a fire, all site and collocated workers would be evacuated.

The most likely accident scenario that could result in an impact to the public involves exposure to emissions and effluents from a capacitor bank fire. In this scenario, a member of the public could receive minimal exposure to smoke. The impact to a member of the public in this scenario would be less than that experienced by a collocated worker. Exposure to the smoke could result in very mild and temporary irritation and discomfort. There are no probable accidents which would result in an adverse impact to the public.

Table 4.6.3.9-6.-- Accident Impacts for High Explosives Fabrication at Los Alamos National Laboratory

			Concentrations to:		Potential Impacts of Exceeding:
Accident Description	**Accident Frequency (per year)**	**TLV-TWA**	**Noninvolved Worker (mg/m^3)**	**Individual at Site Boundary (mg/m^3)**	**TLV-TWA Limits**
Fire and release of chemical TATB	0.01 to 10^{-4}		>50	50	Liver damage, cyanosis, sore throat, muscular pain, kidney damage, and anemia
Concentration[28] (mg/m^3)		1.5			
Distances[29] (m)		2,400			
Area (m^2)		$4.7x10^5$			

Population[30]		2			
Fire and release of chemical TNT	0.01 to 10^{-4}		>50	50	Liver damage, cyanosis, sore throat, muscular pain, kidney damage, and anemia
Concentration[28] (mg/m3)		0.5			
Distances[29] (m)		5,000			
Area (m^2)		1.8×10^6			
Population[30]		25			
Explosion and elevated release of TATB	10-4 to 10-6		6.4	6.7[31]	Liver damage, cyanosis, sore throat, muscular pain, kidney damage, and anemia
Concentration[28] (mg/m^3)		1.5			
Distances[29] (m)		180 to 3,500			
Area (m^2)		1.1×10^6			
Population[30]		8			
Explosion and elevated release of TNT	10^{-4} to 10^{-6}		2.4	2.5[31]	Liver damage, cyanosis, sore throat, muscular pain, kidney damage, and anemia
Concentration[28] (mg/m^3)		0.5			
Distances[29] (m)		170 to 3,700			
Area (m^2)		1.2×10^6			
Population[30]		9			

Table 4.6.3.9-7.-- Consequences and Risk of the Bounding Proposed National Ignition Facility Accident at Los Alamos National Laboratory

	Conceptual Design	Enhanced Baseline Option
Workers Onsite		
Dose (person-rem)	13	21
Fatal cancers	0	0
Risk (cancer fatalities per year)	1×10^{-10}	2×10^{-10}
Maximally Exposed Individual		

Dose (rem)	2x10^{-3}	3x10^{-3}
Fatal cancers	8x10^{-7}	1x10^{-6}
Risk (cancer fatalities per year)	2x10^{-14}	3x10^{-14}
Population Within 80 Kilometers		
Dose (person-rem)	290	490
Fatal cancers	0	0
Risk (cancer fatalities per year)	3x10^{-9}	5x10^{-9}

Source: Appendix I.

4.6.3.10 Waste Management

This section summarizes the impacts on waste management at LANL under No Action as well as for each of the proposed alternatives. There is no spent nuclear fuel or HLW associated with pit fabrication, secondary and case fabrication, HE fabrication, nonnuclear fabrication, the proposed Atlas Facility, or the proposed NIF; therefore, there is no further discussion of these wastes for LANL. Table 4.6.3.10-1 lists the projected waste generation rates and treatment, storage, and disposal capacities under No Action. Projections for No Action were derived from 1993 environmental data, with the appropriate adjustments made for those changing operational requirements where the volume of wastes generated is identifiable. The projection does not include wastes from future, as yet uncharacterized, environmental restoration activities.

Table 4.6.3.10-2 provides the total estimated operational waste volumes projected to be generated at LANL as a result of the various proposed alternatives. The net increase over No Action is provided below in parentheses. The waste volumes generated from the various alternatives and the resultant waste effluent used in the impact analysis can be found in section 3.3 for the stewardship alternatives and section 3.4 for the management alternatives. The waste volumes for the management alternatives are based on surge operations (three shifts). Facilities that would support the Stockpile Stewardship and Management Program at LANL would treat and package all waste generated into forms that would enable long-term storage and/or disposal in accordance with the Atomic Energy Act, RCRA, and other applicable statutes as outlined in appendix section H.1.2.

No Action. Under No Action, TRU, low-level, mixed, hazardous, and nonhazardous wastes would continue to be generated at LANL from the missions outlined in section 3.2.6. The decrease in solid LLW is due to the phase out of the PHERMEX Facility as the new DARHT Facility with contained firing becomes operational. LANL would continue to treat, store, and dispose of its legacy and newly generated wastes in current and planned facilities.

Liquid TRU waste would continue to be generated by the Plutonium Facility (TA-55). The residual TRU waste sludge that remains after treatment would continue to be loaded into 208-L (55-gal) steel drums, solidified, and transported to Area G for storage. Solid TRU waste would be characterized, certified to meet the criteria for acceptance at WIPP, and placed in storage at Area G while awaiting shipment to WIPP or an alternate facility. Plans are to develop a new facility for characterizing and processing solid TRU waste. This new facility is projected to be operational in 2006.

Liquid LLW would be neutralized and solidified in two onsite treatment facilities. Solid LLW would be compacted, packaged, and stored for disposal either in an onsite, expanded Area G LLW burial site or through other disposal options. Liquid mixed waste would undergo neutralization/pH adjustment, oxidation/reduction, precipitation, chelation/flocculation, and filtration. Both liquid and solid mixed waste would be treated and disposed of according to the LANL Site Treatment Plan, which was developed pursuant to the *Federal Facility Compliance Act* of 1992. The resulting waste would then be stored in a RCRA-permitted facility in DOT-approved containers until it is shipped to an offsite DOE disposal facility. Some of this waste would be placed in interim storage until new technologies for treatment and disposal are identified and evaluated. Liquid sanitary wastes would be treated by a consolidation and collection system and discharged to NPDES-permitted sanitary tile fields. Solid nonhazardous waste would be disposed of in a regional commercial disposal facility.

Table 4.6.3.10-1.-- Projected Waste Management Under No Action at Los Alamos National Laboratory

Category	Annual Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)

Transuranic							
Liquid	0.1	Pretreatment at TA-50: neutralization, clariflocculation, filtration, precipitate, and cement mixing	132,659	NA	NA	NA	NA
Solid	54	Volume reduction	51,989	Storage pads at TA-54, modified LLW burial pits and shafts	24,355	None: Federal repository in the future	None
Mixed Transuranic							
Liquid	None	Included in TRU	Included in TRU	Included in TRU	Included in TRU	Included in TRU	Included in TRU
Solid	255	Included in TRU	Included in TRU	Included in TRU	Included in TRU	Included in TRU	Included in TRU
Low-Level							
Liquid	21,400	Chemical treatment and ion-exchange, solidification, and volume reduction (vial crusher)	45 m^3 /hour	Chemical and Ion-Exchange Plant at TA-50 and the Chemical Plant at TA-21	663	Treated effluent is discharged to the environment. Residual sludge is solidified and disposed of at TA-54, Area G, as solid LLW.	None
Solid	2,500	Compaction	76	TA-54 in Area G	Variable	Currently, solid LLW goes to TA-54, Area G, for burial. Continued construction of Area G is under evaluation in the site-wide EIS.	24 to 28 ha
Mixed Low-Level							
Liquid	0	Neutralization, precipitation, oxidation, thermal treatment, solidification, volume reduction, and liquid scintillation cocktail vials	Capabilities under development per site treatment plan for mixed wastes	RCRA-permitted buildings (not built yet) and interim status container storage areas	583	Capabilities under development per site treatment plan for mixed wastes	None
Solid	45	None	Capabilities under development per site treatment plan	TA-54, Area L, or Area G	1,864	Capabilities under development per site treatment plan for mixed wastes	None
Hazardous							

Liquid	273	Thermal treatment, treatment tanks, neutralization, precipitation, and evaporation	Varies depending on the waste stream	Thermal treatment TAs -14, -15, -16, -36, and -39 and storage and treatment at TA-54, Area L	502	Offsite	NA
Solid	669	Thermal treatment and flashpad	Varies depending on the waste stream	See above	See above	See above	See above
Nonhazardous (Sanitary)							
Liquid	692,827	Filtration, settling, and stripping	1,060,063	NA	NA	Permitted discharge sanitary tile fields	2,271,240 L/ day
Solid	5,453	None	None	NA	NA	Offsite county landfill and onsite landfill Area J	NA
Nonhazardous (Other)							
Liquid	See sanitary	See sanitary	See sanitary	See sanitary	See sanitary	See sanitary	See sanitary
Solid	See sanitary	See sanitary	See sanitary	See sanitary	See sanitary	See sanitary	See sanitary

Table 4.6.3.10-2.-- Estimated Annual Generated Waste Volumes for Stockpile Stewardship and Management Alternatives at Los Alamos National Laboratory

Category	**No Action[32] (m^3)**	**Pit Fabrication[33] (m^3)**	**Secondary and Case Fabrication[34] (m^3)**	**High Explosives Fabrication[35] (m^3)**	**Nonnuclear Fabrication (Full Scope) [36] (^{3})**	**Atlas Facility[37] (m^3)**	**National Ignition Facility[38] (m^3)**	**Combined Program Impacts (m^3)**
Transuranic								
Liquid	0.1	5 (+5)	0.1 (+0)	0.1 (+0)	0.1 (+0)	0.1 (+0)	0.1 (+0)	5 (+5)
Solid	54	97 (+43)	54 (+0)	54 (+0)	54 (+0)	54 (+0)	54 (+0)	97 (+43)
Mixed Transuranic								
Liquid	0	0 (+0)	0 (+0)	0 (+0)	0 (+0)	0 (+0)	0 (+0)	0 (+0)
Solid	255	257 (+2)	255 (0)	255 (0)	255 (0)	255 (0)	255 (0)	257 (+2)
Low-Level								
Liquid	21,400	21,400 (+15)	21,600 (+192)	21,400 (0)	21,400) (0	21,400 (0)	21,400 (+0.6)	21,600 (+208)

Solid	2,500	2,880	3,190	2,500	2,500	2,500	2,500	3,580
		(+386)	(+690)	(minimal)	(0)	(0)	(+3)	(+1,080)
Mixed Low-Level								
Liquid	0	0	30	0	0	0	2	32
		(+0)	(+30)	(0)	(0)	(0)	(+2)	(+32)
Solid	45	45	153	45	45	45	45	153
		(0)	(+108)	(0)	(0)	(0)	(+0.3)	(+108)
Hazardous								
Liquid	273	275	333	277	284	273	275	353
		(+2)	(+60)	(+4)	(+11)	(+<1)	(+2)	(+80)
Solid	669	669	885	682	669	670	677	906
		(+0)	(+216)	(+13)	(+0.1)	(+<1)	(+8)	(+237)
Nonhazardous (Sanitary)								
Liquid	693,000	705,000	713,000	699,000	694,000	694,000	711,000	751,000
		(+12,300)	(+20,200)	(+5,900)	(+568)	(+710)	(+17,900)	(+57,600)
Solid	5,450	6,000	6,610	5,450	5,460	5,460	11,500	13,200
		(+552)	(+1,160)	(Included in liquid)	(+10)	(+7)	(+6,000)	(+7,730)
Nonhazardous (Other)[32]								
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	6,930[39]	25[40]	Included in sanitary	Included in sanitary	6,960
				(+6,930)				(+6,960)
Solid	Included in sanitary	Included in sanitary	3,000[40]	28[40]	(+25) 3[40]	Included in sanitary	Included in sanitary	3,030
			(+3,000)	(+28)	(+3)			(+3,030)

Management Alternatives

Pit Fabrication. Over the 3-year construction period, it is estimated that approximately 27 t (30 tons) of TRU waste and 54 t (60 tons) of LLW would be generated. These numbers assume that about 20 glove boxes from the 300 Area and 10 glove boxes from the 400 Area would be removed. The glove boxes should meet the definition of LLW; whereas, approximately two-thirds of the associated piping and ventilation ductwork would be considered TRU waste. Assuming a density of 1,500 kg/m^3 , this is a volume of 6 m^3 /yr (8 yd^3 /yr) of TRU waste and 12 m^3 /yr (16 yd^3 /yr) of LLW. The TRU waste would be packaged to meet the WIPP Waste Acceptance Criteria and stored until it is shipped to WIPP for disposal. This would require two additional truck shipments over the entire construction period. The LLW would be packaged to meet the Area G waste disposal criteria. This would require approximately 0.003 ha (0.007 acres) of LLW disposal area for the entire construction project. Liquid and solid hazardous waste generated during construction would be packaged and shipped offsite to RCRA-permitted treatment and disposal facilities.

Treatment and processing of liquid and solid TRU, and solid mixed TRU wastes to meet the WIPP Waste Acceptance Criteria would result in 60 m^3 (78 yd^3) of TRU waste and 2 m^3 (3 yd^3) of solid mixed TRU waste to be packaged in accordance with DOE and NRC requirements for transport to WIPP for disposal. Seven additional truck shipments per year would be required to transport this waste to WIPP. There is adequate excess capacity at LANL liquid radwaste treatment facilities to handle the 15 m^3 (3,940 gal) of liquid LLW. Following treatment and processing, 393 m^3 (514 yd^3) of solid LLW would require disposal at the Area G LLW disposal site. Assuming a land usage factor of 12,500 m^3 /ha (6,630 yd^3 /acres), approximately 0.03 ha/yr (0.08 acres/yr) of LLW disposal area at LANL would be required.

The LANL Site Treatment Plan for mixed waste was developed pursuant to the Federal Facility Compliance Act. The mixed waste streams identified at LANL have been combined into 30 treatability groups, each with a preferred treatment option. The type of mixed wastes generated by pit fabrication would fit into 1 of the established 30 treatability groups and would not create new treatability groups or new preferred treatment options. Minimal impacts would result from the 2 m^3 (555 gal) of liquid hazardous waste that would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. Minimal impacts would result from the 12,300 m^3 (3.25 million gal) of liquid sanitary waste that would be routed to the TA-46 sanitary wastewater treatment facilities. Minimal impacts would result from the 552 m^3 (722 yd^3) of solid nonhazardous waste that would be disposed of in offsite industrial and sanitary landfills.

Secondary and Case Fabrication. The Secondary and Case Fabrication Facility would not generate any TRU waste. The 192 m^3 (50,700 gal) of liquid LLW would have little impact on LANL radwaste treatment facilities as there is adequate capacity to handle the increase. After treatment and volume reduction, 349 m^3 (456 yd^3) of solid LLW would require disposal in the Area G LLW disposal site. Assuming a land usage factor of 12,500 m^3 /ha (6,630 yd^3 /acres), approximately 0.03 ha/yr (0.07 acres/yr) of LLW disposal area would be required.

The type of mixed wastes generated by secondary and case fabrication would fit into 1 of the established 30 treatability groups and would not require the creation of new treatability groups or new preferred treatment options. The 30 m^3 (7,930 gal) of liquid mixed wastes and 108 m^3 (141 yd^3) of solid mixed wastes generated annually may impact the available storage capacity of the main areas for future mixed waste storage in RCRA-permitted hazardous waste management units. Minimal impacts would result from the 60 m^3 (15,900 gal) of liquid hazardous waste and 216 m^3 (283 yd^3) of solid hazardous waste that would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. Minimal impacts would result from the 20,200 m^3 (5.35 million gal) of liquid sanitary waste that would be routed to septic tanks or sanitary wastewater treatment facilities. After volume reduction, minimal impacts would result from the 639 m^3 (836 yd^3) of solid nonhazardous waste that would be disposed of in offsite industrial and sanitary landfills.

High Explosives Fabrication. The HE Fabrication Facility would not generate any TRU waste, or mixed LLW. Minimal quantities of solid LLW would be generated annually either from handling depleted uranium parts during subassembly operations or from processing of materials returned from the stockpile with slight contamination. The operational life of the Area G LLW disposal site would not be impacted. Minimal impacts would result from the 4 m^3 (925 gal) of liquid hazardous waste and 13 m^3 (16 yd^3) of solid hazardous waste that would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. Minimal impacts would result from the 5,900 m^3 (1.56 million gal) of liquid sanitary waste that would be routed to septic tanks or sanitary wastewater treatment facilities. Minimal impacts would result from the 17 m^3 (22 yd^3) of solid nonhazardous waste that would be disposed of in offsite industrial and sanitary landfills.

Nonnuclear Fabrication. The Nonnuclear Fabrication Facility would not generate any TRU, low-level, or mixed low-level wastes. Minimal impacts would result from the 11 m^3 (3,000 gal) of liquid hazardous waste and 0.1 m^3 (0.13 yd^3) of solid hazardous waste that would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. Minimal impacts would result from the 568 m^3 (150,000 gal) of liquid sanitary waste that would be discharged to the sanitary wastewater system and the 11 m^3 (15 yd^3) of solid nonhazardous waste that would be disposed of in offsite industrial and sanitary landfills.

Sensitivity Analysis . The waste volumes generated from the pit, secondary and case, HE, and nonnuclear fabrication alternatives required to support a larger stockpile level (high case) operating on a single-shift basis are bounded by the base case under surge operations. There would be no additional waste management impacts associated with the alternatives that would support a high case stockpile operating at a single shift. The volumes generated from the proposed alternatives required to support a low case stockpile would be reduced by a factor of at least 3.

Stewardship Alternatives

Proposed National Ignition Facility. The proposed NIF would not generate any TRU waste. The 0.6 m^3 (159 gal) of liquid LLW could be treated with existing onsite capabilities with no impact. The 3 m*3* (4 yd^3) of solid LLW would have a minimal impact on the operational life of the Area G LLW disposal site. Assuming a land usage factor of 12,500 m^3 /ha (6,630 yd^3 /acres), 0.0002 ha/yr (0.0006 acres/yr) of LLW disposal area would be required.

The LANL Site Treatment Plan for mixed waste was developed pursuant to the Federal Facility Compliance Act. The mixed waste streams identified at LANL have been combined into 30 treatability groups, each with a preferred treatment option. The type of mixed wastes generated by the proposed NIF would fit into 1 of the established 30 treatability groups and would not require the creation of new treatability groups or new preferred treatment options. The 2 m^3 (528 gal) of liquid mixed LLW and the 0.3 m^3 (0.4 yd^3) of solid mixed LLW generated would not impact the available storage capacity of the main areas for future mixed waste storage in RCRA-permitted hazardous waste management units. Minimal impacts would result from the 2 m^3 (608 gal) of liquid hazardous waste and 8 m^3 (10 yd^3) of solid hazardous waste that would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. The 17,900 m^3 (4.72 million gal) of liquid sanitary waste would not be expected to impact the existing sanitary wastewater treatment system. Minor impacts would result from the 6,050 m^3 (7,910 yd^3) of solid nonhazardous waste that would be disposed of in offsite industrial and sanitary landfills.

Proposed Atlas Facility. For purposes of this analysis it is assumed that a small amount (<1 m^3 annually) of liquid or solid hazardous waste would be generated by occasional experiments involving lead or other simulant materials. This waste would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. Minimal impacts would result from the generation of 710 m^3 (188,000 gal) of liquid sanitary waste as there is adequate capacity within the existing sanitary wastewater treatment system to handle the increase. Minimal impacts would result from the 9 m^3 (12 yd^3) of solid nonhazardous waste that would be disposed of at the Los Alamos County landfill.

Combined Program Impacts. If all the proposed stockpile stewardship and management alternatives listed in table 4.6.3.10-2 were located at LANL, the impacts from TRU and mixed TRU wastes would be identical to those discussed for the pit fabrication alternative. Following treatment and volume reduction, approximately 745 m^3 (925 yd^3) of solid LLW would require disposal at the Area G LLW disposal site. An estimated 0.06 ha (0.15 acres) of LLW disposal area would be required. The impacts from mixed low-level and hazardous wastes are identical to those discussed for the secondary and case fabrication alternative. The 57,600 m^3 (15.2 million gal) of liquid sanitary wastes would not be expected to impact the sanitary wastewater treatment system since adequate capacity exists to handle this increase. After volume reduction, approximately 7,270 m^3 (9,510 yd^3) of solid sanitary waste would require disposal. This increase could require the construction of a new sanitary landfill sooner than currently planned.

Potential Mitigation Measures . Waste quantities or waste forms could undergo additional reductions by utilizing emerging technologies, thereby further reducing or mitigating impacts. Pollution prevention and waste minimization would be considered in determining the final actions of the Stockpile Stewardship and Management Program at LANL.

4.6.3.11 Environmental Justice

As discussed in section 4.14, any impacts to surrounding communities would most likely result from toxic or hazardous air pollutants and radiological emissions. Section 4.6.3.9, which describes public and occupational health impacts from normal operation, shows that potential chemical air emissions and releases are not within the generally acceptable threshold of regulatory concern. This information is based on the conservative programmatic assumptions and modeling detailed in appendix E. However, the cumulative effect of continuous (or intermittent over time) very low exposures could have some impact on human health or the environment. Any adverse human health or environmental impacts that may occur would affect people living within communities located near LANL. The analysis of the demographic data presented in appendix D for the communities surrounding LANL indicates that if there were any adverse health impacts to these communities, they would not appear to disproportionately affect minority or low-income populations.

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1 Generator power sources already in use by LANL.

Note: NA - not applicable.
Source: LANL 1995b:1; LANL 1995b:3; LANL 1995b:4; LANL 1995c; LANL 1995d; LANL 1995e; LANL 1995g; LANL 1996e:1; appendix I; appendix K.

2 State standard or guideline. The conversion from ppm to g/m^3 for ambient air quality standards is calculated with the corrections for temperature (530°R) and pressure (elevation) (7,400 ft mean sea level).

3 Federal standard.

4 No monitoring data available, concentration assumed less than applicable standard.

5 No standard.
Source: 40 CFR 50; DOE 1995hh; LANL 1995b:1; LANL 1995c; LANL 1995d; LANL 1995e; LANL 1995g; NM EIB 1995a; NM EIB 1996a; appendix I.

6 Total water requirements for construction at LANL are based on a 4-year period for Atlas Facility, a 2-year period for nonnuclear fabrication and HE fabrication, a 4-year period for secondary and case fabrication, and a 5-year period for the proposed NIF.

7 No construction water would be used or construction wastewater generated. Total site water use and wastewater discharged would be the same as No Action operation.

8 NPDES permit is required for stormwater discharges.
NA - not applicable; MLY - million liters per year.
Source: LANL 1995b:1; LANL 1995c; LANL 1995d; LANL 1995e; LANL 1995g; LANL 1996e:1; appendix I; appendix K.

9 Assumes operations are located at TA-3.

10 Conservative assumption poses existence of maximally exposed individual at multiple locations simultaneously.

11 Includes impacts from No Action.

12 The applicable radiological limits for an individual member of the public from total site operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathway, 100 mrem/yr from all pathways combined (DOE Order 5400.5).

13 Natural background radiation levels to average individual is 342 mrem/yr; to the population within 80 km (50 mi) in 2030 is 95,200 person-rem. Impacts from the Phased Containment Option (preferred alternative) representing the DARHT Facility are included within the No Action values presented in the table. However, PHERMEX Facility operations at LANL will be phased out and are therefore not included. Annual incremental doses of $1.7x10^{-5}$ mrem to the maximally exposed individual and $8.6x10^{-5}$ person-rem to the population are incurred from the pit fabrication alternative.
Source: DOE 1995hh; LANL 1995e; LANL 1995g; LANL 1995s; appendix I; appendix K.

14 Assumes operations are located at TA-3.

15 The involved worker is a worker associated with operation of the pit fabrication, secondary and case fabrication, NIF, and other facilities. The dose presented for the involved workforce is only that incremental dose received from the pit fabrication, secondary and case fabrication, NIF, and Atlas Facility. The total dose received by the involved workforce would be higher than that received by the noninvolved workforce from these operations. The estimated number of involved workers is 267 at the proposed NIF, 146 for pit fabrication, and 151 for secondary and case fabrication.

16 The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 835).

17 The noninvolved worker is an onsite worker not associated with operation of the proposed stockpile stewardship and management facilities. The maximum estimated number of noninvolved workers is 5,770 for each of the stockpile stewardship and management alternatives.

18 The total site workforce is the sum of the number of involved and noninvolved worker impacts. The estimated numbers of badged workers in the total site workforce for each of the radiologically concerned alternatives are 5,916 for pit fabrication, 5,921 for secondary and case fabrication, 6,037 for the proposed NIF, and 5,770 for No Action.
Impacts to workers presented in this table include the addition of the Phased Containment Option (preferred alternative) representing the DARHT Facility and the phasing out of the PHERMEX Facility at LANL; NA - not applicable.
Source: DOE 1993n:7; DOE 1995hh; LANL 1995b:6; LANL 1995e; LANL 1995g; appendix I; appendix K.

19 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or to a noninvolved worker as a result of exposure to the indicated dose if the accident occurred.

20 For the offsite population of 287,977 for pit fabrication and 281,812 for secondary fabrication, the average probability of cancer fatality/risk of cancer fatality (per year) for the combined EBA and BEBA is $4.2x10^{-10}$ /$2.2x10^{-11}$ and $7.1x10^{-8}$ /$4.3x10^{-12}$ respectively, for the listed alternative(s), pit fabrication, and secondary and case fabrication.

21 Number of cancer fatalities in the population out to 80 km (50 mi) as a result of exposure to the indicated dose if the accident occurs.
All values are mean values; BEBA - beyond evaluation basis accidents; EBA - evaluation basis accidents.
Results shown are derived from accident analyses in appendix F.

22 NIOSH 1990a.

23 From facility (downwind); exceedance begins at facility, 0 meters.

24 Offsite individuals exposed to concentration exceeding limit.
IDLH - immediately dangerous to life and health; TLV - threshold-limit value; STEL - short-term exposure limit; TWA - time-weighted average.
Source: Model result (see appendix F).

25 NIOSH 1990a.

26 From facility (downwind); exceedance begins at facility, 0 meters, unless indicated otherwise.

27 Offsite individuals exposed to concentration exceeding limit.
IDLH - immediately dangerous to life and health; TLV - threshold-limit-value; STEL - short-term exposure limit; TWA - time-weighted average.

Source: Derived from accident analysis (see appendix F).

28 NIOSH 1990a.

29 From facility (downwind); exceedance begins at facility, 0 meters, unless indicated otherwise.

30 Offsite individual exposed to concentration exceeding limit.

31 Individual at 510 m (1,673 ft) from boundary (individual at boundary is exposed to concentrations of approximately two times lower)
TLV - threshold limit value; TWA - time weighted average; TATB - triaminotrinitrobenzene; TNT - trinitrotoluene.
Source: Results derived from accident analysis (see appendix F).

32 No Action volumes are from table 4.6.3.10-1.

33 Pit fabrication volumes are from table 3.4.3.2-3.

34 Secondary fabrication volumes are from table 3.4.4.3-3 and are based on surge operations (three shifts).

35 HE fabrication volumes are from table 3.4.5.3-4 and are based on surge operations (three shifts).

36 Nonnuclear fabrication volumes are from table 3.4.2.3-3 and are based on surge operations (three shifts).

37 Atlas Facility volumes are from table 3.3.2.3-3.

38 NIF volumes are from table 3.3.2.2-3 and are based on conceptual designs.

39 Treated process water.

40 Recyclable wastes.
Waste generation volumes were rounded to three significant figures. Waste effluent volumes are shown in section 3.3 and 3.4 tables for each alternative.

4.7 Lawrence Livermore National Laboratory

LLNL was established in 1952 and currently occupies approximately 332 ha (821 acres) next to Livermore, CA (Livermore Site), and 2,800 ha (7,000 acres) at Site 300, approximately 29 km (18 mi) southeast of Livermore in support of missions discussed in section 3.2.7. The locations of the sites are illustrated in figure 4.7-1. Figure 4.7-2 shows the DOE property boundaries for the Livermore Site.

4.7.1 Description of Alternatives

No Action. LLNL would continue to perform the missions described in section 3.2.7.

Stockpile Management Alternatives. The secondary and case fabrication mission, the HE fabrication mission, and a portion of the nonnuclear fabrication mission could be located at LLNL. The HE fabrication mission could also be shared with LANL.

Stockpile Stewardship Alternatives. The Contained Firing Facility (CFF) would be located at Site 300 and the proposed NIF could be located at the Livermore Site.

4.7.2 Affected Environment

The following sections describe the affected environment at the LLNL main site (Livermore Site) and Site 300 for land resources, air quality, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure, radiation and hazardous chemical environment, waste management conditions, and current intersite transport issues are described.

4.7.2.1 Land Resources

LLNL consists of two sites: the main facility (approximately 332 ha [821 acres]) at Livermore, and Site 300 (approximately 2,800 ha [7,000 acres]) in the Tracy Hills, approximately 29 km (18 mi) east of the Livermore Site. Both sites are owned by the Federal Government and administered, managed, and controlled by DOE.

Livermore Site . Generalized land uses within the Livermore Site and in the immediate vicinity are shown in figure 4.7.2.1-1. The site itself is categorized into a variety of land uses, with the vast majority dedicated to R&D. The R&D designation includes office facilities, light and heavy laboratories, and light industrial facilities in direct support of programmatic endeavors. A significant portion of the site is classified as undeveloped and industrial uses occupy a substantial amount of land. There are no prime farmlands on the Livermore Site.

The Livermore Site is bordered on the east by Greenville Road. Land use on the east is primarily agricultural. The South Bay Aqueduct, a branch of the California Aqueduct, crosses Greenville Road just south of the Livermore Site. Patterson Pass Road borders the Livermore Site on the north. Land to the immediate north of Patterson Road is light industrial and vacant land. The Patterson Reservoir and filtration plant, part of the South Bay Aqueduct system, are located northeast of the site. The Livermore Site is bordered on the west by South Vasco Road. Land use to the west is primarily urban residential, with some vacant land.

The Livermore Site is bordered on the south by East Avenue. Sandia National Laboratories, Livermore, is located immediately adjacent and south of East Avenue. A small light-industrial park is located on the southwest corner of East Avenue and South Vasco Road. The remainder of lands south of the Livermore Site and Sandia National Laboratories, Livermore, are primarily agricultural, comprised of vineyards and rangeland primarily used for grazing. There are also some rural residences in these areas. The closest residences to the boundaries of the Livermore Site are 0.4 km (0.25 mi) to the east, 0.56 km (0.35 mi) to the west, 2.0 km (1.2 mi) to the north, and 0.8 km (0.50 mi) to the south.

Site 300 . Generalized land uses within Site 300 and in the immediate vicinity are shown in figure 4.7.2.1-2. The site itself consists of a large percentage of undeveloped territory and land dedicated to both R&D and industrial functions. There are no prime farmlands on Site 300. No significant land use changes are projected for Site 300 at present (LLNL 1995k:16-19).

The majority of the land surrounding Site 300 is agricultural and is primarily used for grazing sheep and cattle. There are two, privately operated, research and testing facilities located near Site 300. Physics International is located adjacent to the east boundary, and Stanford Research Institute International is approximately 0.97 km (0.60 mi) south of the site. Both of these facilities conduct HE testing similar to that conducted at Site 300 (LL DOE 1992c:4-6). Corral Hollow Road borders Site 300 on the south. Adjacent to the western portion of Site 300, across Corral Hollow Road, is the Carnegie State Vehicular Recreation Area. This area covers approximately 6,483 ha (16,020 acres) and is operated by the California Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division, for the exclusive use of off-road vehicles. Several rural residences are located along Corral Hollow Road, west of Site 300 and the Carnegie State Vehicular Recreation Area. The closest residences to the boundaries of Site 300 are 0.48 km (0.3 mi) to the east, 0.16 km (0.1 mi) to the west, 3.5 km (2.2 mi) to the north, and 0.72 km (0.45 mi) to the south. The nearest urban area is the city of Tracy, approximately 13 km (8.1 mi) to the northeast.

4.7.2.2 Site Infrastructure

Section 3.2.7 describes the current missions at LLNL. To support these missions an infrastructure exists as shown in table 4.7.2.2-1.

Table 4.7.2.2-1.-- Baseline Characteristics for Lawrence Livermore National Laboratory

Characteristics	Current Value	
Land	**Main Site**	**Site 300**
Area (ha)	332	2,800
Roads (km)	24	40
Railroads (km)	0	0
Electrical		
Energy consumption (MWh/yr)	327,716	15,661
Peak Load (MWe)	57.2	2.6
Fuel		
Natural Gas (m3/yr)	14,160,000	NA
Liquid (L/yr)	31,688	43,527
Coal (t/yr)	0	0

NA - not applicable.
Source: LLNL 1995i:1.

4.7.2.3 Air Quality

This section describes existing air quality, including a review of the meteorology and climatology in the vicinity of the Livermore Site and Site 300. More detailed discussions of the air quality methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.3.7.

Meteorology and Climatology. The climate at the Livermore Site, Site 300, and the surrounding region is classic Mediterranean with hot dry summers and cold wet winters. The average annual temperature at the Livermore Site is 12.5 °C (54.5 °F); the normal seasonal temperature range is defined by winter nighttime lows in the vicinity of 0 °C (32 °F) and summer daytime highs around 38 °C (100.4 °F). The highest and lowest annual precipitation on record are 78.2 cm (30.8 in) and 13.8 cm (5.4 in), respectively. Prevailing winds at the Livermore Site are from the west and southwest. The climate at Site 300, while similar to the Livermore Site, is modified by higher elevation and more pronounced relief. The temperature range is somewhat more extreme than the Livermore Site. Topography significantly influences surface wind patterns at Site 300 with prevailing winds from the west-southwest (LLNL 1993b:1-2,1-3).

Ambient Air Quality. The Livermore Site is located within the San Francisco Bay Area Air Quality Management District. With respect to attainment of the NAAQS (40 CFR 50), this area has been designated as follows: A part of Alameda County, which is in the San Francisco Bay Area Air Quality Management District, is designated as nonattainment for carbon monoxide (with a classification of moderate 12.7 ppm) and ozone (with a classification of moderate) (40 CFR 81.305). Site 300 is located within the San Joaquin Valley Unified Air Pollution Control District. The area is classified as a nonattainment area for ozone (with a classification of serious) and PM10 (with a classification of serious) (40 CFR 81.305). Applicable NAAQS and California State ambient air quality standards are presented in appendix table **B.3.1-1 .**

The primary emission sources of criteria air pollutants at the Livermore Site and Site 300 are numerous boilers, solvent cleaning operations, emergency generators, and various experimental, testing, and process sources. Emission estimates for these sources are presented in appendix table **B.3.7-1 .**

Several PSD Class I areas have been designated in the vicinity of the Livermore Site, including Point Reyes National Wilderness Area, approximately 89 km (55 mi) to the northwest; and Desolation National Wilderness Area, Mokelumne National Wilderness Area, Emigrant National Wilderness Area, Hoover National Wilderness Area, and Yosemite National Park, approximately 160 to 190 km (100 to 120 mi), respectively, to the east and northeast. Since the promulgation of the PSD regulations (40 CFR 52.21) in 1977, no PSD permits have been required for any emission sources at the Livermore Site.

Table 4.7.2.3-1.--Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at the Livermore Site and Site 300, 1993 and 1994

Pollutant	Averaging Time	Most Stringent Regulation or Guideline (g/m3)	Livermore Site Baseline Concentration (g/m3)	Site 300 Baseline Concentration (g/m3)
Criteria Pollutant				
Carbon monoxide	8-hour	10,000[1]	55.79	4.96
	1-hour	23,000[2]	187.80	39.68
Lead	Calendar quarter	1.5[1]	<0.01	[3]

	30-day	1.5[2]	<0.01	[3]
Nitrogen dioxide	Annual	100[1]	5.46	0.28
	1-hour	470[2]	1,082.64	183.54
Ozone	1-hour	180[2]	[3]	[3]
Particulate matter	Annual	30[2]	0.78	0.03
	24-hour	50[2]	15.32	0.91
Sulfur dioxide	Annual	80[1]	0.07	<0.01
	24-hour	105[2]	1.42	0.09
	3-hour	1,300[1]	9.35	0.71
	1-hour	655[2]	14.35	2.12
Mandated by California				
Beryllium	30-day	0.01[4]	0.000089	0.000049
Hydrogen sulfide	1-hour	42[2]	[3]	[3]
Sulfates	24-hour	25[2]	[3]	[3]
Vinyl chloride	24-hour	26[2]	[3]	[3]
Hazardous and Other Toxic Compounds				
Acetone	8-hour	[5]	8.11	0.12
Benzene	8-hour	[5]	0.99	<0.01
2-Butoxyethanol	8-hour	[5]	1.52	[3]
Carbon tetrachloride	8-hour	[5]	2.03	[3]
Chlorofluorocarbons	8-hour	[5]	86.28	0.44
Chloroform	8-hour	[5]	1.87	<0.01
Ethanol	8-hour	[5]	3.19	<0.01

Formaldehyde	8-hour	5	0.53	0.01
Gasoline	8-hour	5	3	0.98
Glycol ethers (other)	8-hour	5	0.03	0.14
Hexane	8-hour	5	0.59	3
Hydrogen chloride	8-hour	5	0.64	0.16
Isopropyl alcohol	8-hour	5	7.23	<0.01
Methanol	8-hour	5	9.41	3
Methyl ethyl ketone	8-hour	5	3.35	<0.01
Methylene chloride	8-hour	5	1.33	<0.01
Naphthalene	8-hour	5	0.73	3
Styrene	8-hour	5	12.59	3
Tetrahydrofuran	8-hour	5	0.61	3
Toluene	8-hour	5	3.81	0.05
1,1,1-Trichloroethane	8-hour	5	9.73	3
Trichloroethylene	8-hour	5	1.74	0.01
Xylene	8-hour	5	2.20	0.01

The State of California employs a health-risk based program for toxic air pollutants. As required by the *California Air Toxic "Hot Spots" Information and Assessment Act* of 1987 (AB2588), the Bay Area Air Quality Management District and the San Joaquin Valley Unified Air Pollution Control District requested that the Livermore Site and Site 300 assess the impact of toxic air emissions on the surrounding area. The risks at the Livermore Site were found to be below the threshold values that are used to determine need for further evaluation. The Site 300 toxic air pollutant inventory has been completed and will be submitted to the San Joaquin Valley Unified Air Pollution Control District for review to determine if a risk assessment is required (LLNL 1993b:2-24).

The "Hot Spots" program, however, is not applicable to the other stockpile stewardship and management candidate sites. To compare with the other stockpile stewardship and management candidate sites, the predicted maximum 8-hour concentrations for toxic air pollutants are provided. Table 4.7.2.3-1 presents the baseline ambient air concentrations for criteria pollutants and other hazardous/toxic air pollutants of concern at the Livermore Site and Site 300. As shown in the table, criteria pollutant baseline concentrations are in compliance with applicable guidelines and regulations, with the exception of 1-hour nitrogen dioxide at the Livermore Site.

4.7.2.4 Water Resources

This section describes the surface and groundwater resources at LLNL. This site includes the facilities in the Livermore Valley and at Site 300, referred to here as Livermore Site and Site 300, respectively.

Surface Water

Livermore Site. The main surface water features at the Livermore Site are the Arroyo Las Positas and Arroyo Seco. Arroyo Las Positas drains in the hills directly east and northeast of the Livermore Site and usually flows only after storms (figure 4.7.2.4-1). This channel enters the Livermore Site from the east, is diverted along a storm ditch around the northern edge of the site, and exits the site at the northwest corner. Arroyo Seco flows through the very southwest corner of the Livermore Site. Arroyo Las Positas flows into Arroyo Seco west of the site. Both stream channels are dry for most of the year.

Nearly all surface water runoff at the Livermore Site is discharged into Arroyo Las Positas; only surface water runoff along the southern boundary and some storm drains in the southwest corner of the Livermore Site drain into Arroyo Seco (LL DOE 1992c:4-147). The locations of hydrological features are shown in figure 4.7.2.4-1.

Two areas on the Livermore Site are within the 100-year floodplains of the Arroyo Las Positas and Arroyo Seco. However no existing onsite structures are within the 100-year floodplain. The channels routing Arroyo Las Positas and Arroyo Seco through the Livermore Site would be able to contain a 100-year flood. The 500-year flood levels have not been delineated.

The total annual water use at the Livermore Site is currently 968 MLY (256 MGY). LLNL receives water from two suppliers. During the summer months, June through August, deliveries are taken primarily from the Alameda County Flood Control and Water Quality Conservation District Zone 7. This water is a mixture of groundwater and water from the South Bay Aqueduct of the State Water Project. For the remainder of the year, LLNL's water usually is supplied from the Hetch-Hetchy Aqueduct.

Approximately 400 MLY (106 MGY) of wastewater from the Livermore Site is discharged to the city of Livermore sewer system and processed at the Livermore Water Reclamation Plant (LLNL 1994a:5-1). This wastewater includes sanitary and industrial discharges from the Livermore Site and Sandia National Laboratories. The discharges are permitted by the city of Livermore and monitored for pH, selected metals, and radioactivity (LLNL 1994a:5-2). LLNL also monitors the waters of the Livermore Site, Site 300, and surrounding areas, as well as stormwater runoff.

Site 300. There are no perennial streams at or near Site 300. The canyons that dissect the hills and ridges at Site 300 drain into intermittent streams. The majority of these onsite streams drain to the south into Corral Hollow Creek, also intermittent, which flows east along the southern boundary of Site 300 in the San Joaquin Valley. In addition to these streams, 24 springs and 2 vernal pools exist onsite. Some surface water discharge occurs from cooling towers and other process runoff areas.

A tapline from the Hetch-Hetchy Aqueduct has been constructed with a capacity of 1.9 MLD (0.502 MGD) or 693 MLY (183 MGY). However, Site 300 has not been connected to the service as of yet. Site 300 is planning to use a new water supply from the San Francisco Water Department via the Aqueduct and the Coast Ridge Tunnel (LLNL 1991b:6).

At Site 300, stormwater, cooling tower water, and groundwater that has been treated to remove contaminants are discharged to onsite or adjacent drainages in accordance with NPDES permit conditions. Approximately 4.8 MLY (1.3 MGY) of wastewater is discharged to the wastewater sewage pond. The maximum capacity of the sanitary wastewater sewage pond in the General Services Area is 12 MLY (3.2 MGY).

Based on the flow and stream channel widths, 100-year flood events would be contained within the channels except for portions of Greenville Road (LL DOE 1992c:6-9). There is no information available for delineating the 500-year floodplain at Site 300. The lined drainage retention basin at Site 300 mitigates effects from significant flooding.

Surface Water Quality

Livermore Site. Offsite surface water bodies in the vicinity of the Livermore Site are routinely monitored for radioactive parameters. In addition, stormwater runoff at the Livermore Site is routinely monitored for radioactive and nonradioactive parameters. Approximately 25 percent of the stormwater runoff generated within the site drains into the lined Central Drainage Retention Basin, and the remainder drains either directly, or via a system of storm sewers and ditches, into Arroyo Seco or Arroyo Las Positas. Table 4.7.2.4-1 summarizes the monitoring results at the Livermore Site for 1993. Maximum concentrations of gross beta were above their comparison criteria at least once in 1993. There was one instance of noncompliance with wastewater permit limits in 1994: a discharge of methylene chloride. This event was reported to the city of Livermore Water Reclamation Plant. Table 4.7.2.4-2 summarizes the surface water monitoring results from the Arroyo Seco at the Livermore Site.

Table 4.7.2.4-1.-- Stormwater Quality Monitoring at the Livermore Site, 1993

			Water Body Concentration Range	
Parameter	**Unit of Measure**	**Water Quality Criteria[6]**	**ASW[7]**	**WPDC[8]**

Radiological				
Alpha (gross)	pCi/L	15[9]	0.27-10.8	1.4-10.5
Beta (gross)	pCi/L	20[10]	3.0-20.8	4.1-18.4
Tritium	pCi/L	80,000[11]	239-531	75.7-194
Nonradiological				
Arsenic	mg/L	0.05[9]	<0.002-0.0029	<0.002-0.0054
Bis (2-Ethylhexyl) phthalate	mg/L	NA	<10-12	<10-13
ChromPium	mg/L	0.1[9]	<0.005-0.0059	<0.005
Chloride	mg/L	250[12]	<1-19	1-24
pH	pH unit	6.5 - 8.5[12]	6.7[13]	6.9[13]
Sulfate	mg/L	250[11]	<2-42	5.2-220
Total alkalinity (as CaCO3)	mg/L	NA	11-46	18-72
Total dissolved solids	mg/L	500[12]	110[12]	95[13]
Zinc	mg/L	5[12]	0.33[12]	0.24[13]

Site 300. At Site 300, surface water samples analyzed in 1994 for gross beta and tritium showed concentrations below maximum contaminant levels for drinking water, except for gross alpha radiation for one sampling event. No concentrations were above comparison criteria in 1993.

Surface Water Rights and Permits. LLNL holds several permits pertaining to local, state, and Federal regulations: NPDES permits; Waste Discharge Requirements permits for any discharge of wastes that could adversely affect the beneficial uses of water; a city of Livermore Water Reclamation Plant permit for wastewater discharges to the city sanitary sewer system; and California Department of Fish and Game permits for streambed alteration for any work that may disturb or impact rivers, streams, or lakes.

Groundwater

Livermore Site. Groundwater at the Livermore Site occurs in an upper unconfined zone overlying a series of semiconfined aquifers. The two geologic units containing the most important aquifers are the surface valley-fill deposits (shallow alluvial aquifer) and the Livermore Formation (semi-confined aquifer).

Table 4.7.2.4-2.-- Maximum Concentrations of Constituents in Surface Water of the Arroyo Seco at the Livermore Site, 1993

		Water Body Concentration Range	
	Unit of Measure	Water Quality Criteria[14]	
Parameter	ASS2[15]		
Radiological			
Alpha (gross)	pCi/L	15[16]	1.08-5.9
Beta (gross)	pCi/L	50[17]	3.5-9.7
Tritium	pCi/L	20,000[16]	74-374
Nonradiological			
Bis (2-Ethylhexyl)-phthalate	mg/L	NA	34
Chloride	mg/L	250[18]	<1-6.2
Fluoride	mg/L	4[16]	<1-0.065
Nitrate/nitrite as NO3	mg/L	10[16]	1.4-2.4
Sulfate	mg/L	250[16]	<2-25

The Livermore Site is located within the Spring subbasin of the Livermore Valley groundwater basin. The aquifers are locally recharged by the stream runoff from precipitation and controlled releases from the South Bay Aqueduct, direct rainfall, irrigation, and treated groundwater infiltration. In addition, stream channels and ditches, and gravel pits west of the city of Livermore also recharge the shallow alluvial aquifer. Groundwater is also naturally discharged from the basin at Arroyo de la Laguna located 18 km (11 mi) southwest of the Livermore Site (LL DOE 1992c:4-151). Depth to the shallow alluvial aquifer beneath the Livermore Site ranges from approximately 9 to 34 m (30 to 110 ft). Groundwater generally flows westward throughout much of the site and southwest in the southeast area of the Livermore Site.

Site 300. At Site 300, there are two regional aquifers or major waterbearing zones: an aquifer in the sandstones and conglomerates of the Neroly Formation and a deep confined aquifer also located in the Neroly Formation. The deep confined aquifer (122 to 152 m deep [400 to 499 ft]), beneath the southern part of the site within the Neroly Formation, provides the water supply for Site 300. In addition, there are a number of local perched groundwater zones. These are not significant aquifers, because water quality is poor and yields are low. Groundwater flow in the deep confined aquifer is controlled by the sandstone beds (LLNL 1995n:E.2.4-27). North of the Patterson Anticline, which is roughly in the center of Site 300, (figure 4.7.2.4-2) water moves to the northeast, and south of the Anticline it moves to the southeast (LLNL 1994a:8-5). Runoff that has concentrated in Elk Ravine and Corral Hollow Creek recharges local bedrock aquifers. No aquifers in the Site 300 area are considered sole source aquifers under the Safe Drinking Water Act (SDWA).

Groundwater Quality

Livermore Site . Groundwater in the vicinity of the Livermore Site is generally suitable as a domestic, municipal, agricultural, and industrial supply, with the exception of groundwater less than 91 m (300 ft) deep (LL DOE 1992c:4-164). A network of groundwater monitoring and extraction wells at the Livermore Site is routinely monitored for radioactive and nonradioactive parameters. Maximum concentrations of gross alpha, nitrate/nitrite, trichloroethylene, and tritium were above their water quality criteria/standard in 1993. The maximum concentrations for tritium are found in one localized well within the Livermore Site boundary (LLNL 1994a:7-14), and pose no threat to water supplies.

VOCs have been detected in the onsite groundwater and in the area around the Livermore Site. All site practices known to contribute VOCs to groundwater have been discontinued. Investigations, however, have determined that VOC-contaminated water is present under 85 percent of the Livermore Site. The contaminant plumes have migrated off site in two areas. One plume containing mainly tetrachloro-ethylene extends from the southwest corner of the Livermore Site about 762 m (2,500 ft) west of Vasco Road under private property. It is migrating to the northwest at a rate of about 21 m (68.9 ft) per year. Three municipal supply wells are situated within about 4.4 km (2.4 mi) of this plume. The other plume, which contains primarily trichloroethylene, extends about 244 m (800 ft) south onto DOE property administered by Sandia National Laboratories, Livermore. LLNL is working with EPA and the State of California to identify appropriate remedial measures.

Approximately 150 million L (34.3 million gal) of groundwater in the southwest corner of the facility have been treated to remove VOCs. The treated water is discharged either to a recharge basin south of the site or to stream channels in accordance with NPDES permit limitations.

Site 300. At Site 300, groundwater is sampled quarterly from inactive and active water supply wells and monitoring wells. Samples are analyzed for radioactive and nonradioactive parameters (table 4.7.2.4-3). Maximum concentrations of arsenic, gross alpha, nitrate/nitrite, trichloroethylene, tritium, and uranium were above their water quality criteria/standard at least once in 1993 (LLNL 1994a: 7-

17-7-18). Currently, LLNL is investigating and identifying characteristics of the groundwater contamination at Site 300. Several plumes of VOCs and tritium have been identified in shallow and deeper bedrock aquifers in this and adjacent offsite areas (LLNL 1994a:7-16-7-17). LLNL is working with the EPA and California to remediate these plumes.

Groundwater Availability and Use

Livermore Site . The Livermore Site relies on imported surface water for its municipal, commercial, residential, and agricultural uses, supplemented only by a relatively small amount of treated groundwater used for irrigation and cooling tower makeup. The water from the supply wells is blended with imported surface water before distribution to the public.

Site 300 . At Site 300, approximately 90 MLY (23.8 MGY) of water are extracted from two groundwater supply wells located in the southeast portion of the site. Other water supply wells located near Site 300 are used for recreation, stock watering, and potable purposes.

Groundwater Rights and Permits. Groundwater rights in the State of California are traditionally associated with Correlative Rights, which are derived from the concept that water users will share the resource during droughts, based on the relative areal extent of the land owned by the competing landowners. If no competition for water exists, then landowners can withdraw groundwater to the extent that they exercise their rights reasonably in relation to the similar rights of others. Because the majority of the water supply at Site 300 is from onsite wells, the present water restriction is the capacity and recharge of the wells.

Table 4.7.2.4-3.-- Groundwater Quality Monitoring at Site 300, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[19]	Well K1-08[20]	Well NC7-25[21]	W-817-01[22]
Radiological					
Alpha (gross)	pCi/L	15[23]	-0.11-1.62	23-29.7	NA
Beta (gross)	pCi/L	50[24]	2.1-3.2	18.6-26.5	NA
Radium-226	pCi/L	3[23]	-0.17-0.460	0.73-1.2	NA
Tritium	pCi/L	20,000[23]	<43.2-24.3	233,000-298,000	<45.9-22.4

Uranium-233,234	pCi/L	20[25]	0.86-1.84	10-12.7	NA
Uranium-235	pCi/L	24[25]	0.013-0.241	0.30-0.86	NA
Uranium-238	pCi/L	24[25]	0.54-0.81	7.6-12.2	NA
Nonradiological					
Arsenic	mg/L	0.05[23]	0.012-0.017	0.0048-0.0068	0.036-0.058
Chromium	mg/L	0.1[23]	<0.01	NA	<0.005-0.0037
1,2-Dichloroethene	mg/L	0.005[23]	NA	<0.0005-<0.001	<0.0005
Lead	mg/L	0.015[23]	<0.002	<0.0002	<0.002-<0.1
Nitrate/nitrite	mg/L	10[23]	5.2-8.1	NA	71-81
RDX	mg/L	NA	NA	NA	<30-117
Tetrachloroethylene	mg/L	0.005[23]	NA	NA	<0.0005
1,1,1-Trichloroethane	mg/L	0.2[23]	NA	<0.0005	NA
Trichloroethylene	mg/L	0.005[23]	NA	0.0005	<0.0005
Trichlorotrifluoro-ethane	NA	NA	NA	0.001	NA

4.7.2.5 Geology and Soils

Geology

Livermore Site. The Livermore Site is located within the California Coast Ranges, an area of north-northwest trending ranges and valleys. Livermore Valley, an exception to this trend, forms an east-west structural basin defined by branches of the San Andreas fault system. The Livermore Site occupies a smooth land surface that slopes gently to the northwest.

The Livermore Site is underlain by late Tertiary and Quaternary rocks that lie on basement rocks of the Franciscan assemblage, which consist of severely deformed sandstone, shale, and chert. In the

Livermore area, this unit is mainly sandstone. The Livermore Valley topographic and structural basin was formed in Pliocene time by movements along faults to the east and west. The basin is filled with 1,219 m (4,000 ft) of Pliocene to Holocene alluvial gravels, sands, and lacustrine clays of the Livermore Formation. Late Quaternary alluvial deposits immediately underlie the Livermore Site.

The historically active, northwest-trending Calaveras fault zone, the easternmost branch of the San Andreas fault system in the San Francisco Bay area, traverses the western margin of Livermore Valley. The Concord-Green Valley fault and parallel trending Greenville fault zone define the eastern boundary of Livermore Valley. In addition, two other capable faults, the Las Positas and Verona faults, as well as several inactive faults, cut the southern part of Livermore Valley. The Livermore Site lies in an area of historically inactive faulting, 1.6 km (1.0 mi) north of the Las Positas fault zone and less than 3.2 km (2.0 mi) west of the Greenville fault zone (figure 4.7.2.5-1).

The Livermore Site lies within seismic Zone 4 (figure A.1-1). The Calaveras fault has had several earthquakes of Richter magnitude 5.0 or greater in the last 150 years. A maximum probable earthquake greater than magnitude 7.0 is possible. In 1980, an earthquake sequence on the Greenville fault produced two earthquakes of magnitude 5.5 and 5.6. There are also surface indications of other recent seismic events, and the maximum credible earthquake estimated for this fault zone is magnitude 6.6 0.2. Although the Las Positas fault zone has no recorded historical movement, a portion of the Las Positas fault from northeast of Arroyo Mocho to a point 229 m (751 ft) east of Greenville Road lies in a special studies zone under the Alquist-Priolo Act. This act requires that active fault location studies be performed before building permits can be issued for most classes of construction (LLNL 1984a:49). The maximum credible earthquake for this fault zone is magnitude 6.0 0.5 (modified Mercalli intensity VI or greater) (LLNL 1984a:52). The potentials for surface faulting, damage from liquefaction, and slope instability at the Livermore Site are all low (LL DOE 1992c:4-84,4-86). The potential for volcanic activity is low as well (DOE 1995cc:4-66).

Site 300. Site 300 is located at the eastern margin of the California Coast Ranges, 16 km (10 mi) east of Livermore Valley. The site lies in an area of northwest-trending steep hills and ridges separated by ravines and is underlain by Eocene to Pliocene sedimentary rocks that rest on a basement of the Cretaceous Great Valley Sequence. Late Miocene to Pliocene interbedded sandstones, siltstones, and claystones are exposed in much of the site. Cretaceous, Eocene, and Early Miocene rocks are also present along the northern and southern borders of the site. These rocks are locally overlain by Quaternary alluvial and terrace deposits and Holocene colluvium, alluvium, and valley fill deposits.

Site 300 lies within seismic Zone 4 (appendix figure A.1-1). Two major faults cut Site 300. The Carnegie and Corral Hollow faults cross the southern boundary of the site; Holocene movement has occurred along these faults (LLNL 1991d:1). The combined Corral Hollow-Carnegie fault zone may be capable of generating an earthquake of Richter magnitude 6.5 to 7.1. The inactive northwest-trending Elk Ravine fault cuts across the northeast section of the site. Site 300 facilities are not within a special studies zone. The principal seismic hazard would be the ground shaking associated with movement along either the Corral Hollow-Carnegie fault or Greenville fault, 8 km (5 mi) to the west of Site 300 (LLNL 1983a:49-52). Surface faulting at Site 300 in areas adjacent to the active Carnegie fault is possible, while the potential for liquefaction at Site 300 is low. The potential for seismically induced landslides at Site 300 still exists (LL DOE 1992c:4-87,4-89).

Soils

Livermore Site. The Livermore Site is located on soils originally classified as the Rincon-San Ysidro association. These soils are nearly level, loamy textured, shallow to very deep soils on older fans and floodplains. The hazard of erosion is slight to moderate. Several of these soils, including the Rincon, San Ysidro, and Zamora Series soils, have moderate to high shrink-swell potential (LL USDA 1966a:17). Recently, the entire area under the Livermore Site has been redesignated as urban and built-up land. There are no prime or unique farmland soils located at the Livermore Site.

Site 300. Site 300 soils in Alameda County belong to the Altamont-Diablo association. Soils in San Joaquin County have different designations than Alameda County soils, but the properties of these soils are identical. The water erosion hazard of these soils is slight to severe; the wind erosion hazard is slight. Many soils have a high shrink-swell potential. There is no prime or unique farmland on Site 300.

4.7.2.6 Biotic Resources

The following section describes biotic resources at the Livermore Site and Site 300 including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. A list of the threatened and endangered species that may be found on or in the vicinity of the Livermore Site and Site 300 is presented in appendix C.

Terrestrial Resources. The Livermore Site and Site 300 are located in the California Chaparral Province. The U.S. Forest Service has classified the general vegetation type of the region as annual grasslands (USDA 1977a).

Livermore Site. The Livermore Site includes developed areas surrounded by security zones of mostly grassland. Developed land area includes approximately 78 percent of the site. The undeveloped land in the security zones is grassland dominated by nonnative grasses such as ripgut brome (*Bromus diandrus*) and slender oat (*Avena barbata*). Arroyo Seco, a stream bed which runs across the southwestern corner of the site, is steep-sided and forms a relatively undisturbed habitat. Both native trees (such as red willow [*Salix spp.*] and California walnut [*Juglans hindsii*]) and introduced species (such as black locust [*Robinia pseudo-acacia*] and almond [*Prunus amygdalus*]) are present (LL DOE 1992c:4-91).

Five species of amphibians, 2 species of reptiles, 31 species of birds, and 10 species of mammals have been reported at the Livermore Site (LL DOE 1992d:F-33,F-36,F-39). Wildlife at the site includes species that are found in the grassland habitat of the security zones and those that live in the developed areas or along the arroyos. Species found in the security zones include the western fence lizard (*Sceloporus occidentalis*), western meadowlark (*Sturnella neglecta*), black-tailed jackrabbit (*Lepus californicus*), and California ground squirrel (*Spermophilus beecheyi*). Nesting birds within the laboratory complex include the American crow (*Corvus brachyrhynchos*), American robin

(*Turdus migratorius*), Anna's hummingbird (*Calypte anna*), white-throated swift (*Aeronautes saxatalis*), California quail (*Callipepla californica*), and house sparrow (*Passer domesticus*). Bird species observed along Arroyo Seco include the mourning dove (*Zenaida macroura*), acorn woodpecker (*Melanerpes formicivorus*), sharp-shinned hawk (*Accipiter striatus*), and turkey vulture (*Cathartes aura*) (LL DOE 1992c:4-95). Game animals include the California quail and desert cottontail (*Sylvilagus auduboni*). Raptors present on site include the red-tailed hawk (*Buteo jamaicensis*), Cooper's hawk (*Accipiter cooperii*), and golden eagle (*Aquila chrysaetos*), while carnivores present include the coyote (*Canus latrans*) and red fox *(Vulpes vulpes)* . Migrating birds present on site, as well as their nests and eggs, are protected by the Migratory Bird Treaty Act. Eagles are similarly protected by the Bald and Golden Eagle Protection Act.

Site 300. Five plant communities are found on Site 300 (figure 4.7.2.6-1). In addition, approximately 5 percent of the site has been disturbed. Introduced grassland is the largest community, covering 81 percent of the site. Native grassland, which covers 10 percent of the site, is the second most abundant community type. Coastal sage scrub and oak woodland plant communities occupy about 2 percent of the Site 300 area. Northern riparian woodland is considered rare on Site 300. Grazing has not been permitted on the site since 1953; thus, the area has more native grasses and herbs than neighboring property. Controlled burning of about 810 ha (2,000 acres) each year is conducted as a means of wildfire control and to aid in maintaining native grass communities. A total of 342 species of plants has been recorded on Site 300 (LL DOE 1992c:4-92; LL DOE 1992d:F-4).

Studies of Site 300 have identified 21 species of amphibians and reptiles, 79 species of birds, and 27 species of mammals (appendix J). Because of the abundance of grassland communities, species favoring this habitat type are most abundant on the site. Common animals found at Site 300 include the gopher snake (*Pituophis melanoleucus*), western meadowlark, savannah sparrow (*Passerculus sandwichensis*), California ground squirrel, and deer mouse (*Peromyscus maniculatus*). In addition, springs and the surrounding vegetation provide important habitat for a number of song birds and game animals (LL DOE 1992c:4-96,4-97). Game animals at Site 300 include the mule deer (*Odocoileus hemionus*), desert cottontail, and California quail. Hunting is not permitted onsite (LLNL 1992a:3). Additional important species found at Site 300 include raptors, such as the great-horned owl (*Bubo virginianus*) and northern harrier (*Circus cyaneus*), and carnivores, such as the coyote and bobcat (*Lynx rufus*). As is the case for the Livermore Site, migratory birds and eagles are protected by Federal legislation.

Wetlands

Livermore Site. Wetlands at the Livermore Site are limited to several small areas along Arroyo Las Positas, located at and downstream from culverts that channel runoff from surrounding areas. Two areas, totaling 0.12 ha (0.3 acres), are dominated by saltgrass (*Distichlis spicata*). A species of sedge (*Carex spp.*) is also common. One saltgrass wetland has both standing and flowing water and areas of very wet soil. The other saltgrass wetland is drier, with sandy soil. A third, smaller wetland (0.04 ha [0.1 acres]) is located in a culvert. Cattail (*Typha spp.*) is the dominant plant in this wetland with other species such as sedge and saltgrass also commonly observed. Both standing and flowing water have been observed in this area, and the soil is sandy (LL DOE 1992d:G-16).

Site 300. Wetlands at Site 300 were delineated according to methods contained in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (January 10, 1989). Site 300 contains 2.7 ha (6.7 acres) of wetlands. The wetland areas are small and scattered on the site in approximately 16 locations. Many of the wetlands are associated with natural springs, although one is associated with a vernal pool, and several have been artificially created from Site 300 runoff. Many of the wetlands associated with springs are at the bottom of deep canyons. Typical wetland vegetation associated with these springs include cattail, rush (*Juncus spp.*), willow, and cottonwood (*Populus spp.*) (LL DOE 1992c:4-112; LL DOE 1992d:G-19,G-46-G-48).

Aquatic Resources

Livermore Site. Potential aquatic habitat on the Livermore Site consists of an intermittent drainage system, seeps, springs, ditches, and a groundwater retention basin. The intermittent drainage system comprises westward-flowing arroyos that contain water during the winter months. Arroyos on the site include Arroyo Las Positas, located along the northern edge of the Livermore Site, and Arroyo Seco, which crosses the southwest corner of the site. Because of their temporary nature, the arroyos do not support fish. The seeps, springs, and ditches also do not support fish; however, the groundwater retention basin contains a population of mosquito fish *(Gambusia affinis)* (LLNL 1995i:3).

Site 300. Potential aquatic habitat on Site 300 consists of vernal pools, ponds, springs, and drainages. There is one perennial stream on the site. A sewage lagoon is located on the property, but it does not support any fish populations (LL DOE 1992c:4-95). Ponds located in the southeast-central portion of the site, and springs and drainages located throughout the site, do not support fish populations (LLNL 1992a:1).

Threatened and Endangered Species

Livermore Site. Forty-six Federal- and state-listed threatened, endangered, and other special status species may be found on and in the vicinity of the Livermore Site (appendix table C-5). Eleven of these species have been observed on the Livermore Site, including the Federal-listed bald eagle *(Haliaeetus leucocephalus)* . The other observed species include state special concern species. Although suitable habitat for several listed species exists onsite, potential occurrence of most of the species in appendix table C-5 is minimal due to the lack of suitable habitat and negative survey results. Site surveillance would be required to verify the occurrence of any listed species. No critical habitat for threatened and endangered species, as defined in the Endangered Species Act (50 CFR 17.11; 50 CFR 17.12), exists on the Livermore Site.

Site 300. Forty-eight Federal- and state-listed threatened, endangered, and other special status species may be found on and in the vicinity of Site 300 (appendix table C-5). Twenty-four of these species have been observed on Site 300. These species include the Federal-listed American peregrine falcon *(Falco peregrinus anatum)* and large-flowered fiddleneck (*Amsinckia grandiflora*), and Federal-proposed endangered Alameda whipsnake *(Masticophis lateralis euryxanthus)* and California red-legged frog (*Rana aurora draytoni*). The other observed species include the state-listed Swainson's hawk and state special concern species. Potential occurrence of most of the other species listed in table C-5 is minimal due to lack of suitable habitat and negative survey results. Site surveillance would be required to verify their occurrence. No critical habitat for threatened and endangered species, as defined in the Endangered Species Act (50 CFR 17.11; 50 CFR 17.12), exists on Site 300.

4.7.2.7 Cultural and Paleontological Resources

Prehistoric Resources. The Livermore Site covers 332 ha (820 acres), 259 ha (640 acres) of which have been developed. Four cultural resources surveys have been conducted for undeveloped areas of the facility. No prehistoric resources were identified, and records searches indicated that no prehistoric resources had been previously recorded on or near the Livermore Site. Prehistoric sites identified in the vicinity of the Livermore Site and Site 300 include villages, campsites, rockshelters, and limited activity locations, including lithic scatters, hearths, and concentrations of fire-affected rocks. A cultural resources management plan is being developed to address issues of resource identification and maintenance.

A 1981 survey of Site 300 identified a quarry site, two prehistoric rockshelters, and one prehistoric rockshelter/historic graffiti site (LL DOE 1981a:2F.58). These sites were recorded but have not been evaluated to determine their eligibility for the NRHP.

Historic Resources. No historic sites have been recorded for the Livermore Site; however, buildings and facilities associated with the World War II-era Livermore Naval Air Station and themes in nuclear weapons development and other research projects may still be present. Because the Livermore Site was established in 1952, existing structures are not associated with the Manhattan Project or initial nuclear production. A formal NRHP evaluation of the buildings and facilities is currently being initiated.

The 1981 survey for parts of Site 300 resulted in 21 recorded historic sites, including historic graffiti, trash scatters, cabins, a foundation, a mine tunnel, a power/telegraph pole, and a townsite. The townsite, Carnegie, is a state-registered landmark. Most of the sites are associated with an industrial mining and manufacturing complex built in Corral Hollow Canyon between 1891 and 1918. Additional archival research is being conducted to clarify the characteristics of the Carnegie townsite. Site 300 was established in 1953; existing structures are not associated with the Manhattan Project or initial nuclear production.

Native American Resources. Native American groups known to have used Alameda and San Joaquin counties include the Costanoans (or Ohlone), Northern Yokuts, and Eastern Miwok. These groups were hunters and gatherers who relied on a variety of resources including deer, elk, antelope, fish, birds, nuts, and fruits. Individual tribes usually had a permanent village and occupied smaller campsites on a seasonal basis. The Northern Valley Yokuts and Eastern Miwok were decimated after European contact due to disease and acculturation, and no longer exist as a group. It is estimated that there are approximately 130 people of Costanoan (Ohlone) descent still living in the San Francisco Bay region.

Sacred and important Native American resources that might be found in the vicinity of the Livermore Site and Site 300 include burials, cremations, vision quest sites, and traditional use areas. Initial consultation with identified local Native American groups to determine important resources has begun.

Paleontological Resources. Most of the surficial and near-surface sediments of the Livermore Site are alluvial deposits of the Livermore Formation. They range in age from latest Pleistocene (15,000 to 20,000 years) to 100,000 years or greater and are not known to be fossiliferous. The only vertebrate fossil deposits in the vicinity of the Livermore Site are in the Quaternary deposits of the surrounding low hills of the east Livermore Valley, but the fossils are few in number and quite scattered. They have been tentatively identified as Rancholabrean and Blancan in age (Pleistocene) and consist of bone fragments of mammoth and giant ground sloth.

Geological formations with paleontological materials at Site 300 are the Franciscan Complex and the Cierbo and Neroly Formations. The Franciscan Complex gravels are known to contain Icthyosaurus fossils; however, no known localities have been recorded within Site 300. The Cierbo Formation outcrops extensively in the northwest quarter of Site 300 and contains Miocene oyster shells. Because these paleontological materials are relatively common, marine invertebrate assemblages are considered to have relatively low research potential.

More than 75 percent of Site 300 is Neroly Formation. Miocene (Caledonian age) mammal fossil deposits have been found within the Neroly Formation in the vicinity of Site 300 and Corral Hollow. Plant leaf and stem fossils have been recovered from the lower Neroly Formation. An assortment of vertebrate taxa are also represented, including camelids, mastodon, early horses, beavers, squirrels, and shrews. Fossil finds are generally widely scattered and consist of no more than several bone fragments. Numerous fossil bones and bone fragments from the Neroly Formation have been found on the south side of Corral Hollow Creek, adjacent to the facility and along a fire trail and road improvement areas within Site 300. The Neroly Formation paleontological locality within Site 300 is being assessed. The paleontological resources on Site 300 may have moderate research potential and may contribute data to aid paleoenvironmental reconstruction.

4.7.2.8 Socioeconomics

Socioeconomic characteristics addressed at LLNL include employment and regional economy, population, housing, and public finance. Employment and regional economy statistics are presented for the regional economic area that encompasses 22 counties in California around LLNL. Statistics for the remaining socioeconomic characteristics are presented for the ROI, a three-county area in which approximately 86 percent of all LLNL employees reside: Alameda County (57 percent), Contra Costa County (13 percent), and San Joaquin County (16 percent). There are no other counties where more than 3 percent of LLNL employees reside. Figure 4.7.2.8-1 presents a map of counties and selected cities composing the LLNL regional economic area and ROI. Supporting data are presented in appendix D.

Regional Economy Characteristics. Selected employment and regional economy statistics for the

LLNL regional economic area are summarized in figure 4.7.2.8-2. The civilian labor force in the regional economic area grew a total of 26 percent between 1980 and 1990, an average annual growth rate of 2.6 percent. Total regional economic area employment in 1994 was 4,068,974, and the unemployment rate was 7.6 percent. In comparison, state unemployment was 8.6 percent. Total personal income in the regional economic area in 1993 was $454 billion, and per capita income was $25,179. State per capita income in 1993 was $21,894.

As shown in figure 4.7.2.8-2, the LLNL regional economic area and the State of California have similar employment patterns with the manufacturing, retail trade, and services sector providing almost the same proportion of nonfarm employment in both regions. The service sector accounts for the largest share of nonfarm private sector employment in both California (32 percent) and the region (38 percent).

Population and Housing. In 1992, population in the ROI totalled 2,652,248. The ROI population increased 26 percent between 1980 and 1992 (about 2 percent annually), a somewhat slower rate of increase than the state population growth of 31 percent (approximately 2.5 percent annually) during the same period. Total population increases within the ROI ranged from over 18 percent (about 1.5 percent annually) in Alameda County to about 45 percent (3.8 percent annual growth) in San Joaquin County during the same period.

The number of housing units in the ROI increased 18 percent during the 1980s (1.8 percent annually). Increases in the number of housing units in the ROI counties ranged from 13 percent (1.3 percent annually) in Alameda County to 25 percent (2.5 percent annually) in Contra Costa County. These growth rates compare to the 21-percent increase in housing units in California during the same period. In 1990, the regional homeowner vacancy rate averaged 1.6 percent, and the rental vacancy rate averaged 5.6 percent. These vacancy rates were comparable to the homeowner and rental vacancy rates for the entire state. Figure 4.7.2.8-3 summarizes population and housing trends for the LLNL ROI.

Public Finance. Financial characteristics of the local jurisdictions in the LLNL ROI that are most likely to be affected by the proposed action are presented in this section. The data reflect total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.2.3-10 and D.2.3-11. Figure 4.7.2.8-4 summarizes 1994 local government revenues and expenditures. Fund balances, which are dollars carried over from previous years, are not included in figure 4.7.2.8-4. All jurisdictions assessed had positive fund balances.

4.7.2.9 Radiation and Hazardous Chemical Environment

The following section provides a description of the radiation and hazardous chemical environment at

LLNL. Also included are descriptions of health effects studies, a brief accident history, and emergency preparedness considerations.

Radiation Environment. Major sources of background radiation exposure to individuals in the vicinity of LLNL are shown in table 4.7.2.9-1. All annual doses to individuals from background radiation are expected to remain constant over time. The total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to LLNL operations.

Table 4.7.2.9-1.-- Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Lawrence Livermore National Laboratory Operations

Source	Committed Effective Dose Equivalent (mrem/ yr)
Natural Background Radiation[26]	
Cosmic and cosmogenic radiation	30
External terrestrial radiation	30
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation [26], [27]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	365

Releases of radionuclides to the environment from LLNL operations provide another source of radiation exposure to individuals in the vicinity of LLNL. The radionuclides and quantities released from LLNL operations in 1994 are listed in the *Environmental Report 1994* (UCRL-50027-94). The doses to the public resulting from these releases are presented in table 4.7.2.9-2. These doses fall within regulatory limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1994 report were used in the development of the reference environment's

(No Action) radiological releases at LLNL in 2005.

Based on a dose-to-risk conversion factor of 500 cancer deaths per 1 million person-rem (5x10-4 fatal cancers per person-rem) to the public (appendix E), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from LLNL operations in 1994 is estimated to be 3.3x10-*8* . That is, the estimated probability of this person dying of cancer from radiation exposure associated with 1 year of LLNL operations is slightly greater than 3 chances in 100 million. (Note that it takes several years from the time of exposure to radiation for cancer to manifest itself.)

Based on the same conversion factor, 3.8x10-*4* , excess fatal cancers are projected in the population living within 80 km (50 mi) of LLNL from normal operation in 1994. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers from all causes expected during 1994 in the population living within 80 km (50 mi) of LLNL was 12,000. This number of expected fatal cancers is much higher than the estimated 3.8x10-*4* fatal cancers that could result from LLNL operations in 1994.

Table 4.7.2.9-2.--Doses to the General Public from Normal Operation at Lawrence Livermore National Laboratory, 1994 (Committed Effective Dose Equivalent)

	Atmospheric Releases		**Liquid Releases**		**Total**	
Affected Environment	**Standard**[28]	**Actual**	**Standard**	**Actual**	**Standard**[28]	**Actual**
Maximally exposed individual (mrem)	10	0.065	4	0.0	100	0.065
Population within 80 kilometers29 (person-rem)	None	0.76	None	0.0	100	0.76
Average individual within 80 kilometers30 (mrem)	None	1.3x10-4	None	0.0	None	1.3x10-4

Workers at LLNL receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities.

Table 4.7.2.9-3 includes the average, maximum, and total occupational doses to LLNL workers from operations in 1994. These doses fall within radiological limits (10 CFR 835). Based on a dose-to-risk conversion factor of 400 fatal cancers per 1 million person-rem (4x10-4 fatal cancers per person-rem) among workers (appendix E), the number of excess fatal cancers to LLNL workers from operations in 1994 is estimated to be 0.0073.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Lawrence Livermore National Laboratory Environment Report-1994* (UCRL-50027-94). The concentrations of radioactivity in various environmental media (e.g., air and water) and in animal tissue in the site region (onsite and offsite) are also presented in the same reference.

Table 4.7.2.9-3.-- Doses to the Onsite Worker from Normal Operation at Lawrence Livermore National Laboratory, 1994

	Onsite Releases and Direct Radiation	
Affected Environment	**Standard**[31]	**Actual**[32]
Average worker (mrem)	None	2.1
Maximally exposed worker (mrem)	5,000	1,300
Total workers (person-rem)	None	18.3

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in sections 4.7.2.3 and 4.7.2.4.

Adverse health impacts to the public can be minimized through administrative and design controls to decrease hazardous chemical releases to the environment and to achieve compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operation at LLNL via inhalation of air containing hazardous chemicals released to the atmosphere by LLNL operations. Risks to public health from ingestion of contaminated drinking water or direct exposure are also potential pathways.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in section 4.7.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are compared with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in appendix E.

Exposure pathways to LLNL workers during normal operation may include inhaling the workplace atmosphere, drinking LLNL potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. LLNL workers are also protected by adherence to OSHA and EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operation processes, ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at LLNL are expected to be substantially better than required by standards.

Health Effects Studies. A study involving two groups of children and young adults under the age of 25 who were born in Livermore between 1960 and 1990 and lived in Livermore between 1960 and 1991 found no increased risk of leukemia or non-Hodgkins lymphoma. The study found a 2.4-fold increase in the risk of malignant melanoma in the children and young adults who lived in Livermore between 1960 and 1991 and a 6.4-fold increased risk of malignant melanoma for children born in Livermore between 1960 and 1991. No increased risk of any other type of cancer was found.

A joint study conducted by the California Department of Public Health and LLNL reported 19 cases of malignant melanoma between 1972 and 1977 among LLNL employees (Lancet 1981a: 712-716). No other cancers were increased among LLNL employees from 1969 to 1980 (WJM 1985a:214-218).

Hiatt and Fireman investigated the hypothesis that the increased incidence of malignant melanoma was due to a difference in medical care received by LLNL employees compared to non-LLNL employees of the same geographic area belonging to the same prepaid health plan (LLNL 1984c). The authors concluded that the sustained increase in melanoma incidence at LLNL is associated with an increased likelihood of being biopsied for pigmented skin lesions because the physicians caring for LLNL employees may be more aware of the potential malignancy of pigmented lesions than those caring for non-LLNL employees.

The most recent case-control study of malignant melanoma concluded that there was no association between occupational factors and the increased melanoma diagnosis among LLNL employees (LLNL 1994e). No clear explanation for the increased melanoma among LLNL workers has been provided. Increased awareness and enhanced surveillance are currently suspected. For a more detailed description of the studies and the findings, refer to appendix section E.4.7.

Accident History. Prior to 1960, there were no accidents at LLNL that had offsite impacts. Since 1960, there have been a number of accidents that have resulted in only negligible exposures to the public.

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response. The LLNL Emergency Preparedness Plan is designed to minimize or mitigate the impact of any emergency upon the health and safety of employees and the public.

4.7.2.10 Waste Management

This section outlines the major environmental regulatory structure and waste management activities for the Livermore Site and Site 300. A more detailed discussion of the ongoing Livermore Site and Site 300 waste management operations and the regulatory setting is provided in appendix section H.2.6.

DOE is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operation at the Livermore Site and Site 300, and is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for compliance with applicable requirements and financial penalties for nonachievement of agreed-upon milestones. These agreements have been reviewed to assure the proposed actions are allowable under the terms of these agreements.

EPA included the Livermore Site on the NPL on July 21, 1987, because of groundwater contamination primarily by solvents containing VOC and fuel hydrocarbons. DOE, EPA, and the State of California entered into a Federal Facility Agreement to serve as the interagency agreement required under CERCLA and *Superfund Amendments and Reauthorization Act* (SARA), Section 120. This Federal Facility Agreement applies to the Livermore Site only and establishes a procedural framework and schedule for conducting source investigations, continued sampling, monitoring, and remediation of groundwater at the site. The Federal Facility Agreement enhances interagency coordination and cooperation, minimizes duplication of analysis and documentation, expedites remedial actions with a minimum of administrative delays, and establishes a basis for a determination that DOE has completed the CERCLA, RCRA, and state requirements.

Site 300 was placed on the NPL in 1990 because VOCs were discovered in the regional aquifer underlying the site and because of the proximity of the contamination to private drinking water supplies. The EPA and Site 300 authorities agreed to combine RCRA and CERCLA restoration requirements under a single Federal Facility Agreement for Site 300. A Federal Facility Agreement covering cleanup activities at Site 300 was executed on June 29, 1992. This agreement addresses the presence of trichloroethylene (TCE) in soil, rock, and groundwater; HE compounds in the HE Process Area; and tritium in the Pit 7 complex and in the Building 850 Area.

Through its research activities at the Livermore Site and Site 300, LLNL manages five broad waste categories: TRU, low-level, mixed, hazardous, and nonhazardous wastes, some of which are classified. Because there is no TRU waste associated with any of the proposed activities at LLNL, there is no discussion in this PEIS of TRU waste generation and management at LLNL. A discussion of the waste management activities associated with each of these waste categories follows.

Low-Level Waste. In 1994, the Livermore Site generated approximately 181 m^3 (47,800 gal) of liquid and 307 m^3 3) of solid LLW (LLNL 1995i:1). Solid LLW at the Livermore Site consists of gloves, absorbent paper, plastics, glass, and other solid materials contaminated with low-level radioactive materials. Wastewater from retention tank systems that exceeds site radiological discharge limits or any special limits established for that tank, and cannot be treated for discharge or released to the sanitary sewer, is treated as LLW. Smaller quantities of contaminated liquids may be accumulated in various sizes and types of containers. Nonreleasable wastewater in generator retention tank systems is pumped into portable tanks for treatment at the Wastewater Treatment Tank Farm at the Building 514 Facility. At the Area 514 Waste Treatment Facility, containerized and bulk radioactive liquid wastes are transferred into one of the six 7,003 L (1,850 gal) treatment tanks to be treated chemically. These tanks are used to treat both radioactive and mixed waste liquids. Following treatment, a sample is gathered by hazardous waste management personnel and analyzed by a certified analytical laboratory for pH, metals, gross alpha and beta activity, tritium, and other possible contaminants, as necessary (depending on the waste's description). If the review indicates that the contents of a treatment tank are below established sewer discharge limits, the liquid is released to the sanitary sewer.

The precipitate wastes from tank farm chemical treatments are filtered in the Dorr-Oliver unit by creating a filter cake (coating a rotating drum with a slurry of diatomaceous earth), depositing the precipitate on the absorbent filter cake, capturing the filtrate in a tank, removing and packaging the contaminated cake, and then either discharging the liquid filtrate to the sanitary sewer or retreating it. The filter cake is then stabilized. Liquid and solid radioactive wastes are processed or stored at Building 514 and 612 complexes.

In 1994, Site 300 generated approximately 463 m^3 (606 yd^3) of solid LLW (LLNL 1995i:1). Site 300 generates solid LLW from the detonation of test assemblies on firing tables. The debris from the detonation is contaminated with depleted uranium and, in some instances, thorium or tritium. LLW is packaged in approved waste containers and transported for staging on site, pending shipment to the Livermore Site or shipment directly to NTS for disposal.

Mixed Low-Level Waste. In 1994, the Livermore Site generated approximately 51 m^3 (13,470 gal) of liquid and 20 m^3 (26 yd^3) of solid mixed LLW (LLNL 1995i:1). Some of the generated liquid mixed LLW is treated at the Area 514 Wastewater Treatment Tank Farm prior to discharge to the sanitary sewer so that hazardous constituents and radionuclides are removed, and this wastewater can be discharged within the allowable limits of the sewer discharge permit. The residual solids from this treatment process contain such hazardous constituents as coolants and solvents used in machining operations, toxic metals, decontamination solutions, and dyes. Mixed LLW is treated or stored at the Area 514 Wastewater Treatment Tank Farm and Building 612 complexes located in the southeast corner of the Livermore Site. Mixed wastes generated by Site 300 are currently stored and will continue to be stored at the Livermore Site until DOE-approved disposal options are available. These options are outlined in the LLNL Site Treatment Plan. In 1994, Site 300 generated approximately 8 m^3 (2,100 gal) of liquid and 0.37 m^3 (0.48 yd^3) of solid mixed LLW.

Hazardous Waste. The Livermore Site and Site 300 presently operate five hazardous waste management facilities: Area 514, Area 612, Building 693, and Building 233 container storage unit are at the Livermore Site. Building 883 is at Site 300. The Area 514 and Area 612 facilities contain treatment and storage units for hazardous and mixed wastes. The Building 693 facility is currently a container storage unit for hazardous waste and limited flammable mixed waste, pending analysis. The Building 233 container storage unit is currently used to store mixed, low-level, and TRU waste. Building 883 is used for hazardous wastes only.

In 1994, approximately 342 m^3 (90,350 gallons) of liquid and 237 m^3 (310 yd^3) of solid hazardous wastes were generated at the Livermore Site (LLNL 1995i:1). Waste Management Facility operations at the Livermore Site are subject to Federal, state, regional, and local environmental requirements. Hazardous waste operations at the Livermore Site include the safe and proper handling, treatment, packaging, storage, and shipment of all hazardous waste generated by the site. The Livermore Site hazardous waste management units operate under RCRA interim status with an approved Part A Permit that was submitted December 16, 1991. A revised Part A Permit has been submitted to the state, while the Part B application submitted on January 17, 1992, undergoes processing by the State of California. Hazardous wastes are generated by the numerous R&D activities conducted throughout the facilities. Storage areas for nonradioactive and radioactive (or mixed) wastes are located at the Area 612 Facility yard. Wastes that contain PCBs and other wastes regulated by the TSCA are stored in Building 625. The nonradiological hazardous waste consists of ignitable, reactive, corrosive, toxic, and biohazardous waste (such as very dilute carcinogens and small animal carcasses) generated in biomedical and environmental research. Liquid hazardous waste contained in carboys may be pumped into drums that are stored, pending offsite transportation. The solid chemical wastes are packaged in drums and temporarily stored. The waste is then packaged according to DOT regulations. A commercial waste handler transports the liquid and solid hazardous waste drums to RCRA-permitted treatment, storage, and disposal facilities.

Building 693 was constructed in 1987. The California Department of Toxic Substances Control approved operation of this chemical waste storage facility in early 1991 under interim status standards. Building 693 began operation in 1992 and is used to store containerized RCRA-, TSCA-, and California-only regulated waste and limited flammable mixed waste, pending safety analysis.

Liquid waste and wastewaters are accumulated in retention tanks, carboys, or drums at the respective source locations throughout the Livermore Site. There, the materials are sampled and analyzed, and the determined waste contaminant levels are compared to the Livermore Site and city of Livermore discharge limits. If the levels of contaminants are below the regulatory limits, the material is released to the sanitary sewer. Industrial wastewater that contains constituents at concentrations greater than allowed by the city of Livermore discharge limits is managed as hazardous waste.

In 1994, Site 300 generated 111 m^3 (29,320 gal) of liquid and 46 m^3 (60 yd^3) of solid hazardous wastes (LLNL 1995i:1). Hazardous waste generated at Site 300 can be broken down into three general categories: explosives, analytical chemicals, and industrial wastes. The generation of solid and liquid hazardous waste varies with the number and type of experiments being conducted at any given time at Site 300. HE wastes are treated at the Building 829 complex, an open burn facility used for thermal treatment of these wastes. This facility will be operated until a new explosives waste treatment facility is permitted and operational as stated in a 1993 compliance order between LLNL, DOE, and the State of California. Site 300 hazardous wastes are stored in Building 883, a RCRA-permitted storage facility, before transfer to the Livermore Site waste management facilities. Generally, wastes are stored up to 1 year before shipment to the Livermore Site. Hazardous wastes are shipped through licensed commercial transporters to various offsite commercial RCRA-permitted treatment, storage, and disposal facilities.

The newly redesigned Decontamination and Waste Treatment Facility will replace and upgrade current waste management facilities presently used to process, treat, and store hazardous, radioactive, and mixed wastes. The Decontamination and Waste Treatment Facility would receive Livermore Site-generated medical, hazardous, LLW, and mixed LLW for consolidation, processing, treatment, and packaging before shipment and disposal offsite at commercial RCRA-permitted facilities.

The explosives waste storage facility project will convert five existing explosives storage magazines for the storage of explosives wastes. A new prefabricated metal building, to be located in a previously paved area, will be used for storing explosives-contaminated solid wastes (including packing material, discarded paper, and plastic labware) and ash from thermal treatment processes. Each of the five earth-covered magazines will be capable of storing specified weight limits of explosives, depending on the explosives waste types present.

Nonhazardous Waste. In 1994, the Livermore Site generated approximately 6,425 t (7,082 tons) of solid nonhazardous wastes (LLNL 1995i:1). Solid, nonhazardous wastes generated consisted of paper, plastics, glass, organic, and other wastes. The Livermore Site does not have onsite solid waste disposal facilities. Solid wastes are collected in dumpsters and other similar containers in such a manner as to assure that they do not contain hazardous or radioactive wastes and are transported to the Vasco Road Landfill for disposal.

In 1994, Site 300 generated approximately 315 m^3 (412 yd^3) of solid nonhazardous wastes (LLNL 1995i:1). The sources of solid, nonhazardous waste on Site 300 include office and laboratory refuse, construction debris, and landscape clippings. Solid, nonhazardous waste generated at Site 300 is transported to the Corral Hollow Sanitary Landfill, approximately 4 km (2.49 mi) east of Site 300 on Corral Hollow Road.

Medical wastes generated at the Livermore Site consist of biohazardous waste and sharps wastes. In 1994, approximately 2 m^3 (3 yd^3) of solid medical wastes were generated. Infectious wastes from the Biomedical Sciences Division are autoclaved in Building 365 to sterilize prior to disposal as sanitary waste, while sharps (e.g., needles, blades, and glass slides) waste is sent to an offsite commercial RCRA-permitted incinerator following sterilization.

Medical wastes at Site 300 are generated at the Medical Facility, Building 877. In 1994, approximately 2 m^3 (528 gal) of liquid and 2 m^3 (3 yd^3) of solid medical wastes were generated (LLNL 1995i:1). These wastes are managed in accordance with established LLNL procedures for handling medical wastes and are transported to the Livermore Site, where they are autoclaved at Building 365. The sterilized materials are then disposed of as sanitary waste.

For 1994, the Livermore Site generated approximately 456,000 m^3 (120,460,000 gal) of sanitary wastewater (LLNL 1995i:2). If sanitary wastewater generated by operations exceed permissible discharge limits and is treatable using permitted Livermore Site waste treatment units, the water is processed to meet the release criteria and then monitored as it is discharged to ensure that permissible discharge limits are not exceeded. These wastes enter the city of Livermore's sewer system and are then processed at the city of Livermore Water Reclamation Plant. The treated sanitary wastewater is piped to San Francisco Bay for discharge, except for a small volume that is used for summer irrigation of the municipal golf course adjacent to the Livermore Water Reclamation Plant. Sludge from the treatment plant is disposed of in offsite landfills.

When wastewater is discharged to the sewer system, it combines with sewage from SNL, Livermore. To protect the Livermore Water Reclamation Plant and to minimize any cleanup that might become necessary, the Livermore Site has an onsite sewage diversion and retention system that is capable of containing approximately 775,000 L (200,000 gal) of potentially contaminated sewage until it can be analyzed and appropriate handling methods implemented. If the liquids cannot be processed for discharge, they are packaged for treatment or disposal at an offsite facility. Treatment residues, or solids generated from the treatment process, are also packaged for treatment or disposal at an offsite facility.

In 1994, Site 300 generated approximately 4,420 m^3 (1,167,600 gal) of sanitary wastewater (LLNL 1995i:2). Sanitary wastewater generated within the General Services Area at Site 300 is discharged to an onsite sewer lagoon. Other more remotely located buildings on Site 300 are serviced by septic systems and leach fields. Industrial wastewaters are contained in retention tanks and analyzed, and their proper disposition determined. These wastewaters may be shipped to the Livermore Site for treatment, then discharged to the sanitary sewer system or shipped directly to an offsite treatment and disposal facility. The nonhazardous rinsewater from the HE machining, pressing, and formulation processes are disposed of by surface evaporation from two ponds.

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[1] Federal standard.

[2] State standard.

[3] No monitoring data available, baseline concentration assumed to be less than applicable standard/ threshold value.

[4] San Francisco Bay Area Air Quality Management District ambient concentration guide.

[5] No standard. Source: 40 CFR 50; CA EPA 1993a; LLNL 1995i:1.

[6] For comparison only.

[7] Storm effluent sampling location (SW corner of the site).

[8] Storm effluent sampling location (NW corner of the site).

[9] Primary Drinking Water Regulations (40 CFR 141).

[10] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[11] DOE's Derived Concentration Guides for water (DOE Order 5400.5). Values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is absed on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guides.

[12] National Secondary Drinking Water Regulations (40 CFR 143).

[13] No range could be provided; based on one sampling event. NA - not applicable. Source: LLNL 1994a.

[14] For comparison only.

[15] Stormwater runoff sampling location along the Arroyo Seco.

[16] National Primary Drinking Water Regulations (40 CFR 141).

[17] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[18] National Secondary Drinking Water Regulations (40 CFR 143). NA - not applicable.b Source: LLNL 1994a.

[19] For comparison only.

[20] Onsite monitoring well near Pit 1.

[21] Onsite monitoring well near Pit 7.

[22] Onsite monitoring well near HE Processing Area.

[23] National Primary Drinking Water Regulations (40 CFR 141), maximum contaminant level.

[24] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[25] DOE Derived Concentration Guide for drinking water (DOE Order 5400.5). Values are based on a committed effective dose of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guide. NA - not applicable; mg/L - milligrams per liter; pCi/L - picocuries per liter. Well locations are shown in figure 4.7.2.4-1. Source: LLNL 1994a.

[26] Source: LLNL 1994a. Value for radon is an average for the United States.

[27] NCRP 1987a.

[28] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268).

[29] In 1994, this population was approximately 6 million.

[30] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site. Source: LLNL 1994a.

[31] 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[32] Source: LLNL 1994a. The number of badged workers in 1994 was approximately 8,700.

4.8.3 Environmental Impacts

4.8.3.1 Land Resources

No Action. Under No Action, DOE would continue current and planned activities at SNL as described in section 3.2.8. No additional land-use impacts are anticipated at SNL beyond the effects of existing and future activities which are independent of the proposed action.

Management Alternatives

Nonnuclear Fabrication. The Nonnuclear Fabrication Facility at SNL would require no additional land acquisition. Modification of existing facilities and new construction at Technical Area I would be required to accommodate the new proposed activities. The new facilities at SNL would provide approximately 58,060 m^2 (625,000 ft^2) of work space and would be located within an undeveloped 9-ha (22-acre) area. The land to be developed represents approximately 6 percent of the land currently identified as available for development at SNL, but it is only a small portion of the land available for future development within SNL. An additional 5,110 m^2 $^{(55,000\ ft2)}$ of support facility space would be located in existing buildings. The proposed nonnuclear fabrication activities would be compatible and consistent with current operations in the area and SNL land-use plans and policies. Impacts to land use or land use plans are not expected.

Sensitivity Analysis. SNL would be able to accommodate all operations and support functions for nonnuclear fabrication with modification of existing facilities. Modification of existing facilities to support base case production would be sufficient to maintain capacity for both the high and low production cases.

Stewardship Alternatives

Proposed National Ignition Facility. Impacts to land use at and around SNL from the proposed NIF project would be limited to the clearing of land, minor and temporary disruptions to contiguous land parcels south of the proposed site from construction activities, and a slight increase in vehicular traffic. The proposed site for NIF would occupy a large parcel of flat, vacant land on the southern end of Technical Area II between East Ordinance Road and "R" Boulevard, and a small plot of land for temporary construction staging on the northern edge of Technical Area IV just south of "R" Boulevard. The proposed NIF project would require the clearing of an estimated 11 ha (28 acres) of land for buildings, walkways, building access and buffer space. Such acreage would account for approximately 7 percent of the land currently identified as available for development at SNL, but it represents only a small portion of the land available for future development within SNL. The project would be located in an area dedicated to similar land uses. No impacts to land use or land-use plans and policies at SNL, in Bernalillo County, the city of Albuquerque, or nearby communities would be expected.

Potential Mitigation Measures. No mitigation measures are anticipated.

4.8.3.2 Site Infrastructure

The SNL site infrastructure resources are capable of accommodating any of the alternatives for which it is a candidate with only moderate changes in the existing electrical and fuel resources. Table 4.8.3.2-1 presents a comparison of the annual operating infrastructure resource requirements for the alternatives of No Action, nonnuclear fabrication, and the proposed NIF. The No Action alternative would continue SNL's current mission objectives in the existing facilities without modification as described in section 3.2.8. Under the No Action alternative, the required site infrastructure resources would be unchanged relative to current resource consumption.

Table 4.8.3.2-1.-- Site Infrastructure Requirements and Changes for Stockpile Stewardship and Management Alternatives at Sandia National Laboratories

Alternative	**Electrical**		**Fuel**		
Energy (MWh/yr)	**Peak Load (MWe)**	**Liquid (L/yr)**	**Natural Gas (m3/yr)**	**Coal (t/ yr)**	
Current Resources (1994)	186,944	32	1,301,598	15773,761	NA
No Action (2005)					
Total site requirements	186,944	32	1,301,598	15,773,761	NA
Change from current resources	0	0	0	0	NA
Nonnuclear Fabrication					
Total site requirement	226,644	38.2	1,301,598	19,043,761	NA
Change from No Action	39,700	6.2	0	3,270,000	NA
National Ignition Facility					
Total site requirement	228,944	42	1,304,398	16,583,761	NA
Change from No Action	42,000	20	2,800	810,000	NA
Combined Program Impacts					
Total site requirement	268,644	58.2	1,304,398	19,853,761	NA
Change from No Action	81,700	26.2	2,800	4,080,000	NA

NA - not applicable. SNL 1995b:1; SNL 1995b:4; SNL 1995b:5; SNL 1995e ; appendix I.

Management Alternatives

Nonnuclear Fabrication. SNL is being considered for the alternative of nonnuclear fabrication. Under this alternative, the majority of the ongoing nonnuclear production activities at KCP would be reconfigured and transferred to SNL, with a small portion going to LANL and possibly LLNL.

The nonnuclear fabrication alternative at SNL would result in a new stand-alone production site with four new production facilities, an office structure, and a central utilities building surrounded by a security fence. In addition, some existing buildings would require minor modifications to accept some functions associated with this action. The nonnuclear fabrication mission at SNL would increase electrical energy usage and fuel (natural gas) consumption by approximately 20 percent relative to the No Action alternative.

SNL's electrical power distribution is by underground 15 kV (nominal) feeder loops. Dual feeders, each capable of carrying the entire load, would be run in new ductbanks and manholes to new double-ended unit substations in a new central plant on the site. The required power for the nonnuclear mission is greater than is usually available from the existing site loops and would most likely require a separate, dedicated, feeder loop from the utility substation. Natural gas is supplied by Kirtland Air Force Base and would be distributed, as required, to the nonnuclear fabrication facilities from the existing underground gas main.

The effect of not including reservoirs in the nonnuclear fabrication mission would not result in any significant reduction in the site infrastructure-related impacts at SNL since this activity only involves final reservoir assembly; primarily welding, along with final inspection, testing, packaging, and shipping. The only machining to be performed would be post-weld dressing. Final certification would include volume measurement and proof testing.

Sensitivity Analysis. The site infrastructure requirements given in table 4.8.3.2-1 reflect facility operating conditions for the production of a base case, multiple-shift, stockpile size. For the reduced stockpile size associated with the low case scenario, there would be a small (10-percent) reduction in the required floorspace and operating personnel. Transition to a high case stockpile size would result in about a 30- to 50-percent increase in these requirements. These deviations in the stockpile size would result in comparable changes in site infrastructure resource requirements.

Stewardship Alternatives

Proposed National Ignition Facility. The proposed NIF alternative at SNL would result in the construction of six new buildings and ancillary facilities (i.e., access roads, parking facilities, and utility extensions). Infrastructure requirements would not exceed any utility resources available at SNL. The NIF mission would increase SNL's electrical energy consumption by approximately 22 percent, whereas the increase in fuel usage would be less than 1 percent relative to the No Action alternative.

Potential Mitigation Measures. No mitigation measures are anticipated.

4.8.3.3 Air Quality

No Action. No Action air quality utilizes estimated air emissions data from operations at SNL in 2005 assuming continuation of current site missions to calculate pollutant concentrations at or beyond the SNL site boundary. The emission rates for criteria and toxic/hazardous pollutants for No Action are presented in table B.3.8-1. Table 4.8.3.3-1 presents the No Action pollutant concentrations calculated from the 2005 emission rates. In this table, pollutant concentrations are compared with applicable Federal and state regulations and guidelines. Concentrations are expected to remain within these standards.

Management Alternatives

Nonnuclear Fabrication. No new air pollutant waste streams will be generated by the nonnuclear fabrication mission at SNL. Emissions from the additional nonnuclear fabrication missions at SNL will include exhausts from vehicles and small quantities of aromatic hydrocarbon solvents, alcohols, and related chemistry. Process gases will be vented, but these consist only of naturally occurring atmospheric gases and vapors (i.e., nitrogen, argon, carbon dioxide, helium, hydrogen, and water) and are not considered to be pollutants. Table 4.8.3.3-1 presents the concentrations of criteria and toxic/hazardous pollutants resulting from No Action and nonnuclear fabrication. Concentrations of pollutants resulting from operation of nonnuclear fabrication added to No Action concentrations are expected to be within Federal and state regulations.

Table 4.8.3.3-1.-- Estimated Concentrations of Pollutants from No Action and Stockpile Stewardship and Management Alternatives at Sandia National Laboratories

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines (g/m^3)	2005 No Action (g/m^3)	Nonnuclear Fabrication (g/m^3)	National Ignition Facility (g/m^3)
Criteria Pollutant					
Carbon monoxide	Annual	4,600[1]	1,603	1,603	1,603
	8-hour	10,000[2]	4,924	4,924	4,925
	1-hour	15,000[1]	10,307	10,307	10,311
Lead	Calendar quarter	1.5[2]	0.0667	0.0667	0.0667
	30-day	3[1]	[3]	[3]	[3]
Nitrogen dioxide	Annual	94[4]	30	30	30.12
	24-hour	117[1]	77	77	78.29
Ozone	1-hour	235[2]	188	188	188
Particulate matter	Annual	50[2]	15.92	15.92	15.93

	24-hour	150[2]	66	66	66.12
Sulfur dioxide	Annual	11[1]	0.8	0.8	0.8
	24-hour	92[1]	5.2	5.2	5.22
	3-hour	1300[2]	21.7	21.7	21.79
Mandated by New Mexico and Albuquerque-Bernalillo County					
Arsenic, copper, and zinc	30-day	10[1]	0.067	0.067	0.067
Hydrocarbons (nonmethane)	3-hour	100[1]	[3]	[3]	[3]
Hydrogen sulfide	1-hour	4[1]	[3]	[3]	[3]
Photochemical oxidants	1-hour	20[1]	[3]	[3]	[3]
Total reduced sulfur	1-hour	4[1]	[3]	[3]	[3]
Total suspended particulates	Annual	60[4]	15.92	15.92	15.92
	30-day	90[4]	<66	<66	<66
	7-day	110	<66	<66	<66
	24-hour	150[4]	66	66	66
Hazardous and Other Toxic Compounds					
Acetone	8-hour	[5]	0.25	0.25	0.25
Benzene	8-hour	[5]	<0.01	<0.01	<0.01
Carbon tetrachloride	8-hour	300[4]	<0.01	<0.01	<0.01
Hydrogen chloride	8-hour	[5]	3.27	3.27	3.27
Isopropyl alcohol	8-hour	9,800[4]	0.11	0.11	0.11
Methanol	8-hour	[5]	0.11	0.11	0.11
Methyl chloroform	8-hour	[5]	0.71	0.71	0.71
Methylene chloride	8-hour	[5]	0.04	0.04	0.04
Toluene	8-hour	[5]	0.55	0.55	0.55
Trichloroethylene	8-hour	[5]	0.10	0.10	0.10
Trichlorotrifluoroethane	8-hour	[5]	0.15	0.15	0.15
Xylene	8-hour	[5]	0.59	0.59	0.59

Sensitivity Analysis. Impacts to air quality from either the low or high case scenario of the nonnuclear fabrication alternative would result in the same concentrations of criteria and toxic/hazardous pollutants for the high and low case. The concentrations of pollutants for both cases are expected to be within applicable Federal and state regulations and guidelines.

Stewardship Alternatives

Proposed National Ignition Facility. Operation of the proposed NIF would generate criteria and toxic/ hazardous pollutants resulting from the combustion of boiler fuel for heating, operation of diesel generators, and solvent cleaning processes. The emissions consist of PM10, carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, and VOCs. Boiler fuel is assumed to be natural gas. Emission rates of criteria and toxic/hazardous pollutants for annual operation of the proposed NIF are presented in table B.3.8-1. Table 4.8.3.3-1 presents the concentrations of criteria and toxic/hazardous pollutants resulting from No Action and those generated from operation of the proposed NIF. Concentrations of pollutants resulting from operation of the proposed NIF added to No Action concentrations are expected to be within Federal and state regulations.

Potential Mitigation Measures. No mitigation measures are anticipated for the nonnuclear fabrication and the proposed NIF at SNL.

4.8.3.4 Water Resources

Environmental impacts associated with the construction and operation of the potential stockpile stewardship and management facilities at SNL could affect surface and groundwater resources. All water required for construction or operation would be supplied from local groundwater resources at Kirtland Air Force Base. The proposed sites for the facilities would be outside the 100- and 500-year floodplains. A description of the proposed functions to be transferred to SNL is presented in sections 3.3 and 3.4. Table 4.8.3.4-1 presents existing surface and groundwater resources and the potential changes to water resources at SNL resulting from the proposed alternatives. The total site water resource requirement for each alternative including No Action are displayed in this table.

Surface Water

No Action. Under No Action, no impacts to surface water resources are anticipated because there are no surface water withdrawals or demands. No construction would occur under No Action; therefore, no additional construction water would be used or discharged. Current operation wastewater discharges of 757 MLY (200 MGY) are expected to remain the same in 2005. Treated wastewater effluent would be monitored to comply with the city of Albuquerque's Sewer Use and Wastewater Control Ordinance. No impacts to surface or surface water quality are expected.

Management Alternatives

Nonnuclear Fabrication. No surface water would be used for construction and modification activities or operation. An additional 6.5 MLY (1.7 MGY) of wastewater would be generated by the construction and modification activities of the nonnuclear fabrication facilities. This wastewater increase represents less than 1 percent over the projected sanitary wastewater generation rate. During operation an additional 291 MLY (76.9 MGY) of wastewater would be generated. This wastewater discharge represents a 38.5-percent increase over projected sanitary wastewater generation. A stormwater pollution prevention plan would be prepared and implemented to minimize soil erosion, sedimentation, and contamination of stormwater. During construction and operation, all wastewater would be collected, treated, and discharged to the city of Albuquerque sewer systems. Treated wastewater would be monitored to meet or exceed standards of the city of Albuquerque's Sewer Use and Wastewater Control Ordinance. There would be no new wastewater streams added or special waste handling capability required. There would be no impacts to surface water quality because all wastewater would be discharged to the city of Albuquerque's sewer systems. There would be no change in stormwater runoff due to this alternative. Adverse impacts to surface water are not expected. Nonnuclear fabrication facilities would be located in portions of Technical Areas I and II that are determined to be above the 500-year floodplain.

Stewardship Alternatives

Proposed National Ignition Facility. Construction of the proposed NIF would be expected to have minor to negligible effects on water quality. A stormwater pollution prevention plan would be prepared and implemented to minimize soil erosion, sedimentation, and contamination of stormwater. During operation of NIF, wastewater discharge would be expected to increase by about 18 MLY (4.8 MGY). Wastewater discharges would have to meet all Kirtland Air Force Base and the city of Albuquerque discharge requirements. Appropriate measures would be taken to comply with stormwater discharge regulations associated with construction activities under the CWA.

Table 4.8.3.4-1.--Potential Changes to Water Resources from Stockpile Stewardship and Management Alternatives at Sandia National Laboratories

Affected Resource Indicator	No Action Single-Shift Operation 2005	Nonnuclear Fabrication Three-Shift Operation	National Ignition Facility
Construction			
Water Availability and Use			
Water source	Ground	Ground	Ground
Total site water operation requirement[6] (MLY)	0[7]	1,391	1,392.9
Percent change from No Action water use (1,390 MLY)	NA	0.05	0.2
Water Quality			
Wastewater discharge to the city of Albuquerque[8] (MLY)	0[7]	763.2	757.4

Percent change from No Action wastewater discharges to the city of Albuquerque p(757 MLY)	NA	0.86	0.05
Operation			
Water Availability and Use			
Water source	Ground	Ground	Ground
Total site operations water requirement (MLY)	1,390	2,283	1,542
Percent change from No Action water use (1390 MLY)	NA	64	11
Percent change from current use (970 MLY)	43	135	59
Water Quality			
Wastewater discharge to the city of Albuquerque (MLY)	757	1,048	775
Percent change from No Action wastewater discharge to the city of Albuquerque (757 MLY)	0	38.5	2
Percent change from current wastewater discharge (757 MLY)	0	38.5	2
Floodplain			
Actions in 100-year floodplain	NA	None	None
Actions in 500-year floodplain	NA	None	None

Groundwater

No Action. Under No Action, baseline conditions and operations, described in section 4.8.2.4, would continue at SNL, and the current groundwater amount of *970* MLY (256 MGY) would increase to *1,390* MLY (367 MGY) by 2005. Groundwater would continue to be withdrawn from local groundwater sources, but no additional impacts to groundwater quality are anticipated because there are no direct discharges to groundwater.

Management Alternatives

Nonnuclear Fabrication. Water requirements for the modification, construction, and operation of the nonnuclear fabrication facilities would be supplied from local groundwater sources at Kirtland Air Force Base. During the modification and construction phase, approximately *0.7* MLY (0.18 MGY) of groundwater would be required. This amount is less than *0.1* percent of the projected SNL groundwater withdrawal of *1,390* MLY (367 MGY) from the Kirtland Air Force Base wells. It is anticipated that an additional *893* MLY (236 MGY) of water would be required to operate the facilities. This amount is an increase of approximately 64-percent over No Action water requirements, but only comprises 29 percent of the Kirtland Air Force Base groundwater rights of 7,900 MLY (2,090 MGY). Adverse impacts to groundwater are not expected.

Groundwater Quality. No process wastes would be discharged directly to the groundwater and all wastewater discharges would be monitored to comply with NPDES permit and other applicable discharge requirements. Given normal safeguards and precautions, no adverse impacts to groundwater quality are expected.

Sensitivity Analysis. All effluent is discharged to the city of Albuquerque; therefore, both the high and low case production scenario for nonnuclear fabrication would have no impacts to surface water quality. Groundwater or groundwater quality would not be affected by the high or low case stockpile requirement for nonnuclear fabrication at SNL.

Stewardship Alternatives

Proposed National Ignition Facility. During construction of the proposed NIF, approximately 3 MLY (0.8 MGY) of additional groundwater would be required. Approximately 152 MLY (40.2 MGY) of additional groundwater would be required during operation of NIF, increasing the water use at SNL by 11 percent over No Action.

Groundwater Quality. No process wastes would be discharged directly to the groundwater, and all wastewater discharges would be monitored to comply with NPDES permit and other applicable discharge requirements. Given normal safeguards and precautions, no adverse impacts to groundwater quality are expected.

Potential Mitigation Measures. No mitigation measures for the stockpile stewardship and management alternatives at SNL are anticipated.

4.8.3.5 Geology and Soils

The proposed alternatives for SNL would have no adverse impact on geological resources described in section 4.8.2.5. Although a moderate seismic risk exists for new facilities, this would be considered in the design of the structures. The existing seismic risk does not preclude safe construction and operation of the proposed project facilities. Control measures would be used to minimize any soil erosion. Impacts would depend on the extent of land disturbing activities and the amount of soil disturbed. Potential changes to geology and soils associated with the proposed alternatives at SNL are discussed below.

No Action. Under No Action, DOE would continue current and planned activities at SNL. Any impacts to geology and soils would be independent of and unaffected by the proposed action.

Management Alternatives

Nonnuclear Fabrication. Construction activities would not affect geologic conditions. Designs of the new 58,060 m2 (625,000 ft2) facility would ensure that it would not be adversely affected by geologic conditions. The properties and conditions of the soils in the proposed project area place no limitations on the construction or safe operation of project facilities.

The area of land disturbance for nonnuclear fabrication at SNL is approximately 9 ha (22 acres). Part of the construction required for the new Nonnuclear Fabrication Facility includes parking spaces in the form of ground-level, uncovered, paved lots. SNL's practice is to use parking lots as construction staging areas for both material and office trailers and to pave the lots as one of the last construction activities. Further, the new buildings are proposed to be slab-on-grade for the first level, and the proposed construction site is relatively flat and unobstructed, which would minimize the amount of land required for cut-and-fill operations during construction. For modification and renovation of existing buildings, staging activities would use the same operations and staging areas that were used during previous renovations.

Disturbance could occur at building, parking, and construction laydown areas, leading to a possible temporary increase in erosion as a result of stormwater runoff and wind action. Soil losses would depend on frequency of storms; wind velocities; size and location of the facilities with respect to drainage and wind patterns; slopes, shape, and area of the tracts of ground disturbed; and whether the soil is bare, particularly during the construction period. Appropriate erosion and sediment control measures would be used to minimize any soil loss.

Net soil disturbance during operations would be less than for construction, because areas temporarily used for laydown would be paved. Although erosion from stormwater runoff and wind action could occur occasionally during operation, it is anticipated to be minimal.

There are no known active faults that cross the area of the proposed facilities. The Tijeras and Sandia faults, located in the eastern portion of SNL, are regarded as the most probable sources for seismic activity in the vicinity of the proposed facilities. The location of active faults and the associated potential ground rupture would be considered in the design of facilities. All facilities would be designed for earthquake-generated ground acceleration in accordance with DOE O 420.1, and accompanying safety guides. Major seismic activity and associated mass movement and subsidence are unlikely to occur during the construction or operational phases, because seismic activity in the region is generally of low intensity and magnitude (see section 4.8.2.5). Hazards resulting from the return of volcanism are unlikely (see section 4.8.2.5). Potential health impacts from accidents associated with geological hazards are discussed in section 4.8.3.9.

Sensitivity Analysis. The high or low case operation scenario would not affect geology and soils.

Stewardship Alternatives

Proposed National Ignition Facility. The construction and operation of the proposed NIF at SNL would not adversely affect geological resources. NIF would require the clearing of an estimated 11 ha (28 acres) of land for buildings, walkways, building access, and buffer space (see appendix I). Soil impacts during construction would be short term and minor with appropriate standard construction erosion and sediment control measures. Net soil disturbance during operation would be less than for construction because areas temporarily used for laydown would be restored. Seismic risks would be taken into account during construction and operation of NIF.

Potential Mitigation Measures. No mitigation measures for the stockpile stewardship and management alternatives at SNL are anticipated.

4.8.3.6 Biotic Resources

The following section addresses impacts to terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Construction and operation of nonnuclear fabrication mission facilities and the proposed NIF would result in a loss of terrestrial habitat. Nonnuclear fabrication mission facilities may also impact special status species.

No Action. Under No Action, the selected nonnuclear fabrication and stewardship R&D missions described in section 3.2.8 would continue at SNL. This would result in no changes to current biotic resource conditions at the site as described in section 4.8.2.6.

Management Alternatives

Nonnuclear Fabrication

Terrestrial Resources. While the nonnuclear fabrication mission at SNL would use some space in existing buildings, approximately 9 ha (22 acres) would be required for construction of new facilities. The area to be developed is located just east of Technical Area I and is characterized as grassland. Grassland is a common plant community type in the area. Animal species within the disturbed area would be either destroyed or displaced depending upon whether they were able to move from the area. For example, many reptiles and small mammals, as well as nests and young birds, would likely be destroyed, while larger mammals and birds would be able to leave the area. Wildlife may also be disturbed by the increased level of human activity associated with the project.

Wetlands. There are no wetlands on or near the proposed site for the location of the nonnuclear fabrication mission at SNL. Wetlands would not be affected by construction or operation of new nonnuclear fabrication facilities.

Aquatic Resources. There is no natural aquatic habitat on or near the proposed site for the location of the nonnuclear fabrication mission at SNL. Aquatic resources would not be affected by construction or operation of new nonnuclear fabrication facilities.

Threatened and Endangered Species. There would be no Federal-listed threatened or endangered species affected by construction and operation of new nonnuclear fabrication facilities at SNL. Considering that grassland habitat is the prevalent plant community type in the site area, the Federal-candidate mountain plover (Charadrius montanus) could potentially exist onsite. This bird species could lose possible nesting and foraging habitat as a result of site development. Preactivity surveys would need to be conducted prior to construction in order to determine if any special status species are present on or near the site.

Sensitivity Analysis. While implementation of a low case workload would not alter impacts to biological resources, the high case workload would result in a slight increase in the disturbed grassland area.

Stewardship Alternatives

Proposed National Ignition Facility

Terrestrial Resources. The proposed NIF would be located within a disturbed grassland area of Technical Area II. Construction of new facilities would require 11 ha (28 acres). Proper erosion and sediment control measures would reduce the potential for disturbance of habitat adjacent to the construction area. Animal species within the disturbed area would be either destroyed or displaced, depending upon whether they were able to move from the area. For example, many reptiles and small mammals, as well as nests and young birds, would likely be destroyed, while larger mammals and birds would be able to leave the area. Wildlife may also be disturbed by the increased level of human activity associated with the project.

Wetlands. The proposed NIF site does not contain, nor is it located near, wetlands. The construction and operation of the proposed NIF is not expected to adversely impact this resource.

Aquatic Resources. The proposed NIF site does not contain, nor is it located near, aquatic resources. The construction and operation of the proposed NIF is not expected to adversely impact this resource.

Threatened and Endangered Species. Adverse impacts to special status species are not expected from the construction or operation of the proposed NIF at SNL due to the lack of suitable habitat and the disturbed nature of the proposed site. A site survey may be required to determine the presence of any special status species.

Potential Mitigation Measures. Minimization of the area to be disturbed, revegetation with native species, and implementation of a soil erosion and sediment control plan would help to lessen short- and long-term impacts to terrestrial species and habitats. Disturbance to wildlife living in areas adjacent to management and stewardship facilities may be minimized by preventing workers from entering undisturbed areas. It may be necessary to survey the site for the nests of migratory birds prior to construction and to avoid clearing operations during the breeding season. If any threatened or endangered species occur on the site, specific mitigation measures would be developed in conjunction with the USFWS.

4.8.3.7 Cultural and Paleontological Resources

For the discussion of impacts, the term cultural resources includes prehistoric, historic, and Native American resources. Cultural and paleontological resources may be affected directly through ground disturbance, building modifications, visual intrusion of the project to the historic setting, or environmental context of historic sites, visual and noise intrusions to Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism. Some NRHP-eligible historic sites may be affected by the proposed action. All of the undisturbed DOE-owned properties at SNL were surveyed for cultural resources between 1989 and 1991. No significant resources were found. However, it is possible that buried archaeological remains are present and that some of the SNL facilities may be NRHP eligible based on their historical or architectural significance (SNL 1993c:1-6). The SNL Sitewide Hydrogeologic Characterization project reports that no important paleontological remains have been recovered from deposits on SNL (apendix I).

No Action. Under No Action, DOE would continue existing and planned missions at SNL as described in section 3.2.8. Any impacts to cultural or paleontological resources would be independent of and unaffected by the proposed action.

Management Alternatives

Nonnuclear Fabrication. This alternative would involve renovation and modification of existing facilities at SNL and the construction of a new stand alone production facility. New construction would be located on available undeveloped land directly east of Technical Area I. Although no NRHP-eligible resources were identified during a pedestrian survey of the proposed nonnuclear fabrication area, the potential for subsurface prehistoric and historic resources exists. In 1989, the Quivira Research Center identified two prehistoric lithic and ceramic scatters in a Kirtland Air Force Base management area adjacent to the proposed project area. Both of these sites are on the southern bank of the Tijeras Arroyo. It is also possible that some of the buildings involved may be NRHP eligible. NRHP-eligible resources would be identified during project-specific surveys and evaluations. Some important Native American and paleontological resources may be affected by the proposed alternative. Any project related effects would be addressed in tiered NEPA documentation.

Sensitivity Analysis. The high and low case scenarios have the same impacts to cultural and paleontological resources. The base case production facilities for the nonnuclear fabrication mission operation would accommodate the high and low case production scenarios.

Stewardship Alternatives

Proposed National Ignition Facility. If the proposed NIF were to be located at SNL, it would require the construction of six buildings on a currently undeveloped tract of 11 ha (28 acres) in Technical Area II. Pedestrian surveys indicate that no prehistoric or historic sites or standing structures exist within the proposed NIF location. The Isleta Pueblo has not identified any important Native American resources nor have important paleontological remains been recovered from deposits in the proposed NIF location. No impacts to cultural or paleontological resources are anticipated from construction and operation of the proposed NIF.

Potential Mitigation Measures. If project design or siting would result in adverse effects to NRHP-eligible sites, then a Memorandum of Agreement would need to be negotiated among DOE, the New Mexico SHPO, and the Advisory Council on Historic Preservation. The Memorandum of Agreement would formalize mitigation measures agreed to by these consulting parties. Mitigation measures could include describing and implementing intensive inventory and evaluation studies, data recovery plans, site treatments, and monitoring programs. The appropriate level of data recovery for mitigation would be determined through consultation with the New Mexico SHPO and the Advisory Council on Historic Preservation, in accordance with Section 106 of the National Historic Preservation Act. Mitigation measures for specific NRHP-eligible sites would be identified during tiered NEPA documentation.

If Native American resources cannot be avoided through project design or siting, then acceptable mitigation measures to reduce project effects on them would be determined in consultation with the affected Native American groups. In accordance with the Native American Graves Protection and Repatriation Act and the American Indian Religious Freedom Act, such mitigations may include, but would not be limited to, appropriately relocating human remains, planting vegetation screens to reduce visual or noise intrusion, increasing access to traditional use areas during operation, or transplanting or harvesting important Native American plant resources.

Because scientifically important buried paleontological materials could be affected, paleontological monitoring of construction activities and data recovery of fossil remains would be appropriate mitigation measures.

4.8.3.8 Socioeconomics

No Action. Under No Action, the existing missions at SNL, as described in section 3.2.8, would continue. No new employment or in-migration of workers would be required. Projections of regional economy and employment rates, population and housing statistics, and public finance characteristics are presented in appendix D.

Regional Economy and Employment. Total employment in the regional economic area is projected to increase by less than 2 percent annually between 1995 and 2000, reaching approximately 420,900 in the latter year. Long-range projections show employment growth averaging slightly above 1 percent annually between 2001 and 2020, and then slowing to less than 1 percent between 2021 and 2030 when total employment reaches 563,880. Site employment for SNL is expected to be 7,341 in 2005. The unemployment rate in the regional economic area was 5.7 percent in 1994 and is expected to remain at this level into the near future. Per capita income is projected to increase from approximately $17,676 in 1995 to $25,867 in 2030.

Population and Housing. Annual ROI county and city population and housing increases are projected to average about 2 percent between 1996 and 2005. Annual increases between 2006 and 2030 are expected to average approximately 1 percent. Population in the ROI is estimated to increase from 653,100 in 1995 to 955,600 in 2030. The total number of housing units in the ROI is projected to increase from 267,700 to 391,800 during the same period.

Public Finance. Between 2000 and 2005, all ROI county, city, and school district total revenues are projected to increase at an annual average of less than 1.6 percent. Total expenditures are projected to increase at an annual average of less than 1.5 percent during the same period. These rates of increase should continue until 2030.

Management Alternatives

Nonnuclear Fabrication

Regional Economy and Employment. Construction-related activities for the Nonnuclear Fabrication Facility would require 379 direct workers during the peak construction year, and would generate 421 indirect jobs in the regional economic area. As a result of the construction and modification activities, total employment in the SNL regional economic area would increase by less than 1 percent. Regional unemployment would fall from the No Action estimate of 5.7 percent to approximately 5.5 percent. Per capita income in the SNL regional economic area would increase very slightly over No Action projections as a result of constructing the facility.

Facility operation-related employment at SNL would begin phasing in as the construction phase neared completion. Operation of the facility in the base case surge mode would require 1,160 direct jobs, and would generate 1,350 additional indirect jobs in the regional economic area. As a result of the operation of the Nonnuclear Fabrication Facility, total employment in the SNL regional economic area would increase by less than 1 percent. Regional unemployment would fall from the 5.7 percent No Action estimate to approximately 5.2 percent. Per capita income for the SNL regional economic area would increase by less than 1 percent over No Action projections. Changes in employment and per capita income resulting from the operation of the Nonnuclear Fabrication Facility are shown in figure 4.8.3.8-1.

Population and Housing. Population in the SNL ROI during peak construction would not increase over No Action projections. Enough workers would be available in the regional economic area and ROI to fill all of the direct and indirect jobs generated by the construction of the facility.

There are not enough available workers to fill all of the direct operation jobs. Approximately 145 workers would in-migrate to fill new positions at the Nonnuclear Fabrication Facility. Changes in the ROI population over No Action during full operation at SNL are shown in figure 4.8.3.8-2. Vacant housing would be sufficient to house in-migrating workers and their families.

Public Finance. Construction of the Nonnuclear Fabrication Facility would not require in-migrating workers. Therefore, changes to local finances compared to No Action projections would be attributed to income increases and would be negligible.

Changes in revenues and expenditures compared to No Action projections due to operation of the Nonnuclear Fabrication Facility with reservoirs at SNL are shown in figure 4.8.3.8-3. In 2005, the percent increase in total ROI revenues and expenditures over No Action projections would be negligible (less than 0.1 percent).

Nonnuclear Fabrication Without Reservoirs

The option of terminating the reservoir production mission at SNL would result in 56 fewer direct operations jobs. There would be less in-migration than in the nonnuclear fabrication with reservoirs alternative. This would result in slightly smaller increases in regional economy, population and housing, and public finance than occurred in the nonnuclear fabrication with reservoirs base case surge alternative.

Sensitivity Analysis. There would be no change in the number of construction workers required to complete the Nonnuclear Fabrication Facility for either the high or low case. Operation of the facility at the high case level, would require the same number of workers and would have the same socioeconomic effects as the base case surge level. For the low case, worker requirements would decrease, causing slightly lower increases in regional economy, population and housing, and public finance than occurred in the base case surge level. These changes would be negligible.

Stewardship Alternatives

Proposed National Ignition Facility. The following is a summary of the socioeconomic effects of construction of the proposed NIF at SNL. See appendix I for a more detailed, project-specific discussion.

Regional Economy and Employment. Construction of the proposed NIF would require 280 construction workers during the peak year of construction, and would generate approximately 1,490 additional indirect jobs in the regional economic area. Employment for operation would begin phasing in as the construction phase neared completion. Operation of the facility would require 330 direct workers, and would generate 340 additional indirect jobs in the regional economic area. Construction and operation of NIF would have only minimal effects on the regional economy and employment.

Population and Housing. Both construction and operation of the facility would require workers and their families to in-migrate to the ROI. This in-migration would cause a slight increase in the population of the ROI. Vacant housing in the ROI is sufficient to handle these increases.

Public Finance. Both revenues and expenditures would increase as a result of the construction and operation of the proposed NIF. Increases due to construction would peak in 1998 and then decline as construction neared completion in 2002. Increases due to operation of the facility would peak in 2003 and continue through the duration of NIF operation.

Potential Mitigation Measures. No mitigation measures are anticipated.

4.8.3.9 Radiation and Hazardous Chemical Environment

This section describes the radiological and hazardous chemical releases and their associated impacts, which could result from No Action and the proposed alternatives at SNL. Within this section, impacts resulting from the base case scenario are quantitatively discussed, and a sensitivity analysis of the high and low case scenarios is qualitatively discussed.

Summaries of the prevailing radiological impacts at SNL to the public and to workers associated with normal operation are presented in tables 4.8.3.9-1 and 4.8.3.9-2, respectively. Accident impacts are given in table 4.8.3.9-3. The impact assessment methodology is described in section 4.1.9, and further supplementary methodological information is presented in appendixes E and F.

Normal Operation. There would be no radiological releases during the construction or modification of any facilities to support the Stockpile Stewardship and Management Program. However, limited hazardous chemical releases (e.g., small spills of diesel fuel from equipment refueling) may occur due to construction activities for the base case scenario and may increase slightly for the high case scenario. The concentration of these releases is expected to be well within the regulated exposure limits and would not result in any adverse health effects.

Water from processes containing hazardous chemicals is not discharged directly into surface water or groundwater that serves as potable water. Process water that may contain hazardous chemicals is treated before discharge to the city of Albuquerque sewer system. Furthermore, state-permitted discharges of stormwater to surface impoundment (lagoons) which can be attributed to the activities associated with normal operation and operation of the stockpile stewardship and management alternatives at SNL are expected to be below New Mexico Water Quality Control Commission Regulations limits. Water quality would not be adversely affected. Thus, the primary pathway considered for the public and the onsite worker is the air pathway.

For normal operation at SNL, all possible hazardous chemicals were examined for further analysis based on their toxicity, concentration, and frequency of use. The HI is a summation of the HQ for all chemicals. The HQ is the value used as an assessment of noncancer toxic effects of chemicals (e.g., kidney or liver dysfunction). It is independent of cancer risk, which is calculated only for those chemicals identified as carcinogens. The HI was calculated for the No Action chemicals and all alternative chemicals proposed to be added (the increment) at the site to yield cumulative levels for the site. An HI of 1.0 indicates that all noncancer exposure values meet OSHA standards; if the cancer risk is 1x10-*6* (the default value, not a regulatory standard), no further analysis is indicated. A cancer risk of 1x10-*6* is considered acceptable by EPA (40 CFR 300.430) because this incidence of cancers cannot be distinguished from the cancer risk for an individual member of the population. Information pertaining to OSHA-regulated exposure limits and toxicity profiles for all hazardous chemicals described in this PEIS may be found in the *Chemical Health Effects Technical Reference* (TTI 1996b).

No Action

Radiological Impacts. Radiological impacts to the public resulting from the No Action alternative are presented in table 4.8.3.9-1. These impacts are representative of the aggregated total which is estimated to exist from all future baseline operational contributions. Total impacts are provided to compare with applicable regulations governing total site operations. To place doses to the public from the No Action alternative into perspective, comparisons are made to natural background radiation. As shown in table

4.8.3.9-1, the total dose to the maximally exposed member of the public from annual total site operations is within radiological limits and would be 1.6x10-3 mrem for the No Action alternative. The annual population dose within 80 km (50 mi) in 2030 would be 0.027 person-rem.

Table 4.8.3.9-1.-- Potential Radiological Impacts to the Public Resulting from Normal Operation of Stockpile Stewardship Alternatives at Sandia National Laboratories

	No Action	**National Ignition Facility**
Affected Environment	**Total Site**	**Total Site**[9]
Maximally Exposed Individual (Public)		
Atmospheric Release		
Dose[10] (mrem/yr)	1.6×10^{-3}	5.6×10^{-3}
Percent of natural background[11]	4.8×10^{-4}	1.7×10^{-3}
25-year fatal cancer risk	2.0×10^{-8}	7.1×10^{-8}
Liquid Release		
Dose[10] (mrem/yr)	0	0
Percent of natural background[11]	0	0
25-year fatal cancer risk	0	0
Atmospheric and Liquid Releases		
Dose[10] (mrem/yr)	1.6×10^{-3}	5.6×10^{-3}
Percent of natural background[11]	4.8×10^{-4}	1.7×10^{-3}
25-year fatal cancer risk	2.0×10^{-8}	7.1×10^{-8}
Population Within 80 Kilometers		
Atmospheric and Liquid Releases in 2030		
Dose (person-rem)	0.027	0.23
Percent of natural background[11]	1.0×10^{-5}	8.9×10^{-5}
25-year fatal cancers	3.3×10^{-4}	2.8×10^{-3}

Total site doses to onsite workers from normal operation for the No Action alternative are presented in table 4.8.3.9-2. The estimated average annual dose to the entire facility workforce for this alternative would be 11 person-rem. The presented noninvolved worker values were not modeled due to the unavailability of certain site-specific information.

Based on the radiological impacts associated with normal operation under the No Action alternative, all resulting doses would be within radiological limits and are well below levels of natural background radiation. The associated risks of adverse health effects to the public and to workers would be small.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public and onsite workers resulting from normal operation under No Action at SNL are presented below. Analyses used to support the values presented in this section are provided in appendix table E.3.4-26. This PEIS does not purport to provide the level of detail needed to go beyond a conservative screening process for hazardous chemicals. As such, the analysis in this PEIS for the No Action alternative should not be relied upon as a basis for judging the sites as having a hazardous health concern. The model used to calculate HI and cancer risk in this PEIS only establishes a baseline for comparison of alternatives among sites. The baseline is then used to determine the extent to which each alternative adds or subtracts from the No Action HI and cancer risk to the public at each site.

The HI for the maximally exposed member of the public at SNL resulting from normal operation under the No Action alternative would be 2.31x10-*3* and the cancer risk would be zero. The HI for the onsite worker would be 1.04x10-*5* and the cancer risk would be zero.

The HIs for the public and for the onsite worker are within the acceptable health levels. The cancer risks to the public and the onsite worker are within the EPA default value of 1x10-*6* .

Management Alternatives

Nonnuclear Fabrication

Radiological Impacts. There are no radiological impacts associated with this alternative.

Hazardous Chemical Impacts. Hazardous chemical impacts for the public and for the onsite worker resulting from normal operation due to the nonnuclear fabrication mission at SNL are presented below. The HI and cancer risk would remain constant over 25 years of operation, provided exposures remain the same. Analyses to support the values presented in this section are provided in appendix table E.3.4-27.

The incremental HI for the maximally exposed member of the public would be 1.02x10-*4* and the incremental cancer risk would be 1.65x10-*7* as a result of the nonnuclear fabrication mission at SNL. The incremental HI for the onsite worker would be 1.60x10-*4* and the incremental cancer risk would be 1.10x10-*5* as a result of the nonnuclear fabrication alternative.

Table 4.8.3.9-2.--Potential Radiological Impacts to Workers Resulting from Normal Operation of Stockpile Stewardship Alternatives at Sandia National Laboratories

Affected Environment	No Action	National Ignition Facility
Involved Workforce[12]		
Average worker dose[13] (mrem/ yr)	NA	30
25-year fatal cancer risk	NA	3.0×10^{-4}
Total dose (person-rem/yr)	NA	8.0
Noninvolved Workforce [14]		
Average worker dose[12] (mrem/ yr)	3.2	3.2
25-year fatal cancer risk	3.2×10^{-5}	3.2×10^{-5}
Total dose (person-rem/yr)	11	11
Total Site Workforce[15]		
Dose (person-rem/yr)	11	19
25-year fatal cancers	0.11	0.19

Total site operations of the nonnuclear fabrication mission would result in HIs for the public (2.41x10-3) and the onsite worker (1.70x10-4) that are within acceptable health levels. The cancer risks for the public (1.65x10-7) are within the default value. The cancer risks to the onsite worker (1.10x10-5) somewhat exceed the default value of 1x10-6 due to emissions of trichloroethylene under the nonnuclear fabrication mission at SNL.

It is likely that emissions of hazardous chemicals would not increase, and may slightly decrease, as a result of implementing the option of not including reservoirs in the nonnuclear fabrication alternative at SNL. Therefore, no effects on the existing HI and cancer risk impacts for the public and onsite workers are expected.

Sensitivity Analysis. Operations under the low case scenario for nonnuclear fabrication are expected to reduce hazardous chemical emissions by up to 50 percent at SNL and, therefore, would likely reduce the HIs and cancer risks for the public and the onsite worker.

Operations under the high case scenario for nonnuclear fabrication may result in up to a 4-fold increase in the emissions of hazardous chemicals at SNL. The HI for the public and the onsite worker should remain within the cumulative HQ screening level of 1.0 (the HI). Cancer risks for the public are well within the default value of 1x10-6 and would not exceed this level under the high case scenario. Since cancer risk impacts for the onsite workers already exceed the EPA default value, operations under the high case scenario would further contribute to the adverse cancer risk impacts.

Stewardship Alternatives

Proposed National Ignition Facility

Radiological Impacts. Radiological impacts to the public resulting from normal operation of the proposed NIF for the enhanced option scenario are presented in table 4.8.3.9-1. These impacts are representative of the aggregate total which is estimated to exist from all future baseline operational SNL contributions and from enhanced option operations of the proposed NIF at the site. Total impacts are provided to compare with applicable regulations governing total site operations. To place doses to the public from this alternative into perspective, comparisons are made to natural background radiation. As shown in table 4.8.3.9-1, the total dose to the maximally exposed member of the public from annual total site operations is within radiological limits and would be 5.6x10-3 mrem for this alternative. The annual population dose within 80 km (50 mi) in 2030 would be 0.23 person-rem.

Total site doses to onsite workers from normal operation of the proposed NIF are presented in table 4.8.3.9-2. The average annual dose to involved workers for this alternative would be 30 mrem. The dose to the entire facility workforce (involved workforce) would be 8.0 person-rem. The presented total dose to noninvolved workers was not modeled due to the unavailability of certain site-specific information.

Based on the radiological impacts associated with normal operation of this alternative, all resulting doses would be within radiological limits and are well below levels of natural background radiation. The associated risks of adverse health effects to the public and to workers would be small.

Hazardous Chemical Impacts. No hazardous chemical impacts are expected from operation of the proposed NIF (see appendix I). Therefore, the HI and cancer risk to the public and the onsite worker were not calculated nor assessed.

Potential Mitigation Measures. Mitigation measures such as substituting less toxic solvents and chemicals or modifying processes are proposed to reduce or eliminate the emissions of trichloroethylene due to site operations. Radioactive airborne emissions to the general population and onsite exposures to workers could be reduced by implementing the latest technology for process and design improvements. For example, to reduce public exposure from emissions, improved building and work area control methods could be used to remove radioactivity from the releases to the environment. Similarly, the use of remote, automated, and robotic production methods are examples of techniques that are being developed that would reduce worker exposure (see section 3.5).

Facility Accidents. The proposed actions have the potential for accidents that may impact the health and safety of workers and the public. The potential for and associated consequences of reasonably foreseeable accidents that have been assessed are summarized in this section.

No Action. Under the No Action alternative, nonnuclear fabrication and stewardship R&D would continue to be performed at SNL with no changes to facilities and operations. Under existing conditions, potential accidents and their consequences have been addressed in facility safety documentation according to requirements in DOE orders. In addition, there are other facilities at SNL besides those for nonnuclear fabrication and stewardship R&D. The potential for accidents at these other facilities has been similarly addressed and documented.

Management Alternatives. This section provides accident information on the nonnuclear fabrication alternative for SNL.

Nonnuclear Fabrication. The impacts of potential accidents associated with nonnuclear fabrication activities at SNL were previously addressed in Nonnuclear Consolidation Environmental Assessment (DOE/EA-0792, June 1993) where it was determined that the then current accident profile would not change as a result of the relocation of nonnuclear fabrication functions to SNL. The present proposed action to transfer the nonnuclear fabrication mission to SNL is not expected to change the accident profile that presently exists at the site.

Stewardship Alternatives

Proposed National Ignition Facility. Studies of potential accidents associated with the proposed NIF have been performed. A bounding accident was postulated based on a preliminary hazard analysis. The bounding accident assumes a severe earthquake of 1 G horizontal ground acceleration occurring during a maximum-credible-yield fusion experiment. Beamlines streaking into the target chamber and building structures other than the target area building would fail during the postulated earthquake. The collapsed beamlines and building structures would provide a pathway for acute atmospheric releases of tritium from the tritium processing system, activated gases in the air, and activated material in the target chamber.

The frequency of this severe earthquake is estimated at 1x10-4 per year. The joint frequency of the severe earthquake during the maximum-credible-yield fusion experiment would be less than 2x10-8 per year. The radiological impacts of the accident, presented in table 4.8.3.9-3, were estimated using the GENII computer code.

Table 4.8.3.9-3.--Consequences and Risk of the Bounding Proposed National Ignition Facility Accident at Sandia National Laboratories

Workers Onsite

Parameter	Conceptual Design	Enhanced Baseline Option
Dose (person-rem)	20	33
Fatal cancers	0	0

Risk (cancer fatalities per year)	$2x10^{-10}$	$3x10^{-10}$
Maximally Exposed Individual		
Dose (rem)	0.07	0.1
Fatal cancers probability	$4x10^{-5}$	$8x10^{-5}$
Risk (cancer fatality per year)	$7x10^{-13}$	$1x10^{-12}$
Population Within 80 Kilometers		
Dose (person-rem)	1,100	1,800
Fatal cancers probability	0	1
Risk (cancer fatalities per year)	$1x10^{-8}$	$2x10^{-8}$

Source: Appendix I.

4.8.3.10 Waste Management

This section summarizes the impacts on waste management at the Albuquerque location of SNL under No Action and for each of the proposed alternatives. There is no spent nuclear fuel, HLW, or TRU waste associated with nonnuclear fabrication or the proposed NIF; therefore, there is no further discussion of these wastes at SNL. Table 4.8.3.10-1 lists the projected waste generation rates and treatment, storage, and disposal capacities under No Action. Projections for No Action were derived from 1994 environmental data, with the appropriate adjustments made for those changing operational requirements where the volume of wastes generated are identifiable. The projection does not include wastes from future, yet uncharacterized, environmental restoration activities.

Table 4.8.3.10-2 provides the total estimated operational waste volumes projected to be generated at SNL as a result of the nonnuclear fabrication alternative and the NIF alternative. The net increase over No Action is shown in the table in parentheses. The waste volumes generated from the alternatives and the resultant waste effluent used in the impact analysis can be found in table 3.4.2.5-3 for nonnuclear fabrication and table 3.3.2.2-3 for NIF. Facilities that would support the Stockpile Stewardship and Management Program would treat and package all waste generated into forms that would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA, and other applicable statutes as outlined in appendix section H.1.2.

No Action. Under No Action, TRU, low-level, mixed, hazardous, and nonhazardous wastes would continue to be generated at SNL from the missions described in section 3.2.8. SNL would continue to treat, store, and dispose of its legacy and newly generated wastes in current and planned facilities. Liquid LLW would be neutralized and solidified. Solid LLW would be compacted, packaged, and stored at the Technical Area III storage site for shipment to NTS. Both liquid and solid mixed waste would be treated in the Technical Area III Radioactive and Mixed Waste Management Facility and disposed of according to the SNL Site Treatment Plan which was developed pursuant to the *Federal Facility Compliance Act* of 1992. The resulting waste would be stored in a RCRA-permitted facility in

DOT-approved containers until shipped to an offsite DOE disposal facility. Some of this waste would be placed in interim storage until new technologies for treatment and disposal are identified and evaluated. Hazardous waste would be packaged and shipped offsite to RCRA-permitted treatment storage and disposal facilities. Liquid sanitary waste would continue to be sent to the City of Albuquerque Municipal Sanitary Sewer System. Solid nonhazardous sanitary waste would be disposed of at the Albuquerque Sanitary Landfill.

Table 4.8.3.10-1.--Projected Waste Management Under No Action at Sandia National Laboratories

Category	Annual Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Low-Level							
Liquid	1	Neutralization and solidification	Included in mixed low-level	Staged at generator sites or in containers at Technical Area III aboveground storage site and other facilities	Included in mixed low-level	NA	NA
Solid	53	Compaction	Included in mixed low-level	Staged at generator sites or in containers at Technical Area III aboveground storage site and other facilities	Included in mixed low-level	None - pending offsite shipment to NTS	NA
Mixed Low-Level							

Liquid	<0.01	Neutralization and solidification; specific preferred treatment option for each treatability group as per Site Treatment Plan for Mixed Waste	Data not available at this time	Technical Area III	Included in solid	NA	NA
Solid	2	Compaction; specific preferred treatment option for each treatability group as per Site Treatment Plan for Mixed Waste	Data not available at this time	Staged at generator sites or in containers at Technical Area III aboveground storage site and other facilities	3,080	Offsite commercial facilities; some waste streams have no disposal options identified	NA
Hazardous							
Liquid	342	Neutralization or thermal treatment (open burn)	Data for neutralization not available at this time	RCRA-permitted Hazardous Waste Management Facility	Included in solid	Shipped to offsite RCRA-permitted facilities	NA
Solid	486[16]	Thermal treatment	9.1 kg/ campaign	RCRA-permitted Hazardous Waste Management Facility	Data not available at this time	Shipped to offsite RCRA-permitted facilities	NA
Nonhazardous (Sanitary)							

Liquid	75,700	Offsite/ Kirtland Air Force Base	NA	None	NA	Offsite- NPDES outfall to municipal facilities	NA
Solid	9,070	Segregation and recycling	NA	None	NA	Offsite sanitary landfill	NA
Nonhazardous (Other)							
Liquid	Included in sanitary	Included in sanitary	NA	None	NA	Included in sanitary	NA
Solid	Included in sanitary	Included in sanitary	NA	None	NA	Onsite classified waste landfill for classified waste; offsite for other nonhazardous wastes	NA

Table 4.8.3.10-2.--Estimated Annual Generated Waste Volumes for Stockpile Stewardship and Management Alternatives at Sandia National Laboratories

Category	No Action[17] (m^3)	Nonnuclear Fabrication[18] (m^3)	National Ignition Facility[19] (m^3)	Combined Program Impacts (m^3)
Low-Level				
Liquid	1	1 (+0)	2 (+0.6)	2 (+0.6)
Solid	53	53 (+0)	56 (+3)	56 (+3)
Mixed Low-Level				
Liquid	<0.01	<0.01 (+0)	2 (+2)	2 (+2)
Solid	2	2 (+0)	2 (+0.3)	2 (+0.3)

Hazardous				
Liquid	342	357 (+15)	344 (+2)	359 (+17)
Solid	486	503 (+17)	494 (+8)	511 (+25)
Nonhazardous (Sanitary)				
Liquid	75,700	367,000 (+291,000)	93,600 (+17,900)	385,000 (+309,000)
Solid	9,070	16,900 (+7,880)	15,100 (+6,000)	22,900 (+13,900)
Nonhazardous (Other)				
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary

Management Alternatives

Nonnuclear Fabrication. The Nonnuclear Fabrication Facility at SNL would not generate any TRU waste, LLW, or mixed LLW. Minimal impacts would result from the 15 m^3 (3,840 gal) of liquid hazardous waste and 17 m^3 (22 yd^3) of solid hazardous waste, which would be packaged and stored onsite in RCRA-permitted facilities prior to shipment offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. The estimated 291,000 m^3 (77,000,000 gal) of sanitary waste would be conveyed to the City of Albuquerque Municipal Sanitary Sewer System. Additional treatment in accordance with site practice and discharge permits may be required. Following volume reduction, 3,940 m^3 (5,150 yd^3) per year of solid nonhazardous waste would be disposed of at the Albuquerque Sanitary Landfill. Minimal impacts to the remaining capacity of the landfill are expected.

Sensitivity Analysis. The waste volumes generated from the Nonnuclear Fabrication Facility required to support a larger stockpile level (high case) operating on a single-shift basis are bounded by the base case under surge operations. Thus, there are no additional waste management impacts associated with the Nonnuclear Fabrication Facility that would support a high case stockpile operating at a single shift. The volumes generated from the Nonnuclear Fabrication Facility required to support a low case stockpile would be reduced by a factor of at least three.

Stewardship Alternatives

Proposed National Ignition Facility. The proposed NIF would not generate any TRU waste. The 0.6 m^3 (159 gal) of liquid LLW would require treatment prior to disposal. Liquid LLW is currently stored at the point of generation. Treatability studies are being conducted prior to applying for a RCRA permit for treating and storing liquid LLW and mixed waste. The 3 m^3 (4 yd^3) of solid LLW would be packaged in approved waste containers and staged in the Technical Area III storage site pending shipment directly to NTS for management. Assuming a land usage factor of 6,000 m^3 /ha (3,180 yd^3 / acres), less than 0.0005 ha/yr (0.0001 acres/yr) of LLW disposal area would be required.

The SNL Site Treatment Plan for Mixed Waste was developed to comply with the *Federal Facility Compliance Act.* The mixed waste streams identified at SNL have been combined into 16 treatability groups, each with a preferred treatment option. The type of mixed wastes generated by NIF would fit into one of the established 16 treatability groups and would not require the creation of new treatability groups or new preferred treatment options. The annual generation of 2 m^3 (528 gal) of liquid mixed wastes and the annual generation of 0.3 m^3 (0.4 yd^3) of solid mixed waste would have a negligible impact on the available storage capacity of the main areas for future mixed waste storage: the seven Manzano bunkers, the Radioactive and Mixed Waste Management Facility, and Building 6596.

Minimal impacts would result from the 2 m^3 (608 gal) of liquid hazardous waste and 8 m^3 (10 yd^3) of solid hazardous waste, which would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. There are no adverse impacts expected from the annual volume of 17,900 m^3 (4.72 million gal) of liquid nonhazardous sanitary waste discharged to the City of Albuquerque Municipal Sanitary Sewer System. Additional treatment in accordance with site practice and discharge permits may be required. Minimal impacts to the Albuquerque Sanitary Landfill would result from the 6,050 m^3 (7,910 yd^3) of solid nonhazardous waste.

Combined Program Impacts. If all the stockpile stewardship and management alternatives listed in table 4.8.3.10-2 were located at SNL, the impacts from low-level and mixed LLW would be identical to those discussed for NIF. Minimal impacts would result from the program total of 17 m^3 (4,450 gal) of liquid and 25 m^3 (33 yd^3) of solid hazardous wastes. Adequate facilities exist to package and stage these wastes in onsite RCRA-permitted facilities prior to shipment offsite to commercial RCRA-permitted treatment and disposal facilities. There are no adverse impacts expected from the program total of 309,000 m^3 (81.7 million gal) annual volume liquid sanitary wastes discharged to the City of Albuquerque Sanitary Sewer System. Additional treatment in accordance with site practice and discharge permits may be required. After volume reduction, approximately 9,990 m^3 (13,100 yd^3) of solid sanitary waste would require disposal at the Albuquerque Sanitary Landfill. Minimal impacts to the landfill are expected.

Potential Mitigation Measures. Waste quantities or waste forms could undergo additional reductions by utilizing emerging technologies, thereby further reducing or mitigating impacts. Pollution prevention and waste minimization would be considered in determining the final actions of the Stockpile Stewardship and Management Program at SNL. Utilization of existing and planned treatment and storage facilities would be maximized to further reduce impacts.

4.8.3.11 Environmental Justice

As discussed in section 4.14, any impacts to surrounding communities would most likely result from toxic or hazardous air pollutants and radiological emissions. Section 4.8.3.9, which describes public and occupational health impacts from normal operation, shows that potential chemical air emissions and releases are not within the generally accepted threshold of regulatory concern. This information is based on the conservative programmatic assumptions and modeling detailed in appendix E. Any adverse human health or environmental impacts that might occur would affect people living within communities located near SNL. The analysis of the demographic data presented in appendix D for the communities surrounding SNL indicates that if there were any adverse health impacts to these communities, they would not appear to disproportionately affect minority or low-income populations.

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1 State and city/county standard.

2 Federal standard.

3 No monitoring data available; concentration assumed less than applicable standard.

4 State standard or guideline.

5 No standard. Source: 40 CFR 50; NM EIB 1995a; NM EIB 1996a; SNL 1995b:1; SNL 1995e; appendix I.

6 Total water requirements for construction at SNL are based on a 3-year period for nonnuclear fabrication and a 5-year period for NIF.

7 No construction water would be used or construction wastewater generated. Total site water use and wastewater discharged would be the same as No Action operation.

8 All discharges to natural drainages require NPDES permits. NA - not applicable; MLY - million liters per year. SNL 1995b:l; SNL 1995e; appendix I.

9 Includes impacts from No Action.

10 The applicable radiological limits for an individual member of the public from total site operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathway, and 100 mrem/yr from all pathways combined (DOE Order 5400.5).

11 Natural background radiation levels to an average individual are 334 mrem/yr and to the population within 80 km (50 mi) in 2030 are 259,500 person-rem. Source: SNL 1994a; appendix I.

12 The involved worker is a worker associated with operation of NIF. The estimated number of involved workers is 267 for NIF.

13 The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 835).

14 The noninvolved worker is an onsite worker not associated with operation of NIF. The estimated number of noninvolved workers is 3,400 for NIF.

15 The total site workforce is the sum of the number of involved and noninvolved workers. The estimated number of workers in the total site workforce is 3,400 for No Action and 3,667 for NIF. NA - not applicable. Source: DOE 1993n:7; appendix I.

16 Includes RCRA-regulated, state-regulated, and TSCA-regulated wastes. NA - not applicable. Source: SNL 1995d.

17 No Action volumes are from table 4.8.3.10-1.

18 Volumes for nonnuclear fabrication are from table 3.4.2.5-3 and are based on surge operations (three shifts).

19 Volumes for NIF are from table 3.3.2.2-3 and are based on the conceptual design. Waste generation volumes were rounded to three significant figures. Waste effluent volumes are found in sections 3.3 and 3.4

4.8 Sandia National Laboratories

SNL is headquartered in Albuquerque, NM, and maintains facilities in other locations. The facilities discussed in this document refer only to the Albuquerque location, which is adjacent to the city of Albuquerque as shown in figure 4.8-1. The site shown in figure 4.8-2 is approximately 10.5 km (6.5 mi) east of downtown Albuquerque. SNL consists of 1,150 ha (2,842 acres) on Kirtland Air Force Base. An additional 6,072 ha (15,003 acres) are provided to DOE through ingrant land from Kirtland Air Force Base, the State of New Mexico, and the Isleta Pueblo to conduct operations.

4.8.1 Description of Alternatives

There are no facilities at SNL that would be phased out as a result of any of the proposed alternatives discussed in the PEIS.

No Action. SNL would continue to perform the missions described in section 3.2.8.

Stockpile Management Alternatives. The majority of the nonnuclear fabrication mission could be located at SNL. A portion of the nonnuclear fabrication mission would also be shared with LANL and possibly LLNL.

Stockpile Stewardship Alternatives. The proposed NIF could be located at SNL.

4.8.2 Affected Environment

The following sections describe the affected environment at SNL for land resources, air quality, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure, radiation and hazardous chemical environment, and waste management conditions, at SNL are described.

4.8.2.1 Land Resources

SNL is located approximately 10.5 km (6.5 mi) east of downtown Albuquerque, NM (figure 4.8-1). Generalized land uses at SNL and in the vicinity are shown in figure 4.8.2.1-1. There are no prime farmlands on SNL. The affected environment consists of two technical areas at the northern end of the site, designated Technical Area I and Technical Area II (figure 4.8-2).

Technical Area I is the most intensively developed of the SNL technical areas, containing administrative and support facilities; project engineering, research, and component development activities; neutron generator production; and special laboratories and shops.

The Kirtland Air Force Base cantonment, the most heavily developed area on the base, is adjacent to

Technical Area I. U.S. Air Force-accompanied base housing is located west and north of Technical Area I. Various Kirtland Air Force Base facilities and operations, including flight operations, are located west of Technical Area I. U.S. Air Force flight operations are collocated with the civilian commercial aircraft operations of Albuquerque International Airport. The runway and taxiways are owned and managed by the city of Albuquerque (SN USAF 1990a:3.6-1). The airport Accident Potential Zone 1 extends east beyond the runway clear zone to the edge of the Technical Area I boundary, with Accident Potential Zone 2 extending across Technical Area I. Flight operations of the airport are regulated by the Federal Aviation Administration, which does not use Accident Potential Zones.

The U.S. Air Force granted an exemption for the development of an all new Air Installation Compatible Use Zone study at Kirtland Air Force Base. The base, however, monitors all development in its vicinity to ensure compatibility with base flying missions. The U.S. Air Force Air Installation Compatible Use Zone Land Use Guidelines do not recommend uses within Zone 1 and Zone 2 that are highly labor intensive; that involve explosive, fire, toxic, corrosive, or other hazardous characteristics; or that occupy high-density offices.

Except for vacant land on both sides of Tijeras Canyon east of Technical Area I and some unmanned utility facilities, the land north of SNL is part of the urbanized city of Albuquerque. The urban land use consists of a mixture of residential, commercial, industrial, institutional, and various supporting public uses. The closest residence to the Kirtland Air Force Base boundary is approximately 6 m (20 ft) to the north. An industrial park is currently being developed immediately east of the Eubank Gate and Technical Area I. Commercial uses are primarily concentrated north of the site along Central Avenue and Gibson Boulevard (SN USAF 1990a:3.6-4-3.6-6). SNL does not contain any public recreation facilities.

4.8.2.2 Site Infrastructure

The site infrastructure characteristics that exist to support the current SNL missions described in section 3.2.8 are summarized in table 4.8.2.2-1.

Table 4.8.2.2-1.--Baseline Characteristics for Sandia National Laboratories

Characteristics	Current Value
Land	
Area (ha)	1,150
Roads (km)	40
Railroads (km)	8
Electrical	

Energy consumption (MWh/ yr)	186,944
Peak load (MWe)	32
Fuel	
Natural gas (m^3/yr)	15,773,761
Liquid (L/yr)	1,301,598
Coal (t/yr)	0
Steam	
Generation (kg/hr)	29,287
Water	
Usage (MLY)	1,387[1]

4.8.2.3 Air Quality

The following section describes existing air quality including a review of the meteorology and climatology in the vicinity of SNL. More detailed discussions of the air quality methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.3.8.

Meteorology and Climatology. The climate at SNL and in the surrounding region is characteristic of a semiarid steppe. The annual average temperature in the area is 13.4 °C (56.2 °F); temperatures vary from an average daily minimum of -5.7 °C (21.7 °F) in January to an average daily maximum of 33.6 °C (92.5 °F) in July. The average annual precipitation is 22.6 cm (8.88 in). The annual average wind speed is 4.0 m/s (9.0 mph) (NOAA 1994c:3).

Ambient Air Quality . SNL is located within the Albuquerque-Mid Rio Grande New Mexico Intrastate AQCR 152. Portions of the AQCR are designated nonattainment for carbon monoxide and total suspended particulates (40 CFR 81.332). The NAAQS and the State of New Mexico ambient air quality standards are given in appendix table B.3.1-1.

The principal sources of criteria air pollutants at SNL are the steam plant and the emergency diesel generator plant (SNL 1994a:5-19,5-20). Other emissions include fugitive particulate emissions from waste-burial activities, other process emissions, vehicular emissions, and temporary emissions from various construction activities. Hazardous/toxic air pollutant emissions at SNL occur from laboratories and miscellaneous operations and consist primarily of hydrogen chloride, methyl chloroform, toluene, and xylene. The emission inventories are included in appendix table B.3.8-1.

Ambient air quality conditions at SNL are shown in table 4.8.2.3-1. Ambient air quality concentrations at SNL are in compliance with applicable guidelines and regulations.

Table 4.8.2.3-1.--Comparison of Baseline Ambient Air Concentrations with Most Stringent

Applicable Regulations and Guidelines at Sandia National Laboratories, 1994

Pollutant	Averaging Time	Most Stringent Regulation or Guideline (g/m^3)	Baseline Concentration (g/ m^3)
Criteria Pollutant			
Carbon monoxide	Annual	4,600 [2]	1,603
	8-hour	10,000 [3]	4,924
	1-hour	15,000 [2]	10,307
Lead	Calendar quarter	1 .5[3]	0 .0667
	30-day	3 [2]	[4]
Nitrogen dioxide	Annual	94 [5]	30
	24-hour	117 [2]	77
Ozone	1-hour	235 [3]	188
Particulate matter	Annual	50 [3]	15 .92
	24-hour	150[3]	66
Sulfur dioxide	Annual	11 [2]	0 .8
	24-hour	92 [2]	5.2
	3-hour	1,300[3]	21.7
Mandated by New Mexico and Albuquerque-Bernalillo County			
Arsenic, copper, and zinc	30-day	10[2]	0 .067
Beryllium	30-day	0 .01[2]	[4]
Hydrocarbon (non-methane)	3-hour	100[2]	[4]
Hydrogen sulfide	1-hour	4 [2]	[4]
Photochemical oxidants	1-hour	20 [2]	[4]
Total reduced sulfur	1-hour	4[2]	[4]
Total suspended particulates	Annual	60 [5]	15 .92
	30-day	90 [5]	<66
	7-day	110 [5]	<66

	24-hour	150 [5]	66
Hazardous and Other Toxic Compounds			
Acetone	8-hour	[6]	0 .25
Benzene	8-hour	[6]	< 0.01
Carbon tetrachloride	8-hour	300[5]	< 0.01
Hydrogen chloride	8-hour	[6]	3 .27
Isopropyl alcohol	8-hour	9,800 [5]	0 .11
Methanol	8-hour	[6]	0 .11
Methyl chloroform	8-hour	[6]	0.71
Methylene chloride	8-hour	[6]	0 .04
Toluene	8-hour	[6]	0 .55
Trichloroethylene	8-hour	[6]	0 .10
Trichlorotrifluoroethane	8-hour	[6]	0 .15
Xylene	8-hour	[6]	0 .59

4.8.2.4 Water Resources

This section describes the surface and groundwater resources at SNL.

Surface Water. SNL is located within Kirtland Air Force Base on the Albuquerque East Mesa. The mesa slopes gently southwest to the Rio Grande, the primary drainage channel for the area. The Rio Grande is located 10 km (6 mi) west of Kirtland Air Force Base and flows north to south. No perennial streams flow through the SNL area. The major surface water feature at SNL is the Arroyo Seco, an intermittent stream that enters the site on the eastern boundary and exits on the northwestern corner. The channel is dry at least 6 months out of the year. Two other primary surface channels at SNL are Tijeras Arroyo and the smaller Arroyo del Coyote (figure 4.8-2). The Arroyo del Coyote joins the Tijeras Arroyo to discharge into the Rio Grande approximately 8 km (5 mi) from the western edge of Kirtland Air Force Base. Both arroyos flow intermittently during spring snowmelt or following thunderstorms. Springs in the eastern mountains provide a perennial flow in the upper reaches of Tijeras Arroyo. Most of this flow evaporates or percolates into the soil before reaching Kirtland Air Force Base.

Tijeras Arroyo separates Technical Areas I, II, and IV from Technical Areas III, V, and the Coyote Test Field. Stormwater runoff is drained from the SNL Technical Areas by a combination of overland flow, natural channels, open drainage ditches, culverts, and storm sewers.

High peak flows of short duration characterize floods in the area. High-intensity summer thunderstorms produce the greatest flows, but flooding is not considered a high probability at SNL. The proposed stockpile stewardship and management activities would be located outside the 100- and 500-year floodplain zones (SNL 1995g:1-7).

SNL contains over 24 km (15 mi) of sewer lines interconnected with those of Kirtland Air Force Base. In 1994, SNL had two categorical pretreatment operations and four general wastewater streams discharging to the city of Albuquerque wastewater treatment plant. Discharges by SNL are regulated by the city of Albuquerque Public Works Department, Liquid Waste Division, under the authority of the city's Sewer Use and Wastewater Control Ordinance. The city's ordinance is approved by EPA in accordance with the Clean Water Act (CWA), as amended (SNL 1995g:6-1). Total flow from SNL is estimated to be 757 MLY (200 MGY).

To comply with EPA regulations, the city of Albuquerque has implemented an industrial wastewater pretreatment program. This program requires SNL to obtain permits for wastewater discharges to the city's wastewater treatment plant. These permits specify the required quality of discharges and the frequency of reporting the results of the monitoring (SNL 1995g:6-1). In 1994, SNL did not meet permit limits on four different occasions. Noncompliances were for excursions of lead, nickel, pH, oil, and grease (SNL 1995g:6-5).

SNL has one active permitted discharge plan from the state to discharge stormwater from oil storage tank areas and building basements to two surface impoundments (lagoons) permitted under the New Mexico Water Quality Control Commission Regulations as implemented by the New Mexico Environmental Improvement Board.

Surface Water Quality. As a part of the annual surface water monitoring program, samples are obtained from stations upstream and downstream of SNL in the Rio Grande and from Coyote Springs. The upstream station on the Rio Grande is at Corrales Bridge, and the downstream station is at the Isleta Indian Reservation, considerably downstream of the influent point of Tijeras Arroyo. Stormwater flowing into Tijeras Arroyo is the only significant surface water flow into the Rio Grande from the site. Stormwater monitoring is conducted twice a year at SNL. Rio Grande water samples are analyzed for gross alpha, gross beta, total uranium, and tritium. Results from the 1994 annual monitoring are presented in table 4.8.2.4-1. Concentrations of radionuclides in surface waters in 1994 did not exceed applicable standards. No nonradiological monitoring is conducted in Tijeras Arroyo or in the Rio Grande.

Groundwater . SNL lies within the north-south trending Albuquerque basin. The principal aquifer of the Albuquerque basin is the Valley Fill aquifer. The Valley Fill consists of unconsolidated and semiconsolidated sands, gravels, silts, and clays that vary in thickness from a few meters adjacent to the mountain ranges to over 6,400 m (21,000 ft) at a point 8 km (5 mi) southwest of the Kirtland Air Force Base airfield. The Valley Fill aquifer is considered a Class IIa aquifer, having a current source of drinking water and waters having other beneficial uses.

The regional water table is separated by a fault complex that divides the area into a deep region on the west side of the complex and a shallower region on the east side. The depth to groundwater ranges from 15 m to 30 m (49 ft to 98 ft) on the east side of the fault complex and from 116 m (380 ft) to 153 m (500 ft) on the west side (SNL 1995g:1-5). Based on available data, the apparent direction of groundwater flow west of the fault complex is generally to the north and northwest. The direction of groundwater flow east of the fault complex typically is west toward the fault system.

Sources of recharge to the aquifer include precipitation, snowmelt along the margins of the basin, underflow from adjacent areas such as the Hagen Basin, and seepage from streams, canal drains, surface reservoirs, and applied crop irrigation water.

Table 4.8.2.4-1.--Surface Water Quality Monitoring of the Rio Grande at Sandia National Laboratories, 1994

Parameter	Unit of Measure	Water Quality Criteria[7]	Water Body Concentration Range[8]
Alpha (gross)	pCi/L	15[9]	2-3
Beta (gross)	pCi/L	50[10]	3-7
Tritium	pCi/L	80,000[11]	20-100
Uranium, total	g/L	NA	1.6-2.6

Groundwater Quality . Groundwater monitoring at SNL has been conducted since 1985. Overall, the groundwater in this region has been classified as a calcium bicarbonate chemical type with a pH ranging from 6.08 to 8.84 and an alkalinity range of 0.40 to 49 mg/L. The east side wells are characterized by lower pH than the west side wells. Currently, no monitoring wells are in the proposed project area. The closest well, located approximately 0.4 km (0.25 mi) southeast of the area, had an August 1990 depth-to-water reading of 152 m (499 ft).

The chemical waste landfill has been identified as a source of groundwater contamination. In 1994, concentrations of nickel and chromium were found above the water quality criteria established by the New Mexico Water Quality Regulations in the groundwater at the chemical waste landfill. No Target Analyte Metals or radionuclides were detected above background levels in groundwater samples collected in 1994. The groundwater contamination areas are not located near buildings that house proposed DP activities.

Groundwater Availability, Use, and Rights . SNL uses approximately 1,387 MLY (366 MGY) of water. Thirty percent of the water used at SNL is purchased from the city of Albuquerque, and the rest is pumped from Kirtland Air Force Base wells.

The city of Albuquerque has annual consumptive water rights of 27,300 MLY (7,210 MGY). The city receives a 50-percent return flow credit for sanitary wastewater discharged to the Rio Grande. In addition, the city of Albuquerque also has 56,800 MLY (15,000 MGY) consumptive water rights to the San Juan/Chama Diversion.

Kirtland Air Force Base has groundwater rights of 7,900 MLY (2,090 MGY). It also has the option of purchasing 10 percent of its water from the city of Albuquerque. Currently, it is operating at a 50-percent capacity.

Groundwater rights in New Mexico are traditionally associated with the appropriation doctrine. In this system, all water is declared to be public and subject to appropriation on the basis "first in time, first in right" principle (VDL 1990a:725). Control of well use is regulated by permits.

4.8.2.5 Geology and Soils

Geology. SNL lies on a sequence of sedimentary, igneous, and Precambrian basement rocks. The northern and western sections rest on Miocene to Quaternary gravels, sands, silts, and clays deposited in the basin formed by uplift of the mountains to the east. The eastern portion of SNL is primarily underlain by Precambrian rocks.

SNL is located in seismic Zone 2 (figure A.1-1). The eastern portion of SNL is cut by the Tijeras, Hubble Springs, Sandia, and Manzano faults. The facility is situated in a region of high seismic activity but low magnitude and intensity (SN ERDA 1977a:82). Available records indicate that more than 1,100 earthquakes have occurred during the past 127 years. Intensities have been as high as a modified Mercalli intensity of VII. However, during the past century, only three earthquakes have caused damage at Albuquerque, which is located approximately 10.5 km (6.5 mi) from SNL.

Possible geological concerns include potential ground shaking and rupturing associated with regional seismic activity and the faults intersecting on the site. Statistical studies indicate that a nondamaging earthquake of modified Mercalli intensity less than III may be expected every 2 years, with a damaging event every 100 years. The potential for damage from volcanic activity is small (DOE 1995cc:4-112).

Soils. SNL is located on soils of the Bluepoint-Kokan, Madurez-Wink, Tijeras-Embudo, Kolob-Rock outcrop, and the Seis-Orthids associations (SN USDA 1977a:31,32,41,42). The Bluepoint-Kokan soils are excessively drained, sandy, and gravelly. The Madurez-Wink soils are well-drained and loamy. The Tijeras-Embudo soils are well-drained, loamy, and gravelly. The Kolob-Rock outcrop association in the eastern portion of SNL includes deep, moderately to very steep, well-drained, loamy, and stony soils, and basalt, sandstone, and limestone rock outcrops. The Seis-Orthids association includes shallow to moderately deep soils on level to very steep slopes that are well-drained, very cobbly, stony and very stony, and loamy.

The hazard of blowing soils on the terraces and pediments is severe. Future water erosion hazards are moderate on the alluvial fans, foothills, and highlands. No soils are classified prime farmland at SNL. The soils at SNL are acceptable for standard construction techniques.

4.8.2.6 Biotic Resources

The following section describes biotic resources at SNL including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. A list of threatened and endangered species that may be found on or in the vicinity of SNL is presented in appendix C.

Terrestrial Resources. SNL is located at the juncture of four major North American physiographic and biotic provinces: the Great Basin, the Rocky Mountains, the Great Plains, and the Chihuahuan Desert. The biotic communities of the area exhibit influences from each of these provinces, with the Great Basin influence generally dominating. SNL occupies about 1,150 ha (2,842 acres) within the larger Kirtland Air Force Base which totals 21,319 ha (52,700 acres). Approximately 39 percent of SNL-controlled land is developed. Vegetation of the area can be classified into four major plant communities: pinyon pine-juniper, grassland, riparian woodland, and riparian scrubland. The pinyon pine-juniper and grassland communities dominate the area, while the riparian woodland and riparian scrubland are limited to the surface drainage courses of canyons and arroyos, respectively (SNL 1992c:5-1). In total, 379 species have been identified that exist or could exist within the area (SNL 1990a:27-37).

At least 10 amphibian, 46 reptile, 124 bird, and 68 mammal species exist, or could exist, in the area of SNL (SNL 1990a:14,16,17,19-22,24-26). Common species include the short-horned lizard (Phrynosoma douglassi), prairie rattlesnake (Crotalus viridis viridis), mourning dove (Zenaida macroura), horned lark (Eremophila alpestris), black-tailed jackrabbit (Lepus californicus), and black-tailed prairie dog (Cynomys ludovicianus). A number of game animals are found on SNL; however, hunting is not permitted. Raptors, such as the Cooper's hawk (Accipiter cooperii) and golden eagle (Aquila chrysaetos), and carnivores, such as the coyote (Canis latrans) and bobcat (Lynx rufus), are ecologically important groups on the site. A variety of migratory birds has been found at SNL. Migratory birds and their nests and eggs are protected by the Migratory Bird Treaty Act. Eagles are similarly protected by the Bald and Golden Eagle Protection Act.

Wetlands. National Wetland Inventory maps of SNL have not been prepared nor have site wetlands been delineated. Springs exist at Lurance Canyon, Sol se Mate, and the outlet of Coyote Canyon. Sole se Mate Spring has a small area of permanent water below it that supports wetland plants such as cattails (Typha spp.) and rushes (Juncus spp.). A swampy area exists at Coyote Springs that supports wetland vegetation (SN ERDA 1977a: 94-95). These springs can be considered an important source of water for wildlife.

Aquatic Resources. Potential aquatic resources found on SNL include Arroyo del Coyote and Tijeras Arroyo (located in the west and central portions of the site, respectively). The Rio Grande River is located about 10 km (6.2 mi) west of the site. There are no continuously flowing streams on the site. Site arroyos flow intermittently during heavy thundershowers (SNL 1994a:1-7). The arroyos do not support any permanent fish population.

Threatened and Endangered Species. The 18 Federal- and state-listed threatened, endangered, and other special status species that could be found on or in the vicinity of SNL are listed in appendix table C-6. No Federal-listed threatened or endangered species are known to exist on SNL. However, potential breeding habitat exists on SNL for the Mexican spotted owl (Strix occidentalis lucida), southwestern willow flycatcher (Empidonax traillii extimus), and the Federal-candidate mountain plover (Charadrius montanus). The only special status species known to exist onsite is the state-threatened gray vireo (Vireo vicinior) (SNL 1992c:5-10,5-11). No critical habitat, as defined in the Endangered Species Act (50 CFR 17.11 and 17.12), exists on SNL.

4.8.2.7 Cultural and Paleontological Resources

Prehistoric Resources. The prehistoric chronology for the SNL area consists of three broad time periods: Paleo-Indian (10,000 to 5,500 B.C.), Archaic (5,500 B.C. to A.D. 1), and Anasazi (A.D. 1 to 1600) (SN NPS 1988a:132). All DOE-owned properties under SNL control have been surveyed or assessed for cultural resources (SNL 1993c:1-6). All five Technical Areas have been intensively surveyed; no prehistoric sites were recorded. However, because techniques and procedures varied greatly between projects in these areas, most surveys prior to 1985 are not considered adequate, and buried sites or archaeological remains may exist. Prehistoric site types may include pueblos, pithouse villages, rockshelters, hunting blinds, agricultural terraces, quarries, lithic and ceramic scatters, and hearths. Similar sites have been found at nearby locations. A systematic walkover survey was completed at the proposed site locations and no cultural resources were identified.

Historic Resources. Historic resources identified in the vicinity of SNL are associated with early mining, ranching and sheepherding activities, commercial ventures, or transportation routes. All five DOE Technical Areas have been intensively inventoried for resources; two historic sites were recorded. These sites were small historic trash scatters and are not eligible for the NRHP. Twenty-three historic resources have been recorded on DOE-owned or -controlled lands outside of the five Technical Areas, and about 65 percent are considered eligible or potentially eligible for the NRHP.

SNL was established in 1945 as the Z Division of the Los Alamos Scientific Laboratory. Technical Area I originally consisted of temporary World War II structures and wooden framed buildings; more permanent buildings were constructed in 1948. Construction in Technical Area II was initiated in 1948, including two buildings (Buildings 904 and 907) used to assemble the first hydrogen bomb. Test facilities were developed in Technical Area III from 1954 through 1960 (SNL 1993c:2-12,2-13). Numerous buildings and structures in Technical Areas I, II, and III were built between 1945 and 1960; most are associated with the AEC, and, as such, may be considered NRHP eligible. Buildings in Technical Areas III, IV, and V may also qualify for eligibility for the NRHP when they are 50 years old. The New Mexico SHPO has requested that buildings in these areas be evaluated at that time. Buildings 904 and 907 may be considered potentially NRHP eligible because of their association with the assembly of the first hydrogen bomb.

Native American Resources. Native Americans with concerns in this area include the Sandia Pueblo, north of Albuquerque, and the Isleta Pueblo, south of Kirtland Air Force Base (SNL 1993c:1-9). Native American resources on SNL/DOE-controlled lands may consist of prehistoric sites with ceremonial features such as kivas, village shrines, petroglyphs, or burials; all of these site types or features would be of concern to local groups. Consultation with the Isleta and Sandia Pueblos has been initiated by DOE for this project, and no Native American cultural resources have been identified within SNL, including the proposed NIF location.

Paleontological Resources. The geology at SNL consists of sedimentary and volcanic rocks. Uppermost is a sequence of gravel, sand, silt, clay, and caliche. Underneath are sedimentary rocks, and, beneath them, Precambrian rocks. Some fossils have been discovered near SNL. These fossils include vertebrate remains 5 to 8 km (3 to 5 mi) west-northwest of Technical Area III, and an ankle bone from an extinct Pleistocene camel and two teeth from a horse on the south side of Tijeras Arroyo. A fossilized horse skull and some hare teeth were recovered near the mouth of Tijeras Arroyo. These fossils may have been transported to their site of discovery. However, it is possible fossils are present at SNL beneath the alluvial fan deposits from the Sandia Mountains.

4.8.2.8 Socioeconomics

Socioeconomic characteristics addressed at SNL include employment and local economy, population and housing, and public finance. Statistics for employment and local economy are based on the regional economic area that encompasses nine counties around SNL located in Arizona and New Mexico. Statistics for population and housing, and public finance are presented for the ROI, a three-county area in which 97 percent of all SNL employees (7,341 persons in 1993) reside: Bernalillo County (88.0 percent), Valencia County (4.5 percent), and Sandoval County (4.5 percent) in New Mexico (appendix table D.1-7). Figure 4.8.2.8-1presents a map of the counties and selected cities composing the SNL regional economic area and ROI. Supporting data is presented in appendix D.

Regional Economy Characteristics. Selected employment and regional economy statistics for the SNL regional economic area are summarized in figure 4.8.2.8-2 *(not available electronically)*. The civilian labor force in the regional economic area increased from 279,186 in 1980 to 344,309 in 1990. This is an increase of 23 percent (annual average increase of 2.3 percent). The 1994 unemployment rate in the regional economic area was 5.7, which was less than 1 percent lower than the rates in Arizona and New Mexico. The region's per capita income of $17,003 in 1993 was approximately 4 percent greater than New Mexico's per capita income of $16,346 and 6 percent lower than Arizona's per capita income of $18,085.

In 1993, as shown in figure 4.8.2.8-2 *(not available electronically*, the percentage of total employment involving the private sector activity of retail trade in the regional economic area (18 percent) was comparable to the economies of Arizona and New Mexico. Service activities in the region (31 percent of the total employment) were also comparable to Arizona and New Mexico. Manufacturing was similar in both the regional economic area (7 percent) and New Mexico, but represented a 2-percent larger share of total employment in Arizona.

Population and Housing. Between 1980 and 1992, the ROI population grew from 515,614 to 616,346. This is an increase of 19.5 percent (annual average increase of 1.6 percent). Within the ROI, Sandoval County experienced the largest increase at 97.7 percent, while Valencia County's population decreased by 21.0 percent. This decrease was due to the formation of Cibola County that was created entirely from the western portion of Valencia County shortly after the 1980 census. If the

1992 Cibola County population was added to Valencia's, the result would be an 18-percent increase from 1980 to 1992.

Between 1980 and 1990, housing units increased from 196,765 to 241,683. This is a 22.8-percent increase (annual average increase of 2.3 percent), which is similar to the percent increase for New Mexico. The total number of housing units estimated for 1992 is 244,900. The 1990 homeowner vacancy rate in the ROI was 1.8 percent. The rental vacancy rate for the ROI counties was 10.2 percent. Population and housing trends are summarized in figure 4.8.2.8-3.

Public Finance. Financial characteristics of the local jurisdictions in the SNL ROI that are most likely to be affected by the proposed action are presented in this section. The data reflect total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.2.3-12 and D.2.3-13. Figure 4.8.2.8-4 summarizes 1994 local governments' revenues and expenditures. Fund balances, which are dollars carried over from previous years, are not included in figure 4.8.2.8-4. All jurisdictions assessed had positive fund balances.

4.8.2.9 Radiation and Hazardous Chemical Environment

The following section provides a description of the radiation and hazardous chemical environment at SNL. Also included are discussions of health effects studies, emergency preparedness considerations, and a brief accident history.

Radiation Environment. Major sources of background radiation exposure to individuals in the vicinity of SNL are shown in table 4.8.2.9-1. All annual doses to individuals from background radiation are expected to remain constant over time. The incremental total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to SNL operations.

Table 4.8.2.9-1.--Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Sandia National Laboratories Operations

Source	Committed Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic and external terrestrial radiation[12]	95
Internal terrestrial radiation[13]	39

Radon in homes (inhaled)[13]	200
Other Background Radiation[13]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	399

Releases of radionuclides to the environment from SNL operations provide another source of radiation exposure to people in the vicinity. The radionuclides and quantities released from operations in 1993 are listed in the *1993 Site Environmental Report Sandia National Laboratories, Albuquerque, New Mexico* (SAND94-1293). The doses to the public resulting from these releases are given in table 4.8.2.9-2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment (No Action) radiological releases at SNL in 2005 (section 4.8.3.9).

Based on a dose-to-risk conversion factor of 500 cancer deaths per 1 million person-rem (5x10-4 fatal cancer per person-rem) to the public (appendix E), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from SNL operations in 1993 was estimated to be approximately 8.0x10-*10* . That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of operations is less than 1 in 1 billion. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Based on the same conversion factor, 1.4x10-*5* excess fatal cancers are projected in the population living within 80 km (50 mi) of SNL from normal operation in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this mortality rate, the number of fatal cancers from all causes expected to occur during 1993 in the population living within 80 km (50 mi) of SNL is 1,156. This number of expected fatal cancers is much higher than the estimated 1.4x10-*5* fatal cancers that could result from SNL operations in 1993.

Table 4.8.2.9-2.--Doses to the General Public from Normal Operation at Sandia National Laboratories, 1993 (Committed Effective Dose Equivalent)

	Atmospheric Releases		**Liquid Releases**		**Total**	
Affected Environment	**Standard[14]**	**Actual**	**Standard[14]**	**Actual**	**Standard[14]**	**Actual**

Maximally exposed individual (mrem)	10	1.6x10^{-3}	4	0.0	100	1.6x10^{-3}
Population within 80 kilometers[15] (person-rem)	None	0.027	None	0.0	100	0.027
Average individual within 80 kilometers[16] (mrem)	None	4.7x10^{-5}	None	0.0	None	4.7x10^{-5}

Workers at SNL receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.8.2.9-3 includes the average, maximum, and total occupational doses to workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a dose-to-risk conversion factor of 400 fatal cancers per 1 million person-rem (4x10-4 fatal cancers per person-rem) among workers (appendix E), the number of excess fatal cancers to SNL workers from operations in 1992 is estimated to be 4.4x10^{-3} .

Table 4.8.2.9-3.--Doses to the Onsite Worker from Normal Operation at Sandia National Laboratories, 1992

	Onsite Releases and Direct Radiation	
Affected Environment	**Standard[17]**	**Actual[18]**
Average worker (mrem)	None	3.2
Maximally exposed worker (mrem)	5,000	1,000
Total workers (person-rem)	None	11

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in *1993 Site Environmental Report Sandia National Laboratories, Albuquerque, New Mexico* (SAND 94-1293). In addition, the concentrations of radioactivity in various environmental media (e.g., air, water, and soil) in the onsite and offsite regions are presented in the same reference.

Chemical Environment . The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in sections 4.8.2.3 and 4.8.2.4.

Adverse health impacts to the public can be minimized through administrative and design controls that decrease hazardous chemical releases to the environment and achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operation at SNL via inhalation of air containing hazardous chemicals released to the atmosphere by operations. Risks to public health from ingestion of contaminated drinking water or by direct exposure are also potential pathways.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in section 4.8.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. All annual concentrations are compared with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in appendix E.

Exposure pathways to SNL workers during normal operation may include inhaling the workplace atmosphere, drinking SNL potable water, and possible other contact with hazardous materials associated with particular work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. SNL workers are also protected by adherence to OSHA and EPA occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amount of chemicals utilized in the operation processes, ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at SNL are expected to be substantially better than required by the standards.

Health Effects Studies. There are no known epidemiological studies that have been conducted which examine the impact of SNL on the health of the surrounding communities.

Broadwell and others reported on 25 workers currently or formerly involved in the manufacture of hybrid microcircuits (AJIM 1995a:677-698). Clinical narratives and retrospective exposure assessments in the study group suggested chronic low-level exposure to solvents, with intermittent acute excursions. Solvent exposures linked to a clinical syndrome were intermittent, and symptoms were reversible after cessation of what were reported as "high-level" exposures. Several exposed workers showed clinical evidence of an acquired toxic encephalopathy supporting an association between long-term solvent exposure and depressed mood, with increased somatic symptoms. Attention to engineering controls, chemical fume hood ventilation, work practices, safety training, and personal protective gear was markedly improved when the lab was moved in the fall of 1990. For a more detailed description of the studies and the findings, refer to appendix section E.4.8.

Accident History. A review of the recent SNL annual environmental and accident reports indicates that there have been no significant adverse impacts to workers, the public, or the environment. This review was performed to provide an indication of the site's accident history. The period of review, from 1986 to 1990, was a time during which plant operations were much higher than in previous years and also higher than what is anticipated for the future.

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response to accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with planning, preparedness, and response.

4.8.2.10 Waste Management

This section outlines the major environmental regulatory structure and ongoing waste management activities for the Albuquerque location of SNL. A more detailed discussion of the ongoing waste management operation is provided in appendix section H.2.7.

DOE is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at SNL. DOE is also engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with these applicable requirements and financial penalties for nonachievement of agreed upon milestones. These agreements have been reviewed to assure the proposed actions are allowable under the terms of these agreements.

SNL is not on the NPL for sites requiring environmental restoration in accordance with CERCLA and *Superfund Amendments and Reauthorization Act* (SARA). The assessment of environmental contamination at SNL began formally in 1984, when DOE started to identify, assess, and remediate potentially hazardous waste sites in response to CERCLA. This program identified 117 sites with potential contamination. A similar investigation was conducted by EPA in 1987. These programs ultimately defined a working inventory of potential "solid waste management units." Current investigations are intended to determine the nature and extent of hazardous and radioactive contamination and to restore any sites where such materials pose a threat to human health or the environment. It is assumed that remediation at all sites will be completed by 2011.

SNL has a Waste Minimization and Pollution Awareness Plan to document projections for present and future waste generation rates. This program tracks the amount of waste generated at the site and encourages the use of waste reduction methods. In the future, it will assess opportunities for preventing pollution from priority waste streams, increasing recycling efforts, and ensuring the procurement of recycled products.

SNL manages a small quantity of spent nuclear fuel and five broad waste categories: TRU, low-level, mixed, hazardous, and nonhazardous. Because there is no spent nuclear fuel or TRU waste associated with any of the proposed activities at SNL, there is no discussion in this PEIS of spent nuclear fuel or TRU waste generation and management at SNL. A discussion of the waste management operations associated with low-level, mixed, hazardous, and nonhazardous wastes follows.

Low-Level Waste. In 1994, SNL generated approximately 0.9 m^3 (241 gal) of liquid and 53 m^3 (70

yd^3) of solid LLW (SNL 1995f:7). SNL generates LLW in both technical and remote test areas as a result of R&D activities. Most of the LLW consists of contaminated equipment and combustible decontamination materials and cleanup debris. All generated LLW is temporarily stored at generator sites or aboveground in transportation containers at the Technical Area III disposal site. All LLW packages are currently onsite pending approval of transport by commercial carriers to NTS for disposal.

Mixed Low-Level Waste. In 1994, SNL generated approximately 0.007 m^3 (2 gal) of liquid and 1.9 m^3 (2.5 yd^3) of solid mixed LLW (SNL 1995f:7). Mixed waste includes radioactively contaminated oils and solvents and radioactively contaminated or activated lead, or other heavy metals. Other mixed waste may be generated as a result of weapons tests. The 557-m^2 (666-yd^2) Radioactive and Mixed Waste Management Facility will have a centralized packaging and storage function for LLW and mixed waste. Mixed waste will be stored at the facility until accepted for disposal at NTS once it is permitted. Processing at the Radioactive and Mixed Waste Management Facility will include activities required to comply with the waste acceptance criteria and Federal regulations. Pursuant to the *Federal Facility Compliance Act,* SNL developed a site treatment plan for mixed wastes at SNL. The site treatment plan is intended to bring SNL into compliance with Land Disposal Restrictions storage prohibitions under the New Mexico Hazardous Waste Act and RCRA. On March 31, 1995, DOE submitted its proposed site treatment plan to the New Mexico Environment Department for review, public comment, and approval. On October 6, 1995, a Compliance Order was issued by the State of New Mexico requiring SNL to comply with the site treatment plan for the treatment of mixed wastes at SNL. The Compliance Plan Volume of the site treatment plan provides overall schedules for achieving compliance with the land disposal restrictions storage and treatment requirements, a schedule for the submittal of applications for permits, construction of treatment facilities, technology development, offsite transportation for treatment, and the treatment of mixed wastes in full compliance with the New Mexico Hazardous Waste Act and RCRA. An annual update to the site treatment plan is required.

Hazardous Waste. In 1994, SNL generated approximately 342 m^3 (90,530 gal) of liquid, and 81.9 t (90.3 tons) of RCRA-regulated and 647 t (713 tons) of state-regulated solid hazardous wastes (SNL 1995f:7). Hazardous/toxic chemical waste is generated at SNL by the numerous R&D activities conducted throughout the facilities. The Hazardous Waste Management Facility can store 265 m3 (70,000 gal) of liquid and solid hazardous wastes at one time. There are no active onsite disposal facilities for hazardous/toxic wastes at SNL. All RCRA-regulated wastes are packaged, manifested, and shipped offsite by DOT-registered transporters for disposal at RCRA-permitted treatment, storage, and disposal facilities.

Nonhazardous Waste. For 1994, SNL generated approximately 75,700 m^3 (19,998,000 gal) of liquid sanitary and industrial wastewater (SNL 1995b:1). SNL contains over 24 km (15 mi) of sewer lines interconnected with those of Kirtland Air Force Base. Pretreated industrial wastewater effluent and sanitary sewage are discharged to the city of Albuquerque sewer system in compliance with NPDES permit discharge limits. In 1994, SNL generated approximately 13,600 t (14,990 tons) of solid sanitary waste (SNL 1995f:7). Solid sanitary waste is collected and taken to the Albuquerque sanitary landfill on a regular basis.

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1 Value based on 1990 data.
Source: SNL 1995b:1.

2 State and city/county standard.

3 Federal standard.

4 No monitoring data available, baseline concentrations assumed less than applicable standard.

5 State standard.

6 No standard.Source: 40 CFR 50; NM EIB 1995a; NM EIB 1996a; SNL 1995b:1.

7 For comparison only.

8 Samples were collected from station 11 located on the Rio Grande at the Isleta Pueblo down gradient of SNL. Samples are collected biannually: in May and August.

9 National Primary Drinking Water Regulations (40 CFR 141).

10 Proposed National Primary Drinking Water Regulations, Radionuclides (56 FR 33050).

11 DOE's Derived Concentration Guides for water (DOE Order 5400.5). Values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guides.NA - not applicable.Source: SNL 1995g.

12 SNL 1994a.

13 NCRP 1987a.

14 The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *CAA* , the 4 mrem/yr limit is required by the *SDWA* , and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268).

15 In 1993, this population was approximately 578,000.

16 Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.

Source: SNL 1994a.

[17] 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[18] DOE 1993n:7. The number of badged workers in 1992 was approximately 3,420.

4.9 Nevada Test Site

NTS was established in 1950 and currently occupies approximately 351,000 ha (867,000 acres) located 105 km (65 mi) northwest of Las Vegas, NV. The site has conducted underground testing of nuclear weapons and evaluation of the effects of nuclear weapons on military communications systems, electronics, satellites, sensors, and other materials. In October 1992, underground nuclear testing was halted, yet the site maintains the capability to resume testing if authorized by the President. Section 3.2.9 provides a description of all DOE missions and support facilities at NTS. The location of NTS within the state of Nevada is illustrated in figure 4.9-1, and the principal facilities at NTS are shown in figure 4.9-2.

4.9.1 Description of Alternatives

There are no facilities at NTS that would be phased out as a result of any of the proposed alternatives discussed in this PEIS.

No Action. NTS would continue to perform the mission described in section 3.2.9.

Stockpile Management Alternatives. The A/D mission, including the nonintrusive modification pit reuse mission (hereafter referred to as A/D), and the option of storage of strategic reserves of plutonium and uranium could be located at NTS.

Stockpile Stewardship Alternatives. NIF could be located at NTS (at the main site or at NLVF).

4.9.2 Affected Environment

The following sections describe the affected environment at NTS and NLVF for land resources, air quality, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure, radiation and hazardous chemical environment, and waste management conditions are described.

4.9.2.1 Land Resources

Land Use. NTS occupies approximately 351,000 ha (867,000 acres) in southern Nye County in southern Nevada, with the southwestern boundary located approximately 16 km (10 mi) from California. The town of Indian Springs and the Indian Springs Air Force Auxiliary Field, in northeast Clark County, NV, are 39 km (24.2 mi) southeast of the closest NTS boundary. All of the land within NTS is owned by the Federal Government and is administered, managed, and controlled by DOE. NTS is also entirely bordered by Federal land: the land to the west, north, and east consists of the Nellis Air Force Range; the land to the south is administered by the Bureau of Land Management.

Generalized land uses at NTS and its vicinity are shown in figure 4.9.2.1-1. NTS is divided into 3 major regions consisting of 26 areas. The northern region of NTS is the underground nuclear weapons test area. Nuclear test ranges are located at Yucca Flats, Pahute Mesa, Rainier Mesa, and Buckboard Mesa. The southwest region of NTS (Area 25) provides support for nonweapons and nonnuclear weapons programs, such as the proposed HLW repository at the Yucca Mountain Project Site. Area 25 also provides support for short-term activities such as the nuclear weapons accident exercises conducted by the Nuclear Emergency Search Team. The southeastern region is the nonnuclear test area and primary administrative and support area of NTS.

Land areas not used for missions or other purposes have been designated in the Nevada Site Development Plan as reserve areas, available for future development (NT DOE 1994d:7-8). Approximately 4,050 ha (10,000 acres) of reserve areas are present within Areas 5 and 6, which are located in Frenchman and Yucca Flats. Figure 4.9.2.1-2 identifies the primary facilities, A/D area, and testing areas at NTS.

The Device Assembly Facility, undergoing final construction, is designed to conduct all nuclear assembly operations at NTS in support of the Nuclear Weapons Test Program. Other nearby facilities include the DOD test area, explosives disposal area, radioactive waste management site, and the Spill Test Facility.

In l992, DOE designated the entire NTS as a National Environmental Research Park. The park is used by the national scientific community as an outdoor laboratory for research on the effects of human activities on the desert ecosystem. There is no prime farmland present on NTS. Offsite agricultural activity occurs on the south side of U.S. Route 95, consisting of a cattle allotment granted by the Bureau of Land Management.

The Timber Mountain Caldera National Natural Landmark is located approximately 11 km (6.8 mi) north-northwest of the Device Assembly Facility, separated by mountains to the west. A wilderness study area located within the Desert National Wildlife Refuge, which has been recommended for inclusion in the National Wilderness System, is approximately 12 km (7.5 mi) to the east. This part of the refuge is also a part of the Nellis Air Force Range; it is jointly managed by the U.S. Air Force and USFWS. Public entry to this portion of the refuge is generally prohibited by the Air Force. The closest offsite residence to the NTS boundary is approximately 2 km (1.2 mi) south, at the unincorporated town of Amargosa Valley.

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Land Use. NLVF occupies 32 ha (80 acres) in the city of North Las Vegas, NV, as shown in figure 4.9.2.1-3. NLVF is zoned for general industrial use and is bordered on the north, south, and east by general industrial zoning. The western border of the site is adjacent to Commerce Street, which separates the property from fully developed, single-family residential-zoned property (figure 4.9.2.1-4).

NLVF is divided into three distinct areas: the A, B, and C Complexes. Complex A covers 8 ha (20 acres) and houses support for the LLNL nuclear test program. Complex B covers 8 ha (20 acres) just south of Complex A and houses support for the LANL test program. Complex C, located west of A and B Complexes, covers 15.5 ha (38.3 acres) and houses a computer center and administrative and engineering support functions (appendix I).

4.9.2.2 Site Infrastructure

As shown in figure 4.9.2.1-1, activities at NTS are concentrated in facilities in several general areas. Section 3.2.9 describes the current NTS missions. To support these missions an infrastructure exists as shown in table 4.9.2.2-1.

Table 4.9.2.2-1.--Baseline Characteristics for Nevada Test Site

Characteristics	Current Value
Land	
Area (ha)	351,000
Roads (km)	640
Railroads (km)	0
Electrical	
Energy consumption (MWh/yr)	121,460
Peak load (MWe)	27.4
Fuel	
Natural gas (m^3/yr)	0
Liquid (L/yr)	5,716,000
Coal (t/yr)	0

NTS 1993a:4; NTS 1995a:1; NTS 1995a:2.

4.9.2.3 Air Quality

The following section describes the existing air quality at NTS and NLVF and includes a review of meteorology and climatology in the vicinity. More detailed discussions of air quality methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.3.9 and appendix I.

Meteorology and Climatology. The climate at NTS and in the surrounding region is characterized by limited precipitation, low humidity, and large diurnal temperature ranges. The lower elevations are characterized by hot summers and mild winters, which are typical of other Great Basin desert areas. As elevation increases, precipitation amounts increase and temperatures decrease (NT DOE 1986b:3-46).

The annual average temperature is 19.5 °C (67.1°F); the average daily minimum temperature is 0.9 °C (33.6°F) in January; and the average daily maximum temperature is 41.1 C (105.9°F) in July. The average annual precipitation at NTS is 10.5 cm (4.13 in) (NOAA 1994d:3). Prevailing winds at NTS vary by location. The annual average wind speed is 4.2 m/s (9.3 mph).

Ambient Air Quality. NTS is located within the Nevada AQCR 147. The region is designated as an attainment or unclassified area (40 CFR 81.329) with respect to the NAAQS. Applicable NAAQS and Nevada State ambient air quality standards are presented in appendix table B.3.1-1.

Two Prevention of Significant Deterioration Class I areas in the vicinity of NTS are Grand Canyon National Park, approximately 193 km (120 mi) to the southeast, and Sequoia National Park, California, approximately 169 km (105 mi) to the west-southwest of the site. Since the promulgation of Prevention of Significant Deterioration regulations (40 CFR 52.21) in 1977, no permits have been required for any emissions source at NTS.

The primary emission sources of criteria air pollutants at NTS include particulates from construction and other surface disturbances, fugitive dust from unpaved roads, various pollutants from fuel burning equipment, incineration, open burning, and volatile organics from fuel storage facilities. A summary of emission estimates for sources at NTS is presented in appendix table B.3.9-1.

Table 4.9.2.3-1 shows the site baseline ambient air concentrations for criteria pollutants and other pollutants of concern at NTS. No hazardous air pollutant or other toxic compound sources are indicated. Baseline concentrations are in compliance with applicable guidelines and regulations. Elevated levels of ozone or particulate matter may occur occasionally because of pollutants transported into the area by wind or because of local sources of fugitive particulates (NT DOE 1983a:30). Concentrations of other criteria pollutants (sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead) are low because there are no large emission sources nearby. The nearest significant emission source for criteria pollutants is the Las Vegas area, which is about 105 km (65 mi) southeast of NTS.

Table 4.9.2.3-1.--Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Nevada Test Site, 1990 to 1992

Pollutant	Averaging Time	Most Stringent Regulation or Guideline (mg/m3)	Baseline Concentration (mg/m3)
Criteria Pollutant			

Carbon monoxide	8-hour	10,000[1]	2,290
	1-hour	40,000[1]	2,748
Lead	Calendar quarter	1.5[1]	[2]
Nitrogen dioxide	Annual	100[1]	[2]
Ozone	1-hour	235[1]	[2]
Particulate matter[3]	Annual	50[1]	9.4
	24-hour	150[1]	106
Sulfur dioxide	Annual	80[1]	8.4
	24-hour	365[1]	94.6
	3-hour	1,300[1]	725
Mandated by Nevada			
Hydrogen sulfide	1-hour	112[4]	[2]

Source: 40 CFR 50; NT REEC O 1990a; NV DCNR 1995a

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Meteorology and Climatology. The climate at NLVF and the surrounding region has four well-defined seasons. Summers display desert conditions, with maximum temperatures usually in the 38 °C (100 °F) range. Winter daytime temperatures average near 15.5 °C (60 °F). Rainy days average less than one in June to three per month in the winter. The annual average temperature at NLVF is 19.1 °C (66.3 °F); average daily temperatures range from 6.9°C (44.5 °F) in January to 32.1 °C (89.8 °F) in July. The average annual precipitation is 106 millimeters (4.19 in). The prevailing winds are from the southwest at an annual average wind speed of 4.2 m/s (9.3 mph) (GRI 1992a). Additional information related to meteorology and climatology at NLVF is presented in appendix I.

Ambient Air Quality. NLVF is located within the Las Vegas Intrastate AQCR 13, which only includes Clark County. Portions of Clark County, including the NLVF site, are in nonattainment with the NAAQS for carbon monoxide, particulate matter, and TSPs (40 CFR 81.329). The Clark County Health District is responsible for air pollution control and attainment of air quality standards in Clark County. Applicable NAAQS and Clark County ambient air quality standards are presented in table 4.9.2.3-1. In addition to NAAQS for criteria pollutants, NLVF is subject to ambient air quality standards adopted by the Clark County Health District.

The Clark County Health District operates a network of ambient air monitoring stations in Clark County. The county monitor closest to NLVF is at the McDaniel Post Office at 1414 East Lake Mead Drive, approximately 1.9 km (1.2 mi) east of the proposed NIF location. Data for this and other monitors near NLVF are provided in appendix I. Table 4.9.2.3-1 presents the 1994 baseline ambient air concentrations for criteria pollutants and other pollutants at NLVF. As the table shows, all of the baseline concentrations are in compliance with the NAAQS.

Table 4.9.2.3-2.--Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at North Las Vegas Facility, 1994

Pollutant	Averaging Time	Most Stringent Regulation or Guideline (mg/m3)	Baseline Concentration[5] (mg/m3)
Criteria Pollutant			
Carbon monoxide	8-hour	10,000[6]	8,635
	1-hour	40,000[6]	13,456
Lead	Calendar quarter	1.5[6]	[7]
Nitrogen dioxide	Annual	100[6]	53
Ozone	1-hour	235[6]	192
Particulate matter	Annual	50[6]	47
	24-hour	150[6]	117
Sulfur dioxide	Annual	60[8]	[7]
	24-hour	260[8]	[7]
	3-hour	1,300[6]	[7]
Mandated by Nevada			
Hydrogen sulfide	1-hour	112[9]	[7]

4.9.2.4 Water Resources

This section describes the surface and groundwater resources at NTS and NLVF.

Surface Water. Surface water is not used at NTS. There are no perennial streams on NTS. The most noticeable natural hydrologic features are the playas (lake beds) that collect stormwater runoff. Runoff in the eastern half of the site ultimately collects in the playas of Yucca Flat and Frenchman Flat. In the northeastern portion, the runoff drains outside the test site and onto the Nellis Air Force Range Complex. In the western half and southernmost part, runoff is carried offsite towards the

Amargosa Desert. Figure 4.9.2.4-1shows the locations of the playas and flats. A few natural springs can be found at NTS.

Because there are no continuously flowing surface waters, there are no studies to assess 500-year floodplain boundaries. Two 100-year flood analyses have been conducted. These analyses show no runoff from a 100-year storm adversely affecting the proposed project areas. However, the proposed project areas are in a region where flash flooding occurs due to locally isolated intense convection storms. These floods normally last less than 6 hours.

Surface Water Quality. There are no NPDES permits for the site because there are no wastewater discharges to onsite or offsite surface waters. However, the state has issued sewage discharge permits for sewage lagoons and ponds for NTS facilities. Because there are no surface waters at or near the proposed project areas, and because there will be no withdrawal or discharge to natural surface waters at NTS, the assessment of surface water quality is not applicable.

Surface Water Rights and Permits. Surface water rights are not an issue because NTS facilities do not withdraw surface water for use, nor do they discharge effluents directly to natural surface waters.

Groundwater. NTS is located within three groundwater subbasins of the Death Valley Groundwater Basin (NT DOE 1994b:9-2). Groundwater beneath the eastern portion of NTS is located in the Ash Meadows Subbasin; the western portion is located in the Alkali Flat Furnace Creek Ranch Subbasin; and a small part of the northwestern corner is located in the Oasis Valley Subbasin (figure 4.9.2.4-1). The proposed project area is situated over the Ash Meadows Subbasin. Three primary aquifers are present within the Ash Meadows Subbasin: the Lower Carbonate (the deepest), the Volcanic, and the Valley-Fill (the shallowest) (NT DOE 1994b:2-13). Other aquifers are present to a limited extent under the area, but their water bearing potential has not been thoroughly investigated. Limited aquifers may occur in other volcanic units, including lava flows and bedded tuffs.

The Lower Carbonate is the regional aquifer and comprises carbonate rocks of Middle Cambrian through Devonian age. The saturated thickness ranges from 100 to over 1,000 m (328 to over 3,280 ft). This aquifer drains in a south-southwest direction, under Yucca and Frenchman Flat, toward Ash Meadows (NT USGS 1975a:C1). The Volcanic and Valley-Fill aquifers range in thickness from zero to about 610 m (2,000 ft) and are confined to their respective drainage basin (such as Frenchman and Yucca Flats) (NT DOE 1992d).

Depth to groundwater at NTS ranges from 160 m (515 ft) beneath Frenchman Flat to over 700 m (2,300 ft) at Pahute Mesa. There are, however, areas of perched water that lie at considerably shallower depths.

Estimates of the perennial yield of the NTS aquifers (i.e., the total amount that can be removed on an annual basis without depleting the groundwater reservoir) include 57,000 MLY (15,058 MGY) (NT USGS 1988a) and 38,000 MLY (10,039 MGY) (NT DOE 1992b:41-43). Groundwater recharge occurs from infiltration of precipitation in the northern and eastern mountain ranges and from underflow from upgradient areas. Natural discharge from the aquifers primarily occurs from evaporation and transpiration in the Amargosa Valley (including Ash Meadows) and Death Valley areas (figure 4.9.2.4-1).

Groundwater pumping at Ash Meadows was curtailed by order of the U.S. Supreme Court to protect the endangered pupfish *Cyprinodon* by maintaining water levels at Devils Hole. Devils Hole is a water-filled cavern near Ash Meadows, approximately 48 km (29.8 mi) southwest of NTS (latitude 36°25'40", longitude 116°18'13"). Studies show that historical pumping on NTS at rates that exceed current rates was probably unrelated to observed declines at Devils Hole (NT LVVWD 1994a). Springs at Ash Meadows nearby contain a large concentration of rare, endangered, and threatened indigenous species which depend upon adequate spring flow for their survival. Substantially increased pumping at NTS is unlikely to lower spring levels but might reduce spring discharge rates (NTS 1995a:1).

Groundwater Quality. Currently, aquifers beneath NTS have not been classified by EPA. However, during an independent study (NT DOE 1989a:ii-v) the aquifers beneath NTS were classified as Class IIa and Class IIb (groundwater currently used for drinking water). In 1972, the Nevada Operations Office instituted a long-term hydrological monitoring program to be operated by EPA under an Interagency Agreement. Groundwater is monitored at and in the vicinity of NTS to detect any radioactivity that may be related to previous nuclear testing activities. Only wells drilled previously for water supply or exploratory purposes are being used in the existing monitoring program. In compliance with the *SDWA* and a State of Nevada DrinkingWater Supply System Permit, drinking water wells and industrial use distribution systems are sampled and analyzed on a monthly basis. Groundwater samples collected are analyzed for a standard suite of parameters and constituents, including radioactive materials, nonradioactive materials, and other field parameters (pH and total dissolved solids).

Groundwater at portions of NTS has been affected by nuclear testing activities conducted during the last 43 years. Approximately 20 percent of the total underground nuclear tests have been conducted below the water table or have been close enough that effects have extended below it. Table 4.9.2.4-1 shows the 1993 groundwater quality in the vicinity of the proposed project site. In general, tritium is the only radionuclide that appears at significant levels in sampled groundwater. Samples collected in 1993 show tritium concentrations ranging from 120 pCi/L in a nonpotable supply well located in the northwestern part of NTS to 0.93 pCi/L in a potable supply well located in the southeastern part of NTS. It is speculated that the Lower and Upper Carbonate aquifers would most likely be the aquifers in which tritium might migrate to offsite areas.

Table 4.9.2.4-1.--Groundwater Quality Monitoring at Nevada Test Site, 1993

			Potable Water Distribution System	
Parameter	Unit of Measure	Water Quality Criteria and Standards[10]	High	Low

Radiological				
Alpha (gross)	pCi/L	15[11]	11	0.62
Beta (gross)	pCi/L	50[12]	13	3.2
Tritium	pCi/L	80,000[12]	120	0.93
Nonradiological				
Alkalinity	mg/L	NA	270	64
Arsenic	mg/L	0.05[11]	0.012	0.003
Barium	mg/L	2.0[11]	0.15	0.00
Chromium	mg/L	0.1[11]	<0.005[12]	<0.005[12]
Lead	mg/L	0.015[11]	<0.005[12]	<0.005[12]
Nitrate	mg/L	10 [11]	6.8	1.2
pH	pH units	6.5-8.5[12]	8.66	7.70
Sodium	mg/L	NA	103	30
Total dissolved solids	mg/L	500[12]	639	283

Groundwater Availability, Use, and Rights. Groundwater is the only local source of industrial and drinking water supplies in the NTS area. Numerous production wells are located on NTS and distributed among various areas of the site. Figure 4.9.2.4-1 shows how the NTS water system has been divided into four water service areas (A, B, C, and D) based on the location of the water supply system and support facilities. Water usage on NTS is largely for potable, construction, and dust control purposes. Water supply wells at NTS draw water from the Lower and Upper Carbonate, the Volcanic, and the Valley Fill aquifers. The total water usage in 1994 was 2,400 MLY (634 MGY), of which 1,300 MLY (343 MGY) were withdrawn from the Ash Meadows Subbasin, and 1,100 MLY (290 MGY) were withdrawn from the Alkali Flat Furnace Creek Ranch Subbasin (figure 4.9.2.4-1). The pumping capacity for all the water supply wells at NTS is estimated at 14,800 MLY (3,910 MGY).

The State of Nevada strictly controls all surface and groundwater withdrawals. The Appropriation Doctrine governs the acquisition and use of water rights. NTS has been withdrawn from public use and thus possesses an unquantified water right sufficient to meet the purposes of NTS land withdrawal, subject to water rights that existed at the time land for NTS was withdrawn.

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NLVF is located in the Las Vegas Valley, which is a desert between sharp, rugged mountain ranges on a gently sloping alluvial fan piedmont. At the lowest point of the alluvial fan is the Las Vegas Wash, which drains an area of 2,280 km^2 (880 mi^2) toward Lake Mead. Stormwater from NLVF is discharged into local flood control systems (appendix I).

The water supply for NLVF is provided by the city of North Las Vegas. Current water usage by NLVF is about 69 MLY (18.2 MGY) (appendix I). Industrial wastewater and sanitary sewage from NLVF are discharged into the city of North Las Vegas sewer system, which is connected to the city of Las Vegas treatment plant. The treated wastewater is discharged into Lake Mead under an NPDES permit issued by the Nevada Division of Environmental Protection (appendix I). NLVF discharges an average of 55 MLY (14.5 MGY) of wastewater. Wastewater quality has historically met the permit requirement established by the city to protect the treatment processes and ultimately the water quality of Lake Mead (appendix I).

4.9.2.5 Geology and Soils

Geology. NTS is located in the southern part of the Great Basin section of the Basin and Range Province in an intermediate position between the high, topographically closed basins in central Nevada and the low, connected basins of the Amargosa Desert-Death Valley region to the southwest. NTS consists of three flats (Yucca, Jackass, and Frenchman) surrounded by mountains (NT DOE 1988a:3-116). The general geology of the test site comprises three major rock units: complexly folded and faulted sedimentary rocks of Paleozoic age overlain at many places by volcanic tuffs and lavas of Tertiary age, which in the valleys are covered by an alluvium of late Tertiary and Quaternary age that was derived from erosion of the nearby hills of Tertiary and Paleozoic rocks (NT ERDA 1977a:2-40).

The general region has been tectonically active in the near past and has numerous faults (figure 4.9.2.5-1). NTS lies in an area of moderate historic seismicity on the southern margin of the Southern Nevada East-West Seismic Belt in seismic Zones 2 and 3 (figure A.1-1). Since about 1848, more than 4,000 earthquakes have been recorded within a 241-km (150-mi) radius of NTS. Most of these earthquakes were minor events with Richter magnitudes of less than 5.5. The largest event on record, which took place 161 km (100 mi) west in Owens Valley, CA, had an estimated magnitude of 8.3. In 1992, an earthquake of 5.6 magnitude occurred in the southwest corner of the site under Little Skull Mountain. The maximum acceleration from this earthquake was approximately 0.21 G (G is the acceleration due to gravity) at Amargosa Valley (DOE 1995i:4-117).

The Yucca and Carpetbag faults were active during the late Quaternary. The Yucca fault has undergone surface rupture within the past few thousand to tens of thousands of years. Some earthquakes can be directly associated with the fault trace and the area beyond the southern end of the mapped section in the Yucca Pass, suggesting that the fault may continue in that direction. No significant vertical surface displacement has occurred on the Carpetbag fault system during the past 150,000 years, but there is evidence of episodes of fracturing and possible minor faulting from 30,000 to 240,000 years ago, with average recurrence intervals at about 25,000 years for the last 125,000 years (NT DOE 1988e:30-31). The Carpetbag fault has been mapped in the subsurface beyond the southern end of Yucca Basin and may project to the northeast of the proposed project area. Possible magnitude, intensity, and acceleration of earthquakes along the Yucca and Carpetbag faults have not been estimated (DOE 1995i:4-117).

The Cane Spring fault, which lies approximately 8 km (5 mi) south of the proposed project area, does not show Holocene displacement but is thought to have been the source of a magnitude 4.3 earthquake in 1971. The maximum credible earthquake associated with the Cane Spring fault is expected to produce a peak acceleration of 0.67 G with a 6.7 magnitude (DOE 1995i:4-117). The recurrence interval is estimated at 10,000 to 30,000 years.

The most recent volcanic activity in the immediate area was 3.7 million years ago, and the likelihood for renewed activity in the next 10,000 years is slight (DOE 1995i:4-117). NTS lies approximately 241 km (150 mi) southeast of the Long Valley area of California, an area with potential volcanic eruption of the Mount St. Helens type.

Soils. Limited soil studies have been performed at NTS. Soil studies (borings) were done for the Device Assembly Facility. Studies in adjacent areas have divided soils into three major types: shallow soils developed in the uplands and mountains; soils on valley fill and nearly level to moderately sloping outwash plains, alluvial fans, and fan aprons; and playas and soils on nearly level flats and basins. Possible erosion hazards range from slight to severe, while the shrink-swell potential ranges from low to high for these soils. The potential for wind erosion and shrink-swell increases into the playas and basins. The potential for water erosion increases with increasing slope. The soils at NTS are considered acceptable for standard construction techniques. There is no prime farmland at NTS.

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NLVF is located within the Las Vegas Valley. Rugged mountain ranges surround the low lying alluvial filled valley. The valley consists primarily of fine grained Miocene and Pliocene sedimentary rocks. NLVF is located within seismic Zone 2 (figure A.1-1). The soils on NLVF range from stiff to very stiff silty and sandy clay and clay with interbedded medium-dense to dense clayey and silty sand. The soils at NLVF are considered acceptable for standard construction techniques.

4.9.2.6 Biotic Resources

The following section describes biotic resources at NTS and NLVF including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Also presented in appendix C is a list of the threatened and endangered species that may be found onsite or in the vicinity of NTS.

Terrestrial Resources . NTS lies in a transition area between the Mojave and Great Basin deserts. As a result, flora and fauna characteristic of both deserts are found within the site boundaries (NT ERDA 1976a:34). Approximately 33 km^2 (12.7 mi^2) of NTS have been developed, which represent less than 1 percent of the site; thus, natural plant communities are found across most of NTS (NT DOE 1988d:3,4,6,7). The site has been divided into nine major communities as shown in figure 4.9.2.6-1. Of the communities present onsite, the mountains, hills and mesas, sagebrush, creosote bush, and hopsage-desert thorn communities are the most extensive. Saltbush and desert thorn communities occupy more limited areas adjacent to the playas in Frenchman and Yucca Flats. Introduced plants such as red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), and Russian thistle (*Salsola kali*) have become important species in some areas. These plants rapidly invade disturbed areas and delay revegetation of areas by native species (NT ERDA 1976a:40; NT Hunter 1991a:1). A total of 711 taxa of vascular plants has been identified on or near NTS (NT ERDA 1976a:34).

Terrestrial wildlife found on NTS includes 33 species of reptiles, 222 species of birds, and 49 species of mammals (NT Greger 1992a; NTS 1990a:1; NTS 1990a:2). Species common to NTS include the side-blotched lizard (*Uta stansburiana*), western shovel-nosed snake (*Chionactis occipitalis*), blackthroated sparrow (*Amphispiza bilineata*), red-tailed hawk (*Buteo jamaicensis*), Merriam's kangaroo rat (*Dipodomys merriami*), and Great Basin pocket mouse (*Perognathus parvus*). Water holes, both natural and manmade, are important to many species of wildlife, including game animals such as pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) (NT Greger nda). Hunting is not permitted anywhere on NTS. Raptors and carnivores are two ecologically important groups on NTS and are represented by species such as the turkey vulture (*Cathartes aura*) and rough-legged hawk (*Buteo lagopus*), and long-tailed weasel (*Mustela frenata*) and bobcat (*Lynx rufus*), respectively. A variety of migratory birds has been found at NTS. Migratory birds and their nests and eggs are protected by the *Migratory Bird Treaty Act* . Eagles are similarly protected by the *Bald and Golden Eagle Protection Act* .

The proposed NIF site would be located in an area of creosote bush habitat to the west of the Mercury Base Camp (figure 4.9.2.6-1). Wildlife present in the site area would include that associated with the Mojave desert and could include Merriam's kangaroo rat, Le Conte's thrasher (*Toxostoma lecontei*), and desert iguana (*Dipsosaurus dorsalis*).

Wetlands . National Wetland Inventory maps of NTS have not been prepared nor have wetlands been delineated on the site. However, small riparian areas (less than 0.4 ha [1.0 acres]) may be associated with site springs. There are no wetlands on or near the proposed NIF site (appendix I).

Aquatic Resources . Potential aquatic habitat on NTS includes surface drainages, playas, springs, and manmade reservoirs. There are no continuously flowing streams on the site, and permanent surface water sources are limited to a few small springs. These surface drainages, playas, and springs are unable to support permanent fish populations (DOE 1995w:2.4-61). Manmade construction water reservoirs located throughout the site support three introduced species of fish: bluegill (*Lepomis macrochirus)* , goldfish (*Carassius auratus*), and golden shiners (*Notemigonus crysoleucas*) (NTS 1992a:6). There are no aquatic resources on or near the proposed NIF site (appendix I).

Threatened and Endangered Species . *Nine* Federal- and state-listed threatened, endangered, and other special status species may be found in the vicinity of NTS (appendix table C-7). Eight of these species have been observed on NTS, seven of which are listed as either Federal- or state-threatened or endangered species. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on NTS.

The Federal-listed bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*) have been recorded as rare migrants on NTS, but the desert tortoise (Gopherus agassizii) is the only resident Federal-listed species known to inhabit NTS. The range of the desert tortoise lies in the southern third of NTS. Tortoises on NTS are most commonly found in the areas shown in figure 4.9.2.6-1. Further surveys may reveal other areas of concentration. The abundance of tortoises on NTS is considered low to very low relative to other areas within this species' geographic range. Densities of tortoises on NTS range from 0 to 17 individuals per square km (0 to 45 individuals per square mile), with most habitats probably having densities of 0 to 8 individuals per square km (0 to 20 individuals per square mile) (NT DOE 1991b:3-23).

The only known population of the Devils Hole pupfish (*Cyprinodon diabolis*) lives in a single, spring-fed sinkhole pool in Ash Meadows, approximately 48 km (29.8 mi) southwest of the proposed project area. There is concern over the survival of the pupfish and other sensitive species found in the Ash Meadows area due to the threat of declining water levels (NT DOI 1991a:*1*,*4*-*6*). Several additional state-listed species have been recorded on NTS. These species include the spotted bat (*Euderma maculatum*), Beatley milkvetch (*Astragalus beatleyae*), and Mojave fishhook cactus (*Sclerocactus polyancistrus*). The Federal-candidate mountain plover has also been observed on NTS (appendix table C-7).

The proposed NIF location contains habitat suitable for several special status species. The desert tortoise is the only Federal-listed species known to inhabit the area. A site-specific survey may be required to verify the existence of special status species.

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Terrestrial Resources. NLVF is in the Southern Basin and Range Ecoregion (see appendix I). NLVF was built on cleared, previously disturbed land that is now mostly covered by buildings, pavement, or landscaping. Exceptions include about 4.5 ha (11 acres) of undeveloped land at the western end of the facility (designated area for proposed new construction associated with NIF), the open area west of the Building C-3, and the stormwater detention basin south of the Building C-1. No original undisturbed native vegetation remains on the site (see appendix I).

Because NLVF is located in an urbanized area and contains little vegetation, few wildlife species exist. The only species that exist are those adapted to urban habitats which may include small mammals such as house mouse (*Mus musculus*) and Norway rat (*Rattus norvegicus*); and ubiquitous bird species such as American robin (*Turdus migratorius*), European starling (*Sturnus vulgaris*), house finch (*Carpodacus mexicanus*), house sparrow (*Passer domesticus*), and rock dove (*Columba livia*) (see appendix I).

Threatened and Endangered Species. Because NLVF is located within urban Las Vegas, and on previously disturbed land within a fenced site, it is not expected that any threatened, endangered, or rare species exist. No designated critical habitats for Federal-listed species exist at NLVF. The facility is within the range of the Federal-listed desert tortoise; however, urbanized areas of Clark County are not considered tortoise habitat. No desert tortoises were found during an offsite survey of undeveloped land located near the western boundary of NLVF (see appendix I).

4.9.2.7 Cultural and Paleontological Resources

Prehistoric Resources*. Approximately 6 percent of NTS has been inventoried for cultural resources including all lands managed through a Memorandum of Agreement with Nellis Air Force Base. Excluding sites in the Yucca Mountain project area, over 1,600 prehistoric sites have been recorded at NTS. Prehistoric site types identified on NTS include habitation sites with wood and brush structures, windbreaks, rock rings, and cleared areas; rockshelters; petroglyphs (rock art); hunting blinds; rock alignments; quarries; temporary camps; milling stations; roasting ovens or pits; water caches; and limited activity locations. Milling stations are especially prevalent near the Yucca Lake playa margins. Several prehistoric rockshelters have been identified on Hogback Ridge.*

At Frenchman Flat, in which the proposed A/D site would be located, 99 archaeological sites have been identified to date, including 2 historic sites and 2 sites related to nuclear testing (NT DOE 1996c:4-190). Forty-nine of these sites have been determined to be NRHP eligible, and a historic district composed of structures related to the development of nuclear weapons has also been proposed. Cultural resources surveys were conducted around the A/D site in 1984. No significant archaeological sites were found.

The proposed NIF would be located in Area 22. Only three prehistoric sites have been identified in Area 22, or Mercury Valley, and none are NRHP eligible. An archaeological survey was conducted at the proposed location and several scatters of debris were identified on the surface. These are not considered eligible for the NRHP.

Historic Resources*. Historic site types on NTS include mines and prospects, trash dumps, settlements, campsites, ranches, homesteads, developed spring heads, trails, and roads. Nuclear test site structures and associated debris, including instrumentation stands and temporary storage bunkers, are also located within NTS. The test site area at Frenchman Flat, which includes the remains of many of these structures, has been recommended to the SHPO as a Historic District. Excluding the Yucca Mountain project area, 63 historic sites, including 7 associated with nuclear testing, have been recorded. One historic site was identified in Mercury Valley, but is not NRHP eligible. The only site currently listed on the NRHP is Sedan Crater. The Crater, located in Yucca Flat, was created in 1962 as part of the Plowshare Program, whose aim was to identify peaceful uses for nuclear explosions. The Emigrant Trail used by the "49ers" that traverses the southwestern corner of NTS is considered NRHP eligible. Additional historic sites may occur on unsurveyed portions of NTS.*

Native American Resources*. At the time of European American contact, southern Nevada was inhabited by the Western Shoshone, the Southern Paiute, and the Owens Valley Paiute. Families lived in small groups from the spring through the fall. During winter, relatively stable villages of several families were established in relatively warm places, close to reserves of pine nuts, seeds, and dried meats.*

Native American resources include burials, ceremonial sites, musical stones, medicine rocks, petroglyphs, and traditional use areas. Local plants important in traditional and religious activities *include jimsonweed, juniper, greasewood, creosote, Indian tobacco, piñon pine, buckbush, and scrub oak. Concern has been expressed about the availability and accessibility of such resources. It is worth noting that many natural resources at NTS are viewed as cultural resources by Native Americans. As an example, sagebrush is used as a tool and for clothing and medicinal purposes. Both Mercury Valley and Frenchman Flat contain a wide variety of plants and animals significant to Native Americans.*

Consultation with Native American cultural and religious leaders has been conducted for other projects at or near NTS to identify traditional cultural resources that may be affected by Federal actions, and to obtain Native American recommendations for mitigating potential adverse impacts on traditional cultural resources. DOE has established ongoing consultation with 17 Native American tribal organizations with cultural ties to NTS. According to these groups, no Native American resources have been identified in the proposed NIF location.

***Paleontological Resources**. The surface geology of NTS is characterized by alluvium-filled valleys surrounded by ranges composed of Paleozoic sedimentary rocks and Tertiary volcanic tuffs and lavas. The Pre-Cambrian and Paleozoic rocks at NTS represent relict deposits made in shallow water at the submerged edge of a continental platform which ran from Mexico to Alaska and existed throughout most of the Paleozoic. Although the Pre-Cambrian sedimentary deposits contain no fossils or only a few poorly preserved fossils, the Paleozoic marine limestones are moderately to abundantly fossiliferous. Marine fossils found in the same Paleozoic formations on Nellis Air Force Range, adjacent to NTS to the north, include trilobites, conodonts, ostracods, solitary and colonial corals, brachiopods, algae, gastropods, and archaic fish. These fossils, however, are relatively common and have low research potential.*

Tertiary volcanic deposits are not expected to contain fossils; however the Late Pleistocene terrestrial vertebrate fossils of the Rancholabrean Land Mammal Age could be expected in the Quaternary deposits. The possibility of finding mammoth, horse, camel, and bison remains might be expected because such fossils have been found at Tule Springs, 56 km (34.8 mi) from the southern edge of NTS and in Nye Canyon. Fossils found at Tule Springs include bison, deer, a small donkey-like horse, camel, Columbia mammoth, ground sloth, giant jaguar, bobcat, coyote, muskrat, and a variety of rabbits, rodents, and birds. This paleontological assemblage has high research potential. Although Quaternary deposits with paleontological materials may occur on NTS, no known fossil localities have been recorded to date.

Other Pleistocene resources include pack rat middens, which are studied by scientists at the University of Nevada, Reno, the Desert Research Institute, and New Mexico Tech, to investigate paleoclimatic regimes. No paleontological resources are expected to exist within the area proposed for the NIF, as the geology in that area does not contain fossiliferous deposits.

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Although a historic site (Kyle Ranch) is located less than 1.6 km (1 mi) southwest of the proposed NIF location, no archaeological remains (prehistoric or historic) are likely to be present because of *the heavy past disturbance of the surface and near-surface sediment (NT DOE 1996c:4-746). Lower lying deposits that are relatively undisturbed are too ancient to contain archaeological remains. No historic structures exist in the proposed NIF location. No Native American cultural resources have been identified at NLVF in the course of past consultation with potentially affected tribal organizations.*

4.9.2.8 Socioeconomics

Socioeconomic characteristics addressed at NTS and NLVF include employment and regional economy, population, housing, and public finance. Statistics for employment and regional economy are presented for the regional economic area that encompasses 11 counties around NTS and NLVF in Arizona, Nevada, and Utah. Statistics for population, housing, and public finance are presented for the ROI, a two-county area in which 97 percent of all NTS employees reside: Clark County (82 percent) and Nye County (15 percent). The residential distribution of NLVF employees follows a similar pattern, with the vast majority of employees residing in these two counties. As a result, both DOE facilities occupy the same ROI and regional economic area. Figure 4.9.2.8-1 presents a map of the counties and selected cities that comprise the NTS and NLVF regional economic area and ROI. Supporting data are presented in appendix D.

Regional Economy Characteristics. *Selected employment and economic statistics for the NTS and NLVF regional economic area are summarized in figure 4.9.2.8-2. The civilian labor force grew 64 percent between 1980 and 1990, an annual average of 6.4 percent. Total employment in the region was 587,533 in 1994. During 1994, unemployment in the regional economic area was 6.1 percent, comparable to state unemployment in Arizona (6.4 percent) and Nevada (6.2 percent), but higher than in Utah (3.7 percent). The 1993 regional economic area per capita income of $20,561 was almost 9 percent lower than Nevada's per capita income of $22,727, but significantly higher than the per capita income in Arizona ($18,085) and Utah ($16,354).*

As shown in figure 4.9.2.8-2, the NTS regional economic area and Nevada have similar employment patterns. In both the region and the state, the service sector accounts for over 40 percent of the total employment. In Utah and Arizona, services account for about a third of employment, with manufacturing providing a greater source of employment in these states than in Nevada.

Population and Housing *. The ROI population, which totalled 865,144 in 1992, increased by about 83 percent (6.9 percent annually) from the 1980 level, a rate of increase that exceeded the state annual population growth rate of about 5 percent during the same period. Some cities within the ROI grew at even faster rates; the city of Henderson, for example, increased at an average annual rate of over 20 percent between 1980 and 1992.*

Increases in housing units averaged approximately 7 percent annually in the ROI between 1980 and 1990, greater than the approximately 3-percent annual increase for Nevada. The homeowner vacancy rate in the ROI averaged 3 percent in 1990, while the vacancy rate for rental units averaged 10 percent. Both rates were comparable to Nevada's vacancy rates. Population and housing statistics for the ROI are summarized in figure 4.9.2.8-3.

Public Finance. *Financial characteristics of the local jurisdictions in the NTS ROI that are most likely to be affected by the proposed action are presented in this section. The data reflect total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.2.3-14 and D.2.3-15. Figure 4.9.2.8-4 summarizes 1994 local government revenues and expenditures. Fund balances, which are dollars carried over from previous years, are not included in figure 4.9.2.8-4. All jurisdictions assessed had positive fund balances.*

4.9.2.9 Radiation and Hazardous Chemical Environment

The following section provides a description of the radiation and hazardous chemical environments at NTS and NLVF. Also included are discussions of health effects studies, emergency preparedness considerations, and an accident history.

Radiation Environment. Major sources of background radiation exposure to individuals in the vicinity of NTS are shown in table 4.9.2.9-1. All annual doses to individuals from background radiation are expected to remain constant over time. The total dose to the population changes as population size changes. Background radiation doses are unrelated to NTS operations.

Table 4.9.2.9-1.-- Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Nevada Test Site Operations

Source	Committed Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic and cosmogenic radiation[13]	74
Internal terrestrial radiation[14]	39
Radon in homes (inhaled)[14]	200
Other Background Radiation[14]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10

Total	378

Releases of radionuclides to the environment from NTS operations provide another source of radiation exposure to individuals in the vicinity of NTS. The radionuclides and quantities released from NTS operations in 1993 are listed in the U.S. Department of Energy Nevada Operations Office Annual Site Environment Report-1993 (DOE/NV/11432-123). The doses to the public resulting from these releases are presented in table 4.9.2.9-2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment's (No Action) radiological releases at NTS in 2005 (section 4.9.3.9).

Table 4.9.2.9-2.--Doses to the General Public from Normal Operation at Nevada Test Site, 1993 (Committed Effective Dose Equivalent)

	Atmospheric Releases		**Liquid Releases**		**Total**	
Affected Environment	**Standard[15]**	**Actual**	**Standard[15]**	**Actual**	**Standard[15]**	**Actual**
Maximally exposed individual (mrem)	10	0.0048	4	0.0	100	0.0048
Population within 80 kilometers[16](person-rem)	None	0.012	None	0.0	100	0.012
Average individual within 80 kilometers[17] (mrem)	None	$5.5\text{x}10^{-4}$	None	0.0	None	$5.5\text{x}10^{-4}$

Based on a dose-to-risk conversion factor of 500 cancer deaths per 1 million person-rem (5x10-4 fatal cancers per person-rem) to the public (appendix E), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from NTS operations in 1993 is estimated to be 2.4x10-9. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of NTS operations is about 2 chances in 1 billion. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Based on the same conversion factor, 6.0x10-6 excess fatal cancers are projected in the population living within 80 km (50 mi) of NTS from normal operation in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers from all causes expected during 1993 in the population living within 80 km (50 mi) of NTS was 44. This number of expected fatal cancers is much higher than the estimated 6.0x10-6 fatal cancers that could *have resulted from NTS operations in 1993.*

Workers at NTS receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.9.2.9-3 includes the average, maximum, and total occupational doses to NTS workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a dose-to-risk conversion factor of 400 fatal cancers per 1 million person-rem (4x10-4 fatal cancers per person-rem) among workers (appendix E), the number of excess fatal cancers to NTS workers from operations in 1992 is estimated to be 0.0008.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the U.S. Department of Energy Nevada Operations Office Annual Site Environment Report-1993 (DOE/NV/11432-123). The concentrations of radioactivity in various environmental media (e.g., air and water) and in animal tissue in the site region (onsite and offsite) are also presented in the same reference.

Table 4.9.2.9-3.--Doses to the Onsite Worker from Normal Operation at Nevada Test Site, 1992

Affected Environment	**Onsite Releases and Direct Radiation**	
	Standard[18]	**Actual**[19]
Average worker (mrem)	None	2.6
Maximally exposed worker (mrem)	5,000	750
Total workers (person-rem)	None	2.0

Chemical Environment. *The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in sections 4.9.2.3 and 4.9.2.4.*

Adverse health impacts to the public can be minimized through administrative and design controls to decrease hazardous chemical releases to the environment and to achieve compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at NTS via inhalation of air containing hazardous chemicals released to the atmosphere by NTS operations. Risks to public health from ingestion of contaminated drinking water or direct exposure are also potential pathways.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in section 4.9.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are compared with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in appendix E.

Exposure pathways to NTS workers during normal operation may include inhaling the workplace atmosphere, drinking NTS potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. NTS workers are also protected by adherence to OSHA and EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operation processes, ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at NTS are expected to be substantially better than required by standards.

Health Effects Studies. *Several epidemiological studies have been conducted to investigate possible adverse health effects of low-level radioactive fallout on residents of Nevada and Utah. A mortality study of Utah children conducted by Lyon et al. investigated the relationship between childhood leukemia and radioactive fallout and found a significant excess of leukemia among children who died during the high fallout period (between 1951 and 1958) compared to those who died during the low fallout periods (between 1944 and 1950 and between 1959 and 1975). A followup to the Lyon et al. study conducted by Beck and Krey found that bone doses of southern Utah residents were too low to account for the excess leukemia deaths.*

A nonstatistically significant excess of thyroid neoplasm was reported among children living near the nuclear testing sites (Utah/Nevada) when compared to a group living in Arizona (HP 1990c:739-746).

An excess number of leukemia cases were observed among men who participated in military maneuvers in August 1957. No excess in "total cancers" was observed but four cases of polycythemia vera were reported where 0.2 were expected (JAMA 1984a:662-664). For a more detailed description of the studies and the findings, refer to appendix section E.4.7.

Accident History. *Nuclear testing began at NTS in 1951. There were some 100 atmospheric nuclear explosions before the Limited Test Ban Treaty was implemented in 1973. Since then, all nuclear tests have been conducted underground.*

Since 1970, there have been 126 nuclear tests that released approximately 54,000 Ci (2,000 TBq) of radioactivity to the atmosphere. Of this amount, 11,500 Ci (430 TBq) were accidental due to containment failure (massive releases or seeps) and late-time seeps. (Seeps are small releases after a *test when gases diffuse through pore spaces of the overlying rock.) The remaining 42,500 Ci (1,600 TBq) were operational releases. From the perspective of human health risk, if the same person had been standing at the boundary of NTS in the area of maximum concentration of radioactivity for every test since 1970, that person's total exposure would be equivalent to 32 extra minutes of normal background exposure, or the equivalent of one-thousandth of a single chest x ray (OTA 1989a).*

***Emergency Preparedness**. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response. The NTS Emergency Preparedness Plan is designed to minimize or mitigate the impact of any emergency upon the health and safety of employees and the public. The plan integrates all emergency planning into a single entity to minimize overlap and duplication and to ensure proper responses to emergencies not covered by a plan or directive. The manager of the Nevada Operations Office has the responsibility to manage, counter, and recover from an emergency occurring at NTS.*

The plan provides for identification and notification of personnel for any emergency that may develop during operational and nonoperational hours. The Nevada Operations Office receives warnings, weather advisories, and any other communications that provide advance warning of a possible emergency. The plan is based upon current Nevada Operations Office vulnerability assessments, resources, and capabilities regarding emergency preparedness.

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NLVF provides calibration services using specialized radiation fields for a variety of instrument test packages in support of DOE Nevada operations. A detailed discussion of the radiation environment, including background, radiological releases, and doses to members of the public are presented in the U.S. Department of Energy Nevada Field Office Annual Site Environmental Report-1993 (DOE/NV/11432-123, September 1994). The concentrations of radioactivity in various environmental media (i.e., air, water, and soil) in the site region and the dose to onsite workers at NLVF are also presented in that reference.

Table 4.9.2.9-4.--Annual Doses to the General Public and Onsite Workers from Normal Operation at North Las Vegas Facility, 1993

Receptor	Atmospheric Releases		Liquid Releases		Total		
	Regulatory Limit[20]	Calculated	Regulatory Limit[20]	Calculated	Regulatory Limit[20]	Calculated	Risk[21]
Individual Dose							

Average exposed individual (mrem)	10	0.0[22]	4	0.0	100	0.0	0.0
Maximally exposed individual (mrem)	10	0.0[23]	4	0.0	100	0.0	0.0
Population Dose							
Population within80 kilometers (person rem)	[23]	0 .0[22]	[23]	0.0	[23]	0.0	0.0
Worker Dose							
Average worker (mrem)	NA[24]	0 .0	NA[24]	0.0	5,000	82	$3.3x10^{-5}$
Maximally exposed worker (mrem)	NA[24]	0 .0	NA[24]	0.0	5,000	440	$1.8x10^{-4}$
Total workers[25] (person-rem)	NA[24]	0 .0	NA[24]	0.0	None	0.57	$2.3x10^{-4}$

Calculated radiological doses are used to estimate the potential health impacts to the public and onsite workers at NLVF from any releases of radioactivity. Small atmospheric releases occurred on July 12 and August 14, 1995. The dose to a maximally exposed individual and to the surrounding population from these releases is expected to be negligible. The actual dose to these receptors will be quantified upon receipt of monitoring data. The annual doses to workers and the public are summarized in table 4.9.2.9-4; corresponding health risks are also presented in the table. These doses are in addition to those from natural background radiation, consumer products, and medical sources, which total about 360 mrem/yr. The onsite worker doses are within regulatory limits. Background radiation doses are unrelated to NLVF operations.

Chemical Environment. Exposure pathways to NLVF workers during normal operation may include inhaling the workplace atmosphere, drinking NLVF potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, *and management controls. NLVF workers are also protected by adherence to OSHA and EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operation processes, ensures that these standards are not exceeded. The maximum daily quantities of NIF-related hazardous materials stored at NLVF are presented in appendix table I.4.4.1.7.2-1. NLVF stores and uses few hazardous materials in amounts greater than the threshold planning quantities that require reporting under 40 CFR 370 (NT DOE 1995g).*

4.9.2.10 Waste Management

This section outlines the major environmental regulatory structure and ongoing waste management activities for NTS, including NLVF. A more detailed discussion of the ongoing waste management operations is provided in appendix section H.2.8.

DOE is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at NTS. DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed upon milestones. These agreements have been reviewed to assure the proposed actions are allowable under the terms of these agreements.

DOE has decided that underground testing areas should be governed pursuant to the provisions of CERCLA. Preliminary assessment/site investigation reports and a hazardous ranking system package were provided to EPA for their use in determining whether NTS should be included on the NPL. In May 1993, the state of Nevada issued a letter to DOE indicating it did not appear that EPA would make a decision on the NPL status of NTS in the near future.

DOE has published the Nevada Test Site Treatment Plan and Federal Facility Compliance Act consent order addressing environmental restoration and waste management on NTS. A mutual consent agreement between the state of Nevada and DOE, updated in June 1995, permits NTS to use the available capacity of the TRU waste storage pad for the storage of onsite generated mixed LLW that does not meet the land disposal provisions of RCRA.

The Nevada Operations Office completed a waste minimization plan for NTS in 1991 and created an organization whose mission is to promote waste minimization and pollution prevention and to ensure compliance with DOE requirements. NTS currently generates waste from ongoing operations and remediation associated with past activities and receives waste from other DOE facilities. NTS manages the following waste categories: TRU, LLW, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Transuranic Waste. *Although NTS does not currently generate any TRU wastes, from 1974 to 1990, < 612 m3 (800 yd3) of mixed TRU waste was received from LLNL and is stored on a 8,300-m2 (89,300-ft2) asphalt storage pad at Area 5 of NTS (NT REECO 1995a:21). DOE and the State of Nevada signed a Settlement Agreement on July 23, 1992, allowing the Nevada Operations Office to* *retain this inventory of mixed TRU waste subject to an appropriate permitting process. None of these waste packages is WIPP certified. They will have to be certified before shipment to WIPP. These wastes have been moved to a 1,995-m2 (21,470-ft2) polyvinyl chloride-coated polyester fabric covered building for storage until WIPP is determined to be a suitable disposal facility, pursuant to the requirements of 40 CFR 191 and 40 CFR 268, or until another suitable repository is found (NT DOE 1996b:30-38). NTS has areas of plutonium-contaminated soil, for which treatment technology is being developed. This activity may produce additional volumes of TRU or mixed TRU waste. Limited quantities of TRU waste were also disposed of in trench 4C and in greater confinement units in Area 5.*

Low-Level Waste*. In 1993, NTS generated approximately 178m 3 (233 yd3) of solid LLW onsite (NT DOE 1994f:4). LLW has been generated and disposed of in eight areas at NTS, but currently only Areas 3 and 5 are active for disposal. Bulk waste is disposed of in Area 3, and packaged classified and unclassified waste is disposed of in Area 5. Disposal of onsite waste began in 1971, and in 1978 operations expanded to receive wastes generated offsite. In 1995, 15 generators shipped LLW to NTS for disposal. An additional nine generators are applying for or awaiting approval (NT DOE 1996c:4-61, 4-62). As of October 1994, approximately 301,667 m3 (394,600 yd3) of LLW in Area 3 (NT DOE 1996c:4-43) and as of December 1993 approximately 167,400 m3 (218,900 yd3) of LLW in Area 5 (NT REECO 1994a:12) have been disposed of. Standard shallow land burial techniques have been employed.*

Mixed Low-Level Waste. *In 1993, NTS did not generate any mixed waste. Disposal of mixed waste received from the Rocky Flats Environmental Technology Site has taken place at NTS. Mixed waste disposal at NTS ceased, pending issuance by the state of Nevada of a RCRA Part B Permit for NTS. environmental restoration at NTS could generate additional volumes of mixed waste which would require some form of treatment. A liquid waste treatment system is being designed to process these mixed wastes. Mixed waste generated in the state of Nevada that meets land disposal restrictions of RCRA can be disposed of in the Area 5 mixed waste disposal unit, Pit 3. Pit 3 currently has an inventory of 8,024 m3 (10,500 yd3) (NT DOE 1996c:4-46). Other units in Areas 3 and 5 where mixed waste was previously disposed of will be closed in conformance with RCRA. The Nevada Division of Environmental Protection provides RCRA oversight for NTS. The 1992 revised RCRA Part B Permit application to include a separate mixed waste storage and disposal unit at NTS, in accordance with the provisions of the Federal Facility Compliance Act of 1992, has been submitted to the state of Nevada. A mutual consent agreement between the state of Nevada and DOE permits the storage of mixed LLW that do not meet RCRA land disposal restrictions on the TRU waste storage pads. DOE has published the NTS Site Treatment Plan and Federal Facility Compliance Act Consent Order that establishes the basis for treatment, storage and disposal of mixed LLW at NTS.*

Hazardous Waste. *For 1993, NTS generated approximately 34.6 m3 (45 yd3) of hazardous wastes (NT DOE 1994f:4). Hazardous wastes result from ongoing operations that utilize solvents, lubricants, fuel, lead, metals, motor oil, and acids. Hazardous wastes are accumulated at satellite areas, stored at the Area 5 RCRA-permitted hazardous waste storage unit, and shipped offsite by truck to a commercial RCRA-permitted facility using DOT-approved transporters. Additional accumulation areas and new equipment are planned to prevent the possibility of cross contamination with* *radioactive wastes (creating mixed wastes) in handling these materials. PCB-contaminated waste is accumulated and stored in the Area 6 TSCA waste accumulation unit. Accumulated PCB waste is shipped offsite to a commercial TSCA-permitted treatment, storage, and disposal facility. Hazardous waste generation is decreasing as the result of an aggressive waste minimization program, and will substantially decrease in the future due to the present moratorium on nuclear testing.*

NLVF generated about 8.2 m3 (2,180 gal) of liquid and 3.5 m3 (4.6 yd3) of solid hazardous wastes in 1994. All hazardous wastes are treated, stored, or disposed of offsite at RCRA-permitted facilities. Spills or releases of hazardous materials have historically been minor in nature and have been promptly cleaned up upon discovery.

A Waste Minimization and Pollution Prevention Awareness Implementation Plan submitted to DOE on December 20, 1991, is in place for NLVF. A formalized system of waste minimization was developed through the implementation of EG&G/EM Policy No. 31-70, Waste Minimization and Pollution Prevention, and Standard Operating Procedure 31-006.A, Hazardous Waste Minimization Plan. Hazardous waste generation from various processes has already been reduced through product substitution or by permanently discontinuing the hazardous waste generating process.

There are no underground storage tanks for hazardous or petroleum substances at NLVF. All aboveground tanks employ either secondary containment or a double-walled tank with continuous leak detection. There are no hazardous waste treatment, storage, or disposal facilities requiring state or Federal permits at NLVF (NT DOE 1995g).

***Nonhazardous Waste**. Nonhazardous sanitary wastes are expected to be generated at the current rates for several years, then decline assuming the present moratorium on underground weapons testing continues. Liquid nonhazardous wastes are disposed of in septic tanks, sumps, or in ponds. Solid wastes are disposed of in landfills at various locations on the site. Recycling of paper, metals, glass, plastics, and cardboard has already resulted in some decreases in waste quantities. NTS generated 7,170 t (7,900 tons) of solid sanitary wastes in 1993 (NT DOE 1994f:4). Solid waste landfills located in Areas 6, 9, and 23 are in use for the disposal of solid nonhazardous wastes.*

The Area 6 landfill is a Class III landfill that accepts hydrocarbon-burdened soil and debris. The Area 9 landfill is a Class II landfill because it accepts less than 18 t (20 tons) of solid waste per day. The Area 9 landfill is allowed to receive all types of nonhazardous solid waste, excluding radioactive waste, free liquids, and asbestos. Its current capacity is approximately 993,883 m3 (1.3 million yd3). Due to changes in state regulatory requirements, the Area 9 landfill will undergo partial closure and reopen as a Class III construction and demolition landfill. The Area 23 landfill receives all types of nonhazardous solid waste with nonpathogenic hospital waste, dead animals, and asbestos-containing materials being buried in separate cells that are identified by concrete markers. The current capacity is approximately 449,541 m3 (588,000 yd3). The Area 23 landfill is scheduled to remain in operation as a Class II landfill after modification to comply with the new state regulations (NT DOE 1996c:4-47).

Policies and procedures are in place at NLVF that promote recycling and resource recovery.

Physical and administrative measures implemented at NLVF minimize or prevent the introduction of pollutants into stormwater. Stormwater from the NLVF site is discharged by concentrated conveyance or sheet flow onto Losee Road. Industrial wastewater and sanitary sewage from NLVF are discharged into city of North Las Vegas sewer lines, which are connected to the city of Las Vegas publicly owned treatment works. The publicly owned treatment works discharges treated wastewater directly into Lake Mead under a NPDES permit issued by the Nevada Division of Environmental Protection. NLVF discharges an average of 147,303 L (38,888 gal) of wastewater per day into the publicly owned treatment works, with a peak maximum of 369,318 L (97,000 gal) of wastewater per day. Approximately 32 to 35 percent of the total wastewater originates from industrial processes, while the remaining 65 percent is predominantly sanitary wastes. Wastewater quality historically has been in compliance with permit conditions established by the city of North Las Vegas to protect the publicly owned treatment works treatment processes and ultimately the water quality in Lake Mead (NT DOE 1995g).

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1 Federal and state standard.

2 No monitoring data available; baseline concentration assumed less than applicable standard.

3 It is assumed that particulate matter data are TSP data.

4 State standard. Source: 40 CFR 50; NT REECO 1990a; NV DCNR 1995a.

5 For short-term standards, baseline concentration is highest second highest concentration for year.

6 Federal standard (40 CFR 50).

7 No monitoring data available; baseline concentration assumed less than applicable standard.

8 County standard.

9 State standard. Source: ANL 1995b; NT County 1993a; NT County 1995c:1.

10 For comparison only.

11 National Primary DrinkingWater Regulations (40 CFR 141).

12 Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050). [d] *DOE's Derived Concentration Guides for water (DOE Order 5400.5). Values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guides.* [e] *Below laboratory detection limit.* [f] *National Secondary Drinking Water*

Regulations (40 CFR 143). Note: NA - not applicable. Source: NT DOE 1994b.

13 Derived from information given in EPA 1981b.

14 NCRP 1987a.

15 The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268).

16 In 1993, this population was approximately 21,750.

17 Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.

18 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable. NT DOE 1994b.

19 DOE 1993n:7. The number of badged workers in 1992 was approximately 780.

20 The regulatory limits for individuals are given in DOE Order 5400.5. The 10 mrem/yr limit from airborne emissions is required by the CAA. The 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The regulatory limit for workers is 5,000 mrem (10 CFR 835).

21 Based on latent fatal cancer risk factors of $5x10^{-4}$ */mrem for individuals, 5x10-4 /person-rem for population, and* $4x10^{-4}$ */mrem for workers (ICRP 1991a).*

22 Two very small atmospheric releases occurred on July 12 and August 14, 1995. Dose to any offsite individual is expected to be a fraction of a mrem (monitoring data is not yet available from all stations).

23 No regulatory limits exist for population doses.

24 NA - not applicable; worker doses were estimated on the basis of readings from monitoring devices called thermoluminescent dosimeters.

25 The number of badged workers in 1994 was approximately seven. Source: NTS 1995a:5.

CHAPTER 5.0 ENVIRONMENTAL, OCCUPATIONAL SAFETY & HEALTH PERMITS, AND COMPLIANCE REQUIREMENTS

Chapter 5 identifies the environmental, occupational safety and health permits, and compliance requirements associated with the proposed action as specified by the major Federal and state statues, regulations, orders, and agreements.

5.1 Introduction and Purpose

Chapter 5 provides information concerning the environmental standards and statutory requirements that impact the various stockpile stewardship and management facilities to the extent necessary to assist in making programmatic-level decisions. It presents some of the more important regulatory requirements associated with the proposed action by identifying the applicable environmental statutes, regulations, and approval requirements. These requirements are found in Federal and state statutes, regulations, permits, approvals, and consultations, as well as in Executive and Department of Energy (DOE) Orders, Consent Orders, Federal Facility Agreements, Federal Facility Compliance Agreements, and Agreements In Principle. These documents provide the standard for evaluating the ability of alternative sites to meet the environment, safety, and health (ES&H) requirements and for obtaining required Federal and state permits and licenses necessary to implement programmatic decisions. The remainder of the chapter provides historical background on environmental protection at nuclear weaons production facilities, explains the concept of shared Federal and state enforcment, and sumarizes compliance with occupational safety and health requirements.

Compliance with the applicable requirements of each of the major environmental statutes, regulations, or orders in the tables would allow DOE to construct and operate the stockpile stewardship and management facilities to meet existing ES&H requirements. To be environmentally sound, programmatic decisions must also plan for future ES&H considerations and requirements described in section 3.3 of the Nuclear Weapons Complex Reconfiguration Study (DOE/DP-0083) in order for the stockpile stewardship and management facilities to accomplish their mission in a timely and cost-effective manner.

5.2 Background

Since the majority of the Nuclear Weapons Complex (Complex) facilities were constructed in the 1940s and 1950s before the advent of today's environmental and worker health requirements, safety and the ability to satisfy national security requirements played dominant roles in the design and operation of these major industrial plants; however, with the emerging awareness of environmental and health-related issues and the enactment of environmental and worker health programs, DOE shifted a great deal of its resources into programs designed to achieve compliance with all applicable Federal, state, and local ES&H requirements. Today, many government agencies at the Federal, state, and local levels have regulatory authority over DOE facility operations. DOE has entered into enforceable compliance agreements with the regulators at most of its facilities. These agreements detail specific programs, funding levels, and schedules for achieving compliance with applicable ES&H statutory and regulatory requirements.

All newly constructed and modified facilities must comply with the increasing number and complexity of environmental regulations. The application of constantly changing requirements to facilities that are more than 40 years old makes it difficult to achieve compliance quickly. These older facilities generally do not meet all current standards for seismic design, fire protection, and environmental protection (air emissions, liquid effluents, and the management of solid and hazardous wastes). However, modernization of facilities to meet all applicable ES&H requirements now and into the 21st century and the development of a system to adequately manage the wastes generated by these facilities would take place regardless of the proposed action addressed in this programmatic environmental impact statement (PEIS).

5.3 Environmental Statutes, Orders, and Agreements

The *Atomic Energy Act* of 1954, as amended, directs DOE to protect public health and minimize dangers to life or property with respect to activities under its jurisdiction. The Environmental Protection Agency (EPA), under authority of the Atomic Energy Act, has set radiation protection standards for workers and the public. EPA has also promulgated Federal environmental regulations and implemented statutes to protect the environment and to control the generation, handling, treatment, storage, and disposal of hazardous materials and waste substances.

Because of their length, and for ease of reading, all tables in this chapter are presented consecutively at the end of the text. Table 5.3-1 lists the applicable Federal environmental statutes, regulations, and Executive Orders, and also identifies the associated permits, approvals, and consultations generally required to site, construct, or operate stockpile stewardship and management facilities. Except for limited Presidential exemptions, Federal agencies must comply with all applicable provisions of Federal environmental statutes and regulations, in addition to all applicable state and local requirements. DOE is committed to fully complying with all applicable environmental statutes, regulatory requirements, and Executive and internal orders. Table 5.3-2 lists selected DOE ES&H orders that apply to all sites, but which may affect each site differently.

Table 5.3-1. Federal Environmental Statutes, Regulations, and Orders

Resource Category	Statute/Regulation/ Order	Citation	Responsible Agency	PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications

Air resources	Clean Air Act (CAA), as amended	42 USC §§7401 et seq.	EPA	Requires sources to meet standards and obtain permits to satisfy: National Ambient Air Quality Standards (NAAQS), State Implementation Plans, Standards of Performance for New Stationary Sources, National Emission Standards for Hazardous Air Pollutants (NESHAP), and Prevention of Significant Deterioration.
	National Ambient Air Quality Standards/State Implementation Plans	42 USC §§7409 et seq.	EPA	Requires compliance with primary and secondary ambient air quality standards governing *sulfur dioxide* , *nitrogen oxide* , carbon monoxide, *ozone* , lead, and *particulate matter* and emission limits/ reduction measures as designated in each state's implementation plan.
	Standards of Performance for New Stationary Sources	42 USC §7411	EPA	Establishes control/ emission standards and recordkeeping requirements for new or modified sources specifically addressed by a standard.

National Emission Standards for Hazardous Air Pollutants	42 USC §7412	EPA	Requires sources to comply with emission levels of carcinogenic or mutagenic pollutants; may require a preconstruction approval, depending on the process being considered and the level of emissions that will result from the new or modified source.
Prevention of Significant Deterioration	42 USC §§7470 et seq.	EPA	Applies to areas that are in compliance with NAAQS. Requires comprehensive preconstruction review and the application of Best Available Control Technology to major stationary sources (emissions of 100 t/year) and major modifications; requires a preconstruction review of air quality impacts and the issuance of a construction permit from the responsible state agency setting forth emission limitations to protect the Prevention of Significant Deterioration increment.
Noise Control Act of 1972	42 USC §§4901 et seq.	EPA	Requires facilities to maintain noise levels that do not jeopardize the health and safety of the public.

Water resources	Clean Water Act (CWA)	33 USC §§1251 et seq.	EPA	Requires EPA or state-issued permits and compliance with provisions of permits regarding discharge of effluents to surface waters.
	National Pollutant Discharge Elimination System (NPDES) (section 402 of CWA)	33 USC §1342	EPA	Requires permit to discharge effluents (pollutants) and stormwaters to surface waters; permit modifications are required if discharge effluents are altered.
	Dredged or Fill Material - (section 404 of CWA)/ *Rivers and Harbors Appropriations Act* of 1899	33 USC §1344/ 33 USC §§401 et seq.	U.S. Army Corps of Engineers	Requires permits to authorize the discharge of dredged or fill material into navigable waters or wetlands and to authorize certain work in or structures affecting navigable waters.
Water resources (continued)	Wild and Scenic Rivers Act	16 USC §§1271 et seq.	Fish and Wildlife Service (USFWS), Bureau of Land Management, Forest Service, National Park Service	Consultation required before construction of any new Federal project associated with a river designated as wild and scenic or under study in order to minimize and mitigate any adverse effects on the physical and biological properties of the river.
	Safe Drinking Water Act (SDWA)	42 USC §§300f et seq.	EPA	Requires permits for construction/operation of underground injection wells and subsequent discharging of effluents to ground aquifers.

	Executive Order 11988: Floodplain Management	3 CFR, 1977 Comp., p. 117	Water Resources Council, Federal Emergency Management Agency, Council on Environmental Quality (CEQ)	Requires consultation if project impacts a floodplain.
	Executive Order 11990: Protection of Wetlands	3 CFR, 1977 Comp., p. 121	U.S. Army Corps of Engineers/ USFWS	Requires Federal agencies to avoid the long- and short-term adverse impacts associated with the destruction or modification of wetlands.
	Compliance with Floodplain/Wetlands Environmental Review Requirements	10 CFR 1022	DOE	Requires DOE to comply with all applicable floodplain/ wetlands environmental review requirements.
Hazardous wastes and soil resources	Resource Conservation and Recovery Act (RCRA)/Hazardous and Solid Waste Amendments of 1984	42 USC §§6901 et seq./PL 98-616	EPA	Requires notification and permits for operations involving hazardous waste treatment, storage, or disposal facilities; changes to site hazardous waste operations could require amendments to RCRA hazardous waste permits involving public hearings.

	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)/ Superfund Amendments and Reauthorization Act of 1986 (SARA)	42 USC §§9601 et seq./PL 99-499	EPA	Requires cleanup and notification if there is a release or threatened release of a hazardous substance; requires DOE to enter into Interagency Agreements with EPA and state to control the cleanup of each DOE site on the National Priorities List (NPL).
	Executive Order 12580: Superfund Implementation	3 CFR, 1987 Comp., p. 193	EPA	DOE shall comply with the National Contingency Plan (NCP) in addition to the other requirements of the order, as amended.
Hazardous wastes and soil resources (continued)	Community Environmental Response Facilitation Act	PL 102-426	EPA	Amends CERCLA (40 CFR 300) to establish a process for identifying, prior to the termination of Federal activities, property that does not contain contamination. Requires prompt identification of parcels that will not require remediation to facilitate the transfer of such property for economic redevelopment purposes.
	Farmland Protection Policy Act of 1981	7 USC §§4201 et seq.	Soil Conservation Service	DOE shall avoid any adverse effects to prime and unique farmlands.

	Federal Facility Compliance Act of 1992	42 USC §6961	States	Waives sovereign immunity for Federal facilities under RCRA and requires DOE to develop plans and enter into agreements with states as to specific management actions for specific mixed waste streams.
Biotic resources	Fish and Wildlife Coordination Act	16 USC §§661 et seq.	USFWS	Requires consultation on the possible effects on wildlife if there is construction, modification, or control of bodies of water in excess of 10 acres (4 ha) in surface area.
	Bald and Golden Eagle Protection Act	16 USC §§668 et seq.	USFWS	Consultations should be conducted to determine if any protected birds are found to inhabit the area. If so, DOE must obtain a permit prior to moving any nests due to construction or operation of project facilities.
	Migratory Bird Treaty Act	16 USC §§703 et seq.	USFWS	Requires consultation to determine if there are any impacts on migrating bird populations due to construction or operation of project facilities. If so, DOE will develop mitigation measures to avoid adverse effects.

	Wilderness Act of 1964	16 USC §§1131 et seq.	Department of Commerce and Department of the Interior	DOE shall consult with the Department of Commerce and Department of the Interior and minimize impact.
	Wild Free-Roaming Horses and Burros Act of 1971	16 USC §§1331 et seq.	Department of the Interior	DOE shall consult with Department of the Interior and minimize impact.
	Endangered Species Act of 1973	16 USC §§1531 et seq.	USFWS/National Marine Fisheries Service	Requires consultation to identify endangered or threatened species and their habitats, assess DOE impacts thereon, obtain necessary biological opinions, and, if necessary, develop mitigation measures to reduce or eliminate adverse effects of construction or operations.
Cultural resources	National Historic Preservation Act of 1966, as amended	16 USC §§470 et seq.	President's Advisory Council on Historic Preservation	DOE shall consult with the State Historic Preservation Office (SHPO) prior to construction to ensure that no historical properties will be affected.
	Archaeological and Historical Preservation Act of 1974	16 USC §§469 et seq.	Department of the Interior	DOE shall obtain authorization for any disturbance of archaeological resources.
Cultural resources (continued)	Archaeological Resources Protection Act of 1979	16 USC §§470aa et seq.	Department of the Interior	DOE shall obtain authorization for any excavation or removal of archaeological resources.

	Antiquities Act	16 USC §§431-33	Department of the Interior	DOE shall comply with all applicable sections of the act.
	American Indian Religious Freedom Act of 1978	42 USC §1996	Department of the Interior	DOE shall consult with local Native American Indian tribes prior to construction to ensure that their religious customs, traditions, and freedoms are preserved.
	Native American Graves Protection and Repatriation Act of 1990	25 USC §3001	Department of the Interior	DOE shall consult with local Native American Indian tribes prior to construction to guarantee that no Native American graves are disturbed.
	Executive Order 11593: Protection and Enhancement of the Cultural Environment	3 CFR 154, 1971-1975 Comp., p. 559	Department of the Interior	DOE shall aid in the preservation of historic and archaeological data that may be lost during construction activities.
Worker safety and health	Occupational Safety and Health Act (OSHA)	5 USC §5108	OSHA	Agencies shall comply with all applicable worker safety and health legislation (including guidelines of 29 CFR 1960) and prepare, or have available, Material Safety Data Sheets.
	Hazard Communication Standard	29 CFR 1910.1200	OSHA	DOE shall ensure that workers are informed of, and trained to handle, all chemical hazards in the DOE workplace.
Other	Atomic Energy Act of 1954	42 USC §2011	DOE	DOE shall follow its own standards and procedures to ensure the safe operation of its facilities.

National Environmental Policy Act (NEPA)	42 USC §§4321 et seq.	Council on Environmental Quality (CEQ)	DOE shall comply with NEPA implementing procedures in accordance with 10 CFR 1021.
Uranium Mill Tailings Radiation Control Act of 1978	42 USC §§7901 et seq.	EPA	DOE shall enforce and implement health and environmental standards and acquire licenses when required.
Toxic Substances Control Act (TSCA)	15 USC §§2601 et seq.	EPA	DOE shall comply with inventory reporting requirements and chemical control provisions of TSCA to protect the public from the risks of exposure to chemicals; TSCA imposes strict limitations on use and disposal of polychlorinated biphenyl-contaminated equipment.
Hazardous Materials Transportation Act	49 USC §§1801 et seq.	Department of Transportation (DOT)	DOE shall comply with the requirements governing hazardous materials and waste transportation.
Hazardous Materials Transportation Uniform Safety Act of 1990	49 USC §1801	DOT	Restricts shippers of highway route-controlled quantities of radioactive materials to use only permitted carriers.

Other (continued)	Emergency Planning and Community Right-To-Know Act of 1986	42 USC §§11001 et seq.	EPA	Requires the development of emergency response plans and reporting requirements for chemical spills and other emergency releases, and imposes right-to-know reporting requirements covering storage and use of chemicals which are reported in toxic chemical release forms.
	Pollution Prevention Act of 1990	42 USC 11001-11050	EPA	Establishes a national policy that pollution should be reduced at the source and requires a toxic chemical source reduction and recycling report for an owner or operator of a facility required to file an annual toxic chemical release form under section 313 of SARA.
	Executive Order 12843: Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances	April 21, 1993	EPA	Requires Federal agencies to minimize procurement of ozone depleting substances and conform their practices to comply with Title VI of CAA Amendments referencing stratospheric ozone protection and to recognize the increasingly limited availability of Class I substances until final phaseout.

Executive Order 12856: Federal Compliance with Right-To-Know Laws and Pollution Prevention Requirements	August 3, 1993	EPA	Requires Federal agencies to achieve 50-percent reduction of agency's total releases of toxic chemicals to the environment and offsite transfers, to prepare a written facility pollution prevention plan not later than 1995, to publicly report toxic chemicals entering any waste stream from Federal facilities, including any releases to the environment, and to improve local emergency planning, response, and accident notification.
Executive Order 12873: Federal Acquisition, Recycling, and Waste Prevention	October 20, 1993	EPA	Requires Federal agencies to develop affirmative procurement policies and establishes a shared responsibility between the system program manager and the recycling community to effect use of recycled items for procurement.
Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	February 11, 1994	EPA	Requires Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

	Executive Order 12088: Federal Compliance with Pollution Control Standards	3 CFR, 1978 Comp., p. 243	Office of Management and Budget	Requires Federal agency landlords to submit to Office of Management and Budget an annual plan for the control of environmental pollution and to consult with EPA and state agencies regarding the best techniques and methods.
	Executive Order 11514: Protection and Enhancement of Environmental Quality	3 CFR, 1966-1970 Comp., p. 902	CEQ	Requires Federal agencies to demonstrate leadership in achieving the environmental quality goals of NEPA; provides for DOE consultation with appropriate Federal, state, and local agencies in carrying out their activities as they affect the environment.
Other (continued)	Nuclear Waste Policy Act of 1982	42 USC §§10101 et seq.	EPA	DOE shall dispose of radioactive waste in accordance with 40 CFR 191.
	Low-Level Radioactive Waste Policy Act	42 USC §§2021b-2021d	Nuclear Regulatory Commission	DOE shall dispose of low-level wastes (LLW) in accordance with the states in which it operates.

Table 5.3-2. Selected Department of Energy Environment, Safety, and Health Orders

DOE Order	Order Title
5400.1	General Environmental Protection Program
5400.5	Radiation Protection of the Public and the Environment
5480.4	Environmental Protection, Safety, and Health Protection Standards
5480.19	Conduct of Operations Requirements for DOE Facilities

5480.21	Unreviewed Safety Questions
5480.22	Technical Safety Requirements
5480.23	Nuclear Safety Analysis Reports
5482.1B	Environment, Safety, and Health Appraisal Program
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5530.1A	Accident Response Group
5530.4	Aerial Measuring System
5630.12A	Safeguards and Security Inspection and Assessment Program
5632.1C	Protection and Control of Safeguards and Security Interests
5700.6C	Quality Assurance
5820.2A	Radioactive Waste Management
M 231.1	Environment, Safety, and Health Reporting
N 441.1	Radiological Protection for DOE Activities
O 151.1	Comprehensive Emergency Management System
O 232.1-1	Occurrence Reporting and Processing of Operations Information
O 420.1	Facility Safety
O 430.1	Life Cycle Asset Management
O 440.1	Worker Protection Management for DOE Federal and Contractor Employees
O 451.1	National Environmental Policy Act Compliance Program
O 460.1	Packaging and Transportation Safety
O 460.2	Departmental Materials Transportation and Packaging Management
O 470.1	Safeguards and Security Program

DOE has entered into agreements with regulatory agencies on behalf of all of the DOE facilities being considered in this PEIS. These agreements normally establish a schedule for achieving full compliance at these DOE facilities. Table 5.3-3 lists those DOE environmental agreements with Federal and state regulatory agencies that have substantive provisions in effect. Appendix section A.1 summarizes the applicability of and provides more detail on the environmental regulatory compliance agreements and consent orders still in effect at each of the nuclear facilities. These agreements and consent orders are generally available from the regulatory agency that is a party to the agreement, normally the state environmental department or EPA region, and also from the local DOE information resource center or reading room. Table 5.3-4 lists the potential requirements imposed by the major state environmental statutes and regulations applicable to this PEIS. These requirements apply to Federal activities within the jurisdiction of the enforcing authority. Just as table 5.3-1 identifies requirements based on Federal laws, table 5.3-4 identifies the permits, approvals, and consultations generally required to site, construct, or operate stockpile stewardship and management facilities in accordance with state statutes and regulations.

Table 5.3-3. Department of Energy Agreements with Federal and State Environmental Regulatory Agencies

Facility	Resource Category	Parties (Agency/State)	Scope of Agreement	Effective Date
Kansas City Plant	Soil	DOE/EPA	RCRA Section 3008 (h) Administrative Order on Consent. Groundwater cleanup primarily for volatile organic compounds (VOCs) and PCBs (agreement between DOE and EPA but Missouri Department of Natural Resources maintains RCRA authority over the KCP groundwater monitoring program)	06/23/89
Lawrence Livermore National Laboratory	Water	DOE/EPA/CA-RWQCB, CA-Dept. Health Svcs	Federal Facility Agreement-Regulates groundwater cleanup activities at LLNL under CERCLA/ SARA Section 120	11/02/88
	Water/Soil	DOE/EPA/CAEPA Department of Toxic Substances Control/RWQCB	CERCLA-Federal Facility Agreement describes the groundwater and soil investigations to be conducted at Site 300 and specifies reporting dates.	9/92
	Air/Soil	DOE/EPA/CAEPA Department of Toxic Substances Control	Hazardous Waste Compliance Agreement 92/93-031 governing open burning of explosives wastes at Site 300.	

Los Alamos National Laboratory	Water	DOE/EPA	CWA-NPDES compliance agreement	08/29/91
Nevada Test Site	Air/Water	DOE/NV	Agreement in Principle for DOE to provide funding to Nevada for oversight of environmental, safety and health activities	10/90
	Soil	DOE/NV	RCRA-Settlement Agreement-TRU mixed waste	07/23/92
	Cultural	DOE/NV	Programmatic Agreement-Archaeological and Historic Preservation activities	05/08/93
Oak Ridge Reservation	Air	DOE/EPA	CAA-Federal Facility Compliance Agreement, Radionuclide NESHAP	05/26/92
	Soil	DOE/EPA/TN	CERCLA-Federal Facility Agreement	01/01/92
	Soil	DOE/EPA	RCRA-Federal Facility Compliance Agreement for storage of mixed waste subject to land disposal restrictions	06/12/92
	Soil	DOE/EPA/TN	Federal Facility Compliance Act Commissioners Order ORR Site-Specific Treatment Plan for Mixed Waste	9/26/95
	All except Radiological	DOE/TN Dept. of Environment and Conservation	Oversight of environmental monitoring programs	5/13/91

	Cultural	DOE/TN	DOE commitment to prepare a cultural resource management plan for ORR and to conduct a survey to identify significant historical properties located within the ORR; interim programmatic exclusions from Section 106 review	5/24/94
Pantex Plant	Soil	DOE/EPA	RCRA-Section 3008 (h) Administrative Order on Consent	12/10/90
Sandia National Laboratories/NM	Soil	DOE/NM	RCRA-Groundwater monitoring at chemical waste landfill	12/29/89
Savannah River Site	Air	DOE/EPA	CAA-Federal Facility Compliance Agreement, Radionuclide NESHAP	10/31/91
	Soil	DOE/SC	RCRA-Settlement Agreement 87-52-SW with amendment, Part B application deficiencies; groundwater monitoring	11/12/87, 05/10/91
	Soil	DOE/EPA	RCRA-Federal Facility Compliance Agreement for land disposal restrictions, with amendment 1, Docket No. 91-01-FFR	03/13/91, 04/24/92
	Soil	DOE/EPA/SC	CERCLA/RCRA-Federal Facility Agreement	01/15/93

Cultural	DOE/SHPO ACHP	Programmatic Memorandum of Agreement-Management of Archaeological Sites	08/90

Table 5.3-4. State Environmental Statutes, Regulations, and Orders

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/ Permits
Kansas City Plant, MO				
Air resources	Missouri Air Conservation Law	MO Stat., Title 40, Chapter 643	MO Department of Natural Resources	Permit required prior to the construction or modification of an air contaminant source.
	Missouri Air Quality Standards	MO Code 10-6.060	MO Department of Natural Resources	Permit required prior to the construction or modification of an air contaminant source.
Water resources	Missouri Clean Water Law	MO Stat., Title 40, Chapter 644	MO Department of Natural Resources	Permit required prior to the construction or modification of a water discharge source.
Hazardous wastes and soil resources	Missouri Solid Waste Law	MO Code, Title 10, Division 80	MO Department of Natural Resources	Permit required prior to the construction or modification of a solid waste disposal facility.
	Missouri Hazardous Waste Management Law	MO Code, Title 10, Division 25	MO Department of Natural Resources	Permit required prior to the construction or modification of a hazardous waste disposal facility.

	Missouri Underground Storage Tank Act	MO Code, Title 10	MO Department of Natural Resources	Permit required prior to the construction or modification of an underground storage tank.
Biotic resources	Missouri Wildlife Code	Rule 3 CSR10-4.111	MO Department of Conservation	Prohibits transactions involving endangered plants and animal species. Lists species endangered in Missouri.

Kansas City Plant, MO (continued)

Biotic resources (continued)	Missouri Wildlife Code	Revised Statutes of Missouri Rule (RSMO) 252.240	MO Department of Natural Resources	Prohibits transactions involving endangered species as listed by the U.S Department of the Interior and prohibits collecting, digging, or picking of any rare or endangered plants without the owner's permission.
Cultural resources	State Historic Preservation Act	RSMO Sections 253.408 to 253.412	MO Department of Natural Resources Historic Preservation Program	Establishes State Historic Preservation Officer, and a state historic preservation office with duties including conducting comprehensive survey of cultural resources, assisting Federal and state agencies to carry out historic preservation responsibilities, and coordinating with state and Federal agencies to ensure that historic properties are taken

			into consideration at all levels of planning and development.
Historic Preservation Revolving Fund Act	RSMO Sections 253.400 to 253.407	MO Department of Natural Resources Historic Preservation Program	Establishes a fund to protect and preserve the historic properties of Missouri, to be administered throughout the State Department of Natural Resources.
Unmarked Human Burial Sites	RSMO Sections 194.400 to 194.410	MO Department of Natural Resources Historic Preservation Program	Requires notification of local law enforcement or SHPO if an unmarked human burial or human skeletal remains are encountered during construction or any ground disturbing activities on state land or waters.
Private Cemeteries	RSMO Section 214.131	MO Department of Natural Resources Historic Preservation Program	Makes desecration or destruction of abandoned family or private cemeteries a misdemeanor.
Historic Shipwrecks, Salvage, or Excavation Regulations	RSMO Section 253.420	MO Department of Natural Resources Historic Preservation Program	The State Department of Natural Resources shall monitor and grant permits for salvage excavations of submerged or embedded abandoned shipwrecks in the state.

Kansas City Plant, MO (continued)

Cultural resources (continued)	Missouri Indian Affairs Commission Act	March 24, 1994	MO Department of Natural Resources Historic Preservation Program	Creates the Missouri Indian Affairs Commission within the Department of Natural Resources. The Commission will act as a liaison between the Indian people and various Indian agencies, including Federal and state agencies.
Worker safety and health	No state-level legislation identified	NA	MO Department of Natural Resources	NA
Lawrence Livermore National Laboratory, CA				
Air resources	California Clean Air Act	CA Health and Safety Code, Sections 39000 et seq.	CA Environmental Protection Agency, Air Resources Board and local districts	Permit required prior to construction or modification of an air contaminant source.
	Air Toxics "Hot Spots" Information and Assessments Act	CA Health and Safety Code, Sections 44300 et seq.	CA Environmental Protection Agency, Air Resources Board and local districts	Screening Risk Assessment required to estimate human health impacts to a resident living near the boundary of the site.
Water resources	California Porter-Cologne Water Quality Act	Water Code, Sections 13000 et seq.	CA Environmental Protection Agency, Water Resources Control Board and Regional Water Quality Control Boards	Permit required prior to construction or modification of water discharges sources.
Hazardous wastes and soil resources	California Hazardous Waste Control Act	CA Health and Safety Code, Sections 25100 et seq.	CA Environmental Protection Agency, Department of Toxic Substances Control	Permit required prior to construction or modification of hazardous waste management facility.

	The Hazardous Waste Source Reduction and Management Review Act of 1989	CA Health and Safety Code, Sections 25244.12 et seq.	CA Environmental Protection Agency, Department of Toxic Substances Control	Requires reports and plans describing how mandatory percentage reductions in waste streams will be achieved.
	"Hazardous Materials" Department of the California Highway Patrol	13 C.C.R, Chapter 6	CA Highway Patrol	Defines routes, stopping places, and rules of the road for transportation of hazardous materials.
	California Environmental Quality Act	CA Public Resources Code, Section 21081.6	CA Environmental Protection Agency	Requires evaluation of environmental impacts associated with Department of Toxic Substances Control permitting decisions.
Lawrence Livermore National Laboratory, CA (continued)				
Biotic resources	California Endangered Species Act	CA Fish and Game Code, Sections 2050-2098	CA Department of Fish and Game	States that agencies should not approve projects that would jeopardize the continued existence of threatened or endangered species or result in destruction or adverse modification of habitat essential to the continued existence of those species if conservation alternatives are reasonable and prudent.

Cultural resources	California Environmental Quality Act	CA Public Resources Code, Section 21083.2	CA Office of Planning and Research	Requires consideration of the effects of a project on prehistoric and historic cultural resources.
Worker safety and health	California Occupational Safety and Health Act does not directly apply to LLNL			
Los Alamos National Laboratory, NM and Sandia National Laboratories/NM				
Air resources	New Mexico Air Quality Control Act	NM Stat., Title 74, Article 2	NM Environment Department	Permit required prior to the construction or modification of an air contaminant source.
	New Mexico Air Quality Standards and Regulations	NM Air Quality Control Regs., §100	NM Environment Department	Permit required prior to the construction or modification of an air contaminant source.
Water resources	New Mexico Water Quality Act	NM Stat., Title 74, Article 6	NM Water Quality Control Com.	Permit required prior to the construction or modification of a water discharge source.
	New Mexico Water Quality Regulations	NM Water Regulations	NM Water Quality Control Com.	Permit required prior to the construction or modification of a water discharge source.
Hazardous wastes and soil resources	New Mexico Solid Waste Act	NM Stat., Chap. 74, Article 8	NM Environment Department	Permit required prior to the construction or modification of a solid waste disposal facility.

	New Mexico Solid Waste Management Regulations	NM Solid Waste Mgmt. Regs.	NM Environment Department	Permit required prior to the construction or modification of a solid waste disposal facility.
	New Mexico Hazardous Waste Management Regulations	NM Hazardous Waste Mgmt. Regs.	NM Environment Department	Permit required prior to the construction or modification of a hazardous waste disposal facility.
Los Alamos National Laboratory, NM and Sandia National Laboratories/NM (continued)				
Hazardous wastes and soil resources (continued)	New Mexico Underground Storage Tank Regulations	NM Underground Storage Tank Regulations	NM Environment Department	Permit required to comply with tank requirements prior to the construction or modification of an underground storage tank.
Biotic resources	New Mexico Wildlife Conservation Act	NM State Act 1978, Sections 17-2-37 through 17-2-46	NM Department of Game and Fish	Permit and coordination required if a project may disturb habitat or otherwise affect threatened or endangered species.
	New Mexico Endangered Plant Species Act	NM State Act 1978, Sections 75-6-1	NM State Forestry Department	Coordination with the department required.
Cultural resources	New Mexico Cultural Properties Act	NM State Act 1978, Sections 18-6-1 through 18-6-23	NM State Historic Preservation Office	Established State Historic Preservation Office and requirements to prepare an archaeological and historic survey and consult with the State Historic Preservation Office.
Worker safety and health	No state-level legislation identified	NA	NA	NA.
Nevada Test Site, NV				

Air resources	Nevada Air Pollution Control Law	NV Statutes, Title 40	NV State Environmental Commission	Permit required prior to construction or modification of an air contaminant source.
	Nevada Air Quality Regulations	NV Admin. Code, Chapter 445	NV State Environmental Commission	Permit required prior to construction or modification of an air contaminant source.
Water resources	Nevada Water Pollution Control Law	NV Statutes, Title 40, Chapter 445	NV Department of Environmental Protection	Permit required prior to construction or modification of a water discharge source.
	Nevada Water Pollution Control Regulations	NV Admin. Code, Chapter 445	NV Department of Environmental Protection	Permit required prior to construction or modification of a water discharge source.
Nevada Test Site, NV (continued)				
Hazardous wastes and soil resources	Nevada Underground Storage Tank Rules	NV Admin. Code, Chapter 459	NV Department of Environmental Protection	Permit required prior to construction or modification of an underground storage tank.
	Nevada Solid Waste Disposal Law	NV Statutes, Title 40, Chapter 444	NV Department of Environmental Protection	Permit required prior to construction or modification of a solid waste disposal facility.
	Nevada Solid Waste Disposal Regulations	NV Admin. Code, Chapter 44	NV Department of Environmental Protection	Permit required prior to construction or modification of a solid waste disposal facility; permit for septage hauling may be required.

	Nevada Hazardous Waste Disposal Law	NV Statutes, Title 40, Chapter 459	NV Department of Environmental Protection	Permit required prior to construction or modification of a hazardous waste disposal facility.
	Nevada Hazardous Waste Facility Regulations	NV Admin. Code, Chapter 444	NV Department of Environmental Protection	Permit required prior to construction or modification of a hazardous waste disposal facility.
Biotic resources	Nevada Non-Game Species Act	NV Admin. Code, Title 45, Chapter 503	NV Department of Wildlife	Consult with NV Department of Wildlife and minimize impact.
Cultural resources	Historic Preservation and Archaeology Regulations	NV Statutes, Title 26, Chapter 381-383	NV Advisory Board for Historic Preservation and Archaeology	Permit required prior to the investigation, exploration, or excavation of a historic or prehistoric site.
Worker safety and health	No state-level legislation identified	NA	NA	NA.
Oak Ridge Reservation, TN				
Air resources	Tennessee Air Pollution Control Regulations	TN Rules, Division of Air Pollution	TN Air Pollution Control Board	Permit required to construct, modify, or operate an air contaminant source; sets fugitive dust requirements.
Water resources	Tennessee Water Quality Control Act	TN Code, Title 69, Chapter 3	TN Water Quality Control Board	Authority to issue new or modify existing NPDES permits required for a water discharge source.
Oak Ridge Reservation, TN (continued)				
Hazardous wastes and soil resources	Tennessee Underground Storage Tank Program Regulations	TN Rules, Chapter 1200-1-15	TN Division of UST Programs	Permit required prior to construction or modification of an underground storage tank.

	Tennessee Hazardous Waste Management Act	TN Code, Title 68, Chapter 46	TN Division of Solid Waste Management	Permit required to construct, modify, or operate a hazardous waste treatment, storage, or disposal facility.
	Tennessee Solid Waste Processing and Disposal Regulations	TN Rules, Chapter 1200-1-7	TN Division of Solid Waste Management	Permit required to construct or operate a solid waste processing or disposal facility.
Biotic resources	Tennessee State Executive Order on Wetlands	TN State Executive Order	TN Division of Water Quality Control	Consultation with responsible agency.
	Tennessee Threatened Wildlife Species Conservation Act of 1974	TN Code, Title 70, Chapter 8	TN Wildlife Resources Agency	Consultation with responsible agency.
	Tennessee Rare Plant Protection and Conservation Act of 1985	TN Code, Title 70, Chapter 8-301 et seq.	TN Wildlife Resources Agency	Consultation with responsible agency.
	Tennessee Water Quality Control Act	TN Code, Title 69, Chapter 3	TN Division of Water Quality Control	Permit required prior to alteration of a wetland.
Cultural resources	Tennessee Desecration of Venerated Objects	TN Code, Title 39, Chapter 17-311	TN Historical Commission	Forbids a person to offend or intentionally desecrate venerated objects including a place of worship or burial.
	Tennessee Abuse of Corpse	TN Code, Title 39, Chapter 17-312	TN Historical Commission	Forbids a person from disinterring a corpse that has been buried or otherwise interred.
	Native American Indian Cemetery Removal and Reburial	TN Comp. Rules and Regulations, Chapter 400-9-1	TN Historical Commission	Requires notification if Native American Indian remains are uncovered.

	Tennessee Protective Easements	TN Code, Title 11, Chapter 15-101	TN State Government	Grants power to the state to restrict construction on land deemed as a "protective" easement.
Worker safety and health	No state-level legislation identified	NA	NA	NA.
Pantex Plant, TX				
Air resources	Texas Air Pollution Control Regulations	TX Admin. Code, Title 30, Chapter 101-125, 305	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit required prior to construction or modification of an air contaminant source.
Pantex Plant, TX (continued)				
Water resources	Texas Water Quality Standards	TX Admin. Code, Title 30, Chapter 305, 308-325	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit may be required prior to any modification of waters of the state including stream alteration for the construction of intakes, discharges, bridges, submarine utility crossings, etc.
	Texas Consolidated Permit Rules	TX Admin. Code, Title 30	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit may be required prior to any modification of waters of the state including stream alteration for the construction of intakes, discharges, bridges, submarine utility crossings, etc.

	Texas Water Quality Acts	TX Code, Title 30, Chapter 290	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit may be required prior to any modification of waters of the state including stream alteration for the construction of intakes, discharges, bridges, submarine utility crossings, etc.
Hazardous wastes and soil resources	Texas Underground Storage Tanks Rules	TX Admin. Code, Title 30, Chapter 334	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit required prior to construction or modification of an underground storage tank.
	Texas Solid Waste Management Regulations	TX Admin. Code, Title 30, Chapter 305, 335	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit required prior to construction or modification of a solid waste disposal facility.
	Texas Solid Waste Disposal Act	TX Admin. Code, Title 30, Chapter 305, 334, and 335	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit required prior to construction or modification of a solid waste disposal facility.
Biotic resources	Texas Parks and Wildlife Regulations	TX Parks and Wildlife Code, Chapter 67, 68, and 88	TX Parks and Wildlife Department	Permit required by anyone who possesses, takes, or transports endangered, threatened, or protected plants or animals.
Cultural resources	Antiquities Code of Texas	TX Statutes, Volume 17, Article 6145	TX State Historical Survey Committee	Permit required for the examination or excavation of sites and the collection or removal of objects of antiquity.
Worker safety and health	No state-level legislation identified			
Savannah River Site, SC				

Air resources	South Carolina Pollution Control Act/South Carolina Air Pollution Control Regulations and Standards	SC Code, Title 48, Chapter 1	SC Dept. of Health and Environmental Control (SCDHEC)	Permit required prior to construction or modification of an air contaminant source.
	Augusta-Aiken Air Quality Control Region	40 CFR 81.114	SC and GA	Requires SRS and surrounding communities in the 2-state region to attain National Ambient Air Quality Standards (NAAQS).
	South Carolina Atomic Energy & Radiation Control Act	SC Code, Title 13, Chapter 7	SCDHEC	Establishes standards for radioactive air emissions.
Water resources	South Carolina Pollution Control Act	SC Code, Title 48, Chapter 1	SCDHEC	Permit required prior to construction or modification of a water discharge source.
	South Carolina Water Quality Standards	SC Code, Title 61, Chapter 68	SCDHEC	Permit required prior to construction or modification of a water discharge source.
	South Carolina Safe Drinking Water Act	SC Code, Title 44, Chapter 55	SCDHEC	Establishes drinking water standards.
Hazardous wastes and soil resources	South Carolina Underground Storage Tanks Act	SC Code, Title 44, Chapter 2	SCDHEC	Permit required prior to construction or modification of an underground storage tank.
	South Carolina Solid Waste Regulations	SC Code, Title 61, Chapter 60	SCDHEC	Permit required to store, collect, dispose, or transport solid wastes.
	South Carolina Industrial Solid Waste Disposal Site Regulations	SC Code, Title 61, Chapter 66	SC Pollution Control Authority	Permit required for industrial solid waste disposal systems.

	South Carolina Hazardous Waste Management Act	SC Code, Title 44, Chapter 56	SCDHEC	Permit required to operate, construct, or modify a hazardous waste treatment, storage, or disposal facility.
	South Carolina Solid Waste Management Act	SC Code, Title 44, Chapter 96	SCDHEC	Establishes standards to treat, store, or dispose of solid waste.
Biotic resources	South Carolina Nongame and Endangered Species Conservation Act	SC Code, Title 50, Chapter 15	SC Wildlife and Marine Resources Department	Consult with SC Wildlife and Marine Resources Department and minimize impact.
Cultural resources	South Carolina Institute of Archaeology and Anthropology	SC Code, Title 60, Chapter 13-210	SC State Historic Preservation Office	Consult with SC State Historic Preservation Office and minimize impact.
Worker safety and health	No state-level legislation identified	NA	NA	NA

5.4 Federal and State Environmental Enforcement

Under various Federal environmental statutes (table 5.3-1), EPA may delegate the implementation and execution of the laws' various provisions to states with approved programs that are at least as stringent as the minimum Federal requirements contained in the laws and EPA regulations. Table 5.3-4 lists many of the states' laws and regulations, including provisions that are more stringent than the minimum requirements. In addition, the *Federal Facility Compliance Act* of 1992 waives sovereign immunity from enforcement of the *Resource Conservation and Recovery Act* (RCRA) at Federal facilities and thereby gives states the authority to assess fines and penalties under certain conditions. It further requires DOE to develop plans and enter into agreements with states as to specific management actions for particular mixed waste streams. Such agreements could have a direct effect on the wastes generated as a result of the implementation of the proposed action, yet such an effect cannot be determined until such time as these agreements are approved according to the terms of the *Federal Facility Compliance Act* .

Some environmental regulatory programs are enforced through review, approval, and permitting requirements that attempt to minimize the negative impacts from releases to the environment from potential pollution sources by limiting activities to established standards. Federal and state agencies share environmental regulatory authority over DOE facility operations when Federal legislation delegates permitting or review authority to qualifying states. Some examples are the following: National Emission Standards for Hazardous Air Pollutants and the Prevention of Significant

Deterioration under the *Clean Air Act* ; the Water Quality Standards and the National Pollutant Discharge Elimination System under the *Clean Water Act* ; the Hazardous Waste Programs under RCRA; and the Drinking Water and Underground Injection Control Programs under the *Safe Drinking Water Act* . When Federal legislation allows delegation of enforcement authority, states must set standards equal to or more stringent than those required by Federal law to obtain such authority. Where the Federal regulatory agency has delegated its authority, the state or local regulations set the governing standards; however, when Federal legislation does not provide for delegation of enforcement authority to the states (e.g., the *Toxic Substances Control Act*), the standards are administered and enforced solely by the Federal Government.

5.5 Compliance with Occupational Safety and Health Requirements

The health and safety of all workers associated with the stockpile stewardship and management facilities is a primary consideration in the programmatic decision resulting from this PEIS. A comprehensive nuclear and occupational safety and health initiative was announced by the Secretary on May 5, 1993, entailing closer consultation with the Occupational Safety and Health Administration (OSHA) regarding regulation of worker safety and health at DOE contractor-operated facilities. Regulation of worker health and safety at DOE contractor-operated facilities will gradually shift from DOE to OSHA. The Occupational Safety and Health Act of 1970 (Public Law 91-596) establishes Federal requirements for ensuring occupational safety and health protection for employees. DOE facilities also comply with the Emergency Planning and Community Right-To-Know Act (42 USC §11001), which requires facilities to report the release of extremely hazardous substances and other specified chemicals; to provide material safety data sheets or lists thereof; and to provide estimates of the amounts of hazardous chemicals onsite. The reporting and emergency preparedness requirements are designed to protect both individuals and communities.

CHAPTER 6: REFERENCES

ORDERS AND REGULATIONS

10 CFR 20 Nuclear Regulatory Commission (NRC), "Energy: Standards for Protection Against Radiation," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, January 1, 1995.

10 CFR 61 NRC, "Energy: Licensing Requirements for Land Disposal of Radioactive Waste," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, January 1, 1995.

10 CFR 835 U.S. Department of Energy, (DOE), "Energy: Occupational Radiation Protection," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, January 1, 1995.

10 CFR 1021 DOE, "Energy: Compliance with the National Environmental Policy Act," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, January 1, 1995.

36 CFR 60 National Park Service, "National Register of Historic Places," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 50 Environmental Protection Agency (EPA), "Protection of the Environment: National Primary and Secondary Ambient Air Quality Standards," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 52 EPA, "Protection of the Environment: Approval and Promulgation of Implementation Plans," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 61 EPA, "Protection of the Environment: National Emission Standards for Hazardous Air Pollutants," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 81 EPA, "Protection of the Environment: Designation of Areas for Air Quality Planning Purposes," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 141 EPA, "Protection of the Environment: National Primary Drinking Water Regulations," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 143 EPA, "Protection of the Environment: National Secondary Drinking Water Regulations," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 190 EPA, "Protection of the Environment: Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 268 EPA, "Protection of the Environment: Land Disposal Restrictions," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 300 EPA, "Protection of the Environment: National Oil and Hazardous Substances Pollution Contingency Plan," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 433 EPA, "Protection of Environment--Effluent Guidelines and Standards: Metal Finishing Point Source Category," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 503 EPA, "Protection of Environment: Standards for the Use or Disposal of Sewage Sludge," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1500 Council on Environmental Quality (CEQ), "Protection of the Environment: Purpose, Policy and Mandate," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1501 CEQ, "Protection of the Environment: NEPA and Agency Planning," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1502 CEQ, "Protection of the Environment: Environmental Impact Statement," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1503 CEQ, "Protection of the Environment: Commenting," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1504 CEQ, "Protection of the Environment: Predecision Referrals to the Council of Proposed Federal Actions Determined to be Environmentally Unsatisfactory," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1505 CEQ, "Protection of the Environment: NEPA and Agency Decision Making," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1506 CEQ, "Protection of the Environment: Other Requirements of NEPA," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1507 CEQ, "Protection of the Environment: Agency Compliance," Code of Federal Regulations,Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

40 CFR 1508 CEQ, "Protection of the Environment: Terminology and Index," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, Revised July 1, 1995.

49 CFR Subchapter C Department of Transportation, "Transportation--Hazardous Materials Regulations," Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, October 1, 1994.

50 CFR 17.11 U.S. Fish and Wildlife Service (FWS), "Endangered and Threatened Wildlife and Plants--Endangered and Threatened Wildlife," Code of Federal Regulations, Fish and Wildlife Service, U.S. Department of the Interior, Washington, DC, October 31, 1995.

50 CFR 17.12 FWS, "Endangered and Threatened Wildlife and Plants--Endangered and Threatened Plants," Code of Federal Regulations, Fish and Wildlife Service, U.S. Department of the Interior, Washington, DC, October 31, 1995.

56 FR 33050 EPA, "National Primary Drinking Water Regulations; Radionuclides," Federal Register, Vol. 56, No. 138, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, July 18, 1991.

58 FR 16268 DOE, "Radiation Protection of the Public and the Environment," Federal Register, Vol. 58, No. 56, Office of the Federal Register, National Archives and Records Administration, U.S.

Government Printing Office, Washington, DC, March 25, 1993.

60 FR 28680 DOE, "Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs," Federal Register, Vol. 60, No. 105, June 1, 1995.

60 FR 29914 FWS, "Endangered and Threatened Wildlife and Plants; Determination of Critical Habitat for the Mexican Spotted Owl," Federal Register, Vol, 60, No. 108, June 6, 1995.

60 FR 31291 DOE, "Notice of Intent to Prepare a Stockpile Stewardship and Management Programmatic Environmental Impact Statement," Federal Register, Vol. 60, No. 114, June 14, 1995.

61 FR 7596 FWS, "Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that are Candidates for Listing as Endangered or Threatened Species," Federal Register, Vol. 61, No. 40, February 28, 1996.

61 FR 9441 DOE, "Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs," Federal Register, Vol. 61, No. 47, March 8, 1996.

DOE Order 5400.5 DOE, "Radiation Protection of the Public and the Environment, Office of Environment, Safety and Health, Washington, DC, January 7, 1993.

PL 101-615 Public Law 101-615--101st Cong. 2d sess., "Hazardous Materials Transportation Uniform Safety Act of 1990," Amended November 16, 1990.

PL 102-484 Public Law 102-484--102d Cong. 2d sess., "National Defense Authorization Act for Fiscal Year 1993," October 23, 1992.

PL 103-160 Public Law 103-160--103d Cong. 1st sess., "National Defense Authorization Act of 1994," November 3, 1993.

GENERAL

AD 1990a Schneider, J.S., D.H. Moore, and R.W. Sagebiel, "Early Diagnosis of Cutaneous Malignant Melanoma at Lawrence Livermore National Laboratory," Arch Dermatol, 967-969, 1990.

AEC 1968a Casarett, A.P., Radiation Biology, prepared under the direction of the American Institute of Biological Science for the Division of Technical Information United States Atomic Energy Commission, Prentice Hall, Inc., Englewood Cliffs, NJ, 1968.

AEH 1981a Polednak, A.P., "Mortality Among Welders, Including a Group Exposed to Nickel Oxides," Archives of Environmental Health, Vol. 36, pp 235-241, 1981.

AEH 1987a Archer, V. E., "Association of Nuclear Fallout with Leukemia in the United States," Archives of Environ Health, Vol. 42, No. 5, pp 263-271, 1987.

AJE 1987c *Machado, S.G., C.E. Land, and F.W. McKay , "Cancer Mortality and Radioactive Fallout in Southwestern Utah," American Journal of Epidemiology* , Vol. 125, No. 1, pp 44-61, The Johns Hopkins University School of Hygiene and Public Health, Baltimore, MD, 1987.

AJE 1988a Checkoway, H., N. Pearce, D.J. Crawford-Brown, and D.L. Cragle, "Radiation Doses and Cause-Specific Mortality Among Workers at a Nuclear Materials Fabrication Plant," American Journal of Epidemiology, Vol. 127, No. 2, pp 255-266, The Johns Hopkins University School of Hygiene and Public Health, Baltimore, MD, 1988.

AJE 1990a Gilbert, E.S., S.A. Fry, L.D. Wiggs, G.L. Voelz, D.L. Cragle, and G.R. Petersen, "Methods for Analyzing Combined Data from Studies of Workers Exposed to Low Doses of Radiation," American Journal of Epidemiology, Vol. 131, pp 917-927, 1990.

AJIM 1988a Carpenter, A.V., W.D. Flanders, E.L. Frome, W.G. Tankersley, and S.A. Fry, "Chemical Exposures and Central Nervous System Cancers: A Case-Control Study Among Workers at Two Nuclear Facilities," American Journal of Industrial Medicine, Vol. 13, pp. 351-362, Alan R. Liss, Inc., 1988.

AJIM 1988b Cragle, D.L., R.W. McLain, J.R. Qualters, J.L.S. Hickey, G.S. Wilkinson, W.G. Tankersley, and C.C. Lushbaugh, "Mortality Among Workers at a Nuclear Fuels Production Facility," American Journal of Industrial Medicine, Vol. 14, pp 379-401, Alan R. Liss, Inc., 1988.

AJIM 1993a Wing, S., C.M. Shy, J.L. Wood, S. Wolf, D.L. Cragle, W. Tankersley, and E.L. Frome, "Job Factors, Radiation and Cancer Mortality at Oak Ridge National Laboratory: Follow-Up Through 1984," American Journal of Industrial Medicine, Vol 23, pp 265-279, Wiley-Liss, Inc., 1993.

AJIM 1995a Broadwell, D.K., D.J. Darcey, H.K. Hudnell, D.A. Otto, and W.K. Boyes, "Work-Site Clinical and Neurobehavioral Assessment of Solvent-Exposed Microelectronics Workers," American Journal of Industrial Medicine, Vol. 27, pp. 677-698, 1995.

AJIM 1996a Loomis, D.P. and S.H. Wolf, "Mortality of Workers at a Nuclear Materials Production Plant at Oak Ridge, Tennessee, 1947-1990," American Journal of Industrial Medicine, Vol. 29, pp 131-141, 1996.

AJM 1974a Rallison, M.L., B.M. Dobyns, F.R.eating, J.E. Rall, and F.H. Tyler, "Thyroid Disease in Children," American Journal of Medicine, Vol. 56, pp 457-463, 1974.

AJPH 1971a Weiss, E.S., M.L. Rallison, W.T. London, G.D.C. Thompson, "Thyroid Nodularity in Southwestern Utah School Children Exposed to Fallout Radiation," American Journal Public Health, pp 241-249, 1971.

AJPH 1987a Carpenter, A.V., W.D. Flanders, E.L. Frome, P.Cole, and S.A. Fry, "Brain Cancer and Nonoccupational Risk Factors: A Case-Control Study Among Workers at Two Nuclear Facilities," American Journal of Public Health, Vol. 77, No. 9, pp. 1180-1182, September 1987.

Almanac 1993a The 1993 Information Please Almanac Atlas and Yearbook, Houghton Mifflin Company, 46th Edition, Boston, MA, 1993.

AN 1988a Albers, J.W., et al, "Neurological Abnormalities Associated with Remote Occupational Elemental Mercury Exposure," Annals of Neurology, Vol. 24, pp 651-659, 1988.

ANL 1993b Yuan, Y.C., et al., RISKIND--A Computer Program for Calculating Radiological Consequences and Health Risks from Transportation of Spent Nuclear Fuel, ANL/EAIS-6, Argonne National Laboratory, Argonne, IL, 1993.

ANL 1995a:1 Argonne National Laboratory (ANL), "Comments of the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," (Version 3 and later), Argonne, IL, 1995.

ANL 1995b ANL, Preliminary Draft Technical Support Material for the National Ignition Facility Project Specific analysis -- Formally the NIF PSA Appendices, Ver. 1, Environmental Assessment Division, Argonne, IL, 1995.

AOEH 1992a Cragle, D.L., S.M. Wells, and W.G. Tankersley, "An Occupational Morbidity Study of a Population Potentially Exposed to Epoxy Resins, Hardeners and Solvents," Applied Occupational and Environmental Hygiene, Vol. 7, pp 826-834, 1992.

APCA 1986a Schulman, L.L., and S.R. Hanna, "Evaluation of Downwash Modifications to the Industrial Source Complex Model," Journal of the Air Pollution Control Association, prepared by Environmental Research and Technology, Inc., Concord, MA for Air Pollution Control Association, 1986.

APHA 1988a Wiggs, L.D., C.A. Weber, and E.T. Lee, "Suicide Mortality Among Female Nuclear Industry Workers," 116th Annual Meeting of the American Public Health Association and Related Organizations Technology and Health Problems and Promise, prepared by Los Alamos National Laboratory and University of Oklahoma, Health Sciences Center for the American Public Health Association, Washington, DC, November 13-17, 1988.

BJIM 1985a Checkoway, H., R.M. Mathew, C.M. Shy, J.E. Watson, Jr., W.G. Tankersley, S.H. Wolf, J.C. Smith, and S. A. Fry, "Radiation, Work Experience, and Cause Specific Mortality Among Workers at an Energy Research Laboratory," British Journal of Industrial Medicine, Vol. 42, pp 525-533, 1985.

CA DFG 1994a California Department of Fish and Game, Special Animals, State of California, The Resources Agency, Natural Heritage Division, Natural Diversity Data Base, Sacramento, CA, August 1994.

CA DFG 1995a California Department of Fish and Game, Endangered and Threatened, Animals of California, State of California, The Resources Agency, Natural Heritage Division, Natural Diversity Data Base, Sacramento, CA, October 1995.

CA DFG 1995b California Department of Fish and Game, Endangered, Threatened, and Rare Plants of California, State of California, The Resources Agency, Natural Heritage Division, Plant Conservation Program, Sacramento, CA, September 1995.

CA DFG 1995c California Department of Fish and Game, Special Plants List, State of California, The Resources Agency, Natural Heritage Division, Natural Diversity Data Base, Sacramento, CA, October 1995.

CA DHS 1995a California Department of Health Services, Cancer Incidence Among Children and Young Adults in Livermore, California 1960-1991, Environmental Health Investigations Branch, September 6, 1995.

CA EPA 1993a California Environmental Protection Agency Air Resources Board, California Air Quality Data, Summary of 1993 Air Quality Data, Gaseous and Particulate Pollutants, Vol. XXV, Sacramento, CA, 1993.

Census 1982c Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--South Carolina, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1982d Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--Tennessee, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1982f Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--Missouri, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1982j Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--Georgia, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1982o Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--New Mexico, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1982u Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--Kansas, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1982v Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--Texas, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1982w Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--Nevada, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1982y Bureau of the Census, 1980 Census of Population and Housing Summary of Population and Housing Characteristics--California, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1982.

Census 1983b Bureau of the Census, 1980 Census of Population Characteristics of the Population General Social and Economic Characteristics--South Carolina, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1983.

Census 1983c Bureau of the Census, 1980 Census of Population Characteristics of the Population General Social and Economic Characteristics--Georgia, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1983.

Census 1983g Bureau of the Census, 1980 Census of Population Characteristics of the Population General Social and Economic Characteristics--New Mexico, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1983.

Census 1983q Bureau of the Census, 1980 Census of Population Characteristics of the Population General Social and Economic Characteristics--Tennessee, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1983.

Census 1990a Bureau of the Census, County and City Data Book, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, 1990.

Census 1991a Bureau of the Census, 1990 Census of Population and Housing Summary Population and Housing Characteristics--Georgia, 1990 CPH-1-12, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1991b Bureau of the Census, 1990 Census of Population and Housing Summary Population and Housing Characteristics--South Carolina, 1990 CPH-1-42, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1991c Bureau of the Census, 1990 Census of Population and Housing Summary Population and Housing Characteristics--Tennessee, 1990 CPH-1-44, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1991f Bureau of the Census, 1990 Census of Population and Housing Summary Population and Housing Characteristics--Missouri, 1990 CPH-1-27, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1991g Bureau of the Census, 1990 Census of Population and Housing Summary Population and Housing Characteristics--Nevada, 1990 CPH-1-30, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1991h Bureau of the Census, *1990 Census of Population and Housing Summary Population and Housing Characteristics--New Mexico,* 1990 CPH-1-33, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1991j Bureau of the Census, *1990 Census of Population and Housing Summary Population and Housing Characteristics--California*, 1990 CPH-1-6, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1991m Bureau of the Census, 1990 Census of Population and Housing Summary Population and Housing Characteristics--Texas, 1990 CPH-1-45, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1991ff Bureau of the Census, 1990 Census of Population and Housing Summary Population and Housing Characteristics--Kansas, 1990 CPH-1-18, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1991.

Census 1993a Bureau of the Census, "1992 Population Estimates for States, Counties, MCD's and Incorporated Places," (Database), U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, 1993.

Census 1993b Bureau of the Census, 1990 Census of Population Social and Economic Characteristics--Tennessee, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1993c Bureau of the Census, 1990 Census of Population Social and Economic Characteristics--South Carolina, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1993e Bureau of the Census, 1990 Census of Population Social and Economic Characteristics--Georgia, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1993f Bureau of the Census, 1990 Census of Population Social and Economic Characteristics--Arizona, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1993m Bureau of the Census, 1990 Census of Population Social and Economic Characteristics--New Mexico, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1993q Bureau of the Census, 1990 Census of Population Social and Economic Characteristics--Missouri, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1993s Bureau of the Census, 1990, Census of Population and Housing Summary Tape File, Database (A3), Department of Commerce, Washington, DC, 1993.

Census 1993t Bureau of the Census, *1990 Census of Population Social and Economic Characteristics--Kansas*, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1993.

Census 1993w Bureau of the Census, *1990 Census of Population Social and Economic Characteristics--Texas*, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, August 1993.

Census 1993x Bureau of the Census, *1990 Census of Population Social and Economic Characteristics--California*, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1993y Bureau of the Census, *1990 Census of Population Social and Economic Characteristics--Nevada*, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1993z Bureau of the Census, *1990 Census of Population Social and Economic Characteristics--Utah*, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, September 1993.

Census 1994o Bureau of the Census, County and City Data Book 1994, U.S. Department of Commerce, Economics and Statistical Administration, Washington, DC, 12th Edition, August 1994.

DOC 1982a Cottman, J.L., C.A. von Hake (Editors), Earthquake History of the United States, prepared by U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Geological Survey, Boulder, CO, 1982.

DOC 1990c U.S. Department of Commerce, *BEA Regional Projections to 2040, Volume 3: BEA*

Economic Areas, Projections Branch, Regional Economic Analysis Division, Bureau of Economic Analysis, October 1990.

DOC 1990d U.S. Department of Commerce, *BEA Regional Projections to 2040, Volume 1: States,* Projections Branch, Regional Economic Analysis Division, Bureau of Economic Analysis, June 1990.

DOC 1994j Campbell, P. R., Population Projections for States, by Age, Sex, Race and Hispanic Origin: 1993-2020, P2S-1111, U.S. Department of Commerce, Economics and Statistics Administration, Washington, DC, 1994.

DOC 1995a Bureau of Economic Analysis, REIS - Regional Economic Information System 1969 - 1993 (CD-ROM), U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, Regional Economic Measurement Division, Washington, DC, May 1995.

DOD 1962a Glasstone, S. (Editor), The Effects of Nuclear Weapons, U.S. Department of Defense and U.S. Atomic Energy Commission, Washington, DC, Revised Edition, 1962.

DOD 1977a Glasstone, S. and P.J. Dolan (Editors), The Effects of Nuclear Weapons, U.S. Department of Defense and U.S. Department of Energy, Washington, DC, Third Edition, 1977.

DOE 1985a DOE, Department of Energy National Environmental Research Parks, DOE/ER-0246, Office of Energy Research, Office of Health & Environmental Research, Washington, DC, August 1985.

DOE 1985b Robinette, C. D., S. Jablon, and T. L. Preston, Studies of Participants in Nuclear Tests, September 1, 1978 through October 31, 1984, Final Report, DOE/EV/01577, work performed under Contract DE-AI08-78EV01577 by Medical Follow-up Agency, National Research Council, for the U. S. Department of Energy, Washington, DC, 1985.

DOE 1991h Martin Marietta Energy Systems (MMES), Integrated Data Base for 1991: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, DOE/RW-0006, Revision 7, prepared under Contract DE-AC05-84OR 21400 by Oak Ridge National Laboratory for the U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Office of Environmental Restoration and Waste Management, Washington, DC, October 1991.

DOE 1991j DOE, Nuclear Weapons Complex Reconfiguration Site Evaluations, A Report by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel, Predecisional, U.S. Department of Energy Field Office, San Francisco, CA, October 1991.

DOE 1992c DOE, Implementation Plan Nuclear Weapons Complex Reconfiguration Programmatic Environmental Impact Statement, DOE/EIS-0161IP, prepared by Office of Defense Programs, Deputy Assistant Secretary for Weapons Complex Reconfiguration, Washington, DC, February 1992.

DOE 1992e DOE, Environmental and Other Evaluations of Alternatives for Siting, Constructing, and Operating New Production Reactor Capacity, Volume 1: Section 1-10, DOE/NP-0014, U.S. Department of Energy, Office of New Production Reactors, Washington, DC, September 1992.

DOE 1992f ORNL, Integrated Data Base for 1992: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, DOE/RW-0006, Revision 8, prepared under Contract DE-AC05-84OR 21400 by Oak Ridge National Laboratory for the U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Office of Environmental Restoration and Waste Management, Washington, DC, October 1992.

DOE 1992o:3 DOE, "Hazardous Materials Shipments for Selected Sites--Times and Distance," computer printout, information provided from U.S. Department of Energy Albuquerque Field Office, Transportation Safeguards Division, Transportation Management Branch, Oak Ridge, TN, March 23, 1992.

DOE 1993e DOE, Environmental Restoration and Waste Management Five-Year Plan, Fiscal Years 1994-1998, DOE/S-00097PVol.1, Volume 1, U.S. Department of Energy, Washington, DC, January 1993.

DOE 1993h DOE, U.S. Department of Energy Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities and Technologies, DOE/NBM-1100, Volume V: Site Specific--Tennessee through Washington, U.S. Department of Energy, Washington, DC, April 1993.

DOE 1993j DOE, Nonnuclear Consolidation Environmental Assessment Nuclear Weapons Complex Reconfiguration Program, DOE/EA-0792, Volume 1, U.S. Department of Energy, Washington, DC, June 1993.

DOE 1993n:7 DOE, "Compilation of Doses to Workers at DOE Facilities in 1992," U.S. Department of Energy, Washington, DC, 1993.

DOE 1994c ORNL, Integrated Data Base for 1993: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, DOE/RW-0006, Revision 9, prepared under Contract DE-AC05-84OR 21400 by Oak Ridge National Laboratory, Managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Office of Environmental Restoration and Waste Management, Washington, DC, March 1994.

DOE 1994d ORNL, Integrated Data Base for 1993: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, DOE/RW-0006, Revision 10, prepared under Contract DE-AC05-84OR 21400 by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Office of Environmental Management, Washington, DC, December 4, 1994.

DOE 1994k ICF Incorporated, "Final Phase II Mixed Waste Inventory Report (Database)," prepared by ICF Incorporated, Arlington, VA, U. S. Department of Energy, Patricia Bubar, Director, EM-25, Federal Facility Compliance, Task Force, Office of Waste Management, Environmental Management, Washington, DC, May 14, 1994.

DOE 1994n Martin Marietta Energy Systems (MMES), "Waste Management Information System (Database)," Version 2.0, prepared under Contract DE-AC05-84OR214 Hazardous Waste Remedial Action Program for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, TN, March 1994.

DOE 1994s Kelly, D.L., User's Guide for Shipping Type B Quantities of Radioactive and Fissile Material, Including Plutonium, in DOT-6M Specification Packaging Configurations, DOE/RL-94-68, prepared by Westinghouse Hanford Company, Richland, WA, for the U.S. Department of Energy, Transportation Management Division, Office of Environmental Management, September 1994.

DOE 1994v DOE, Comparative Study of Waste Isolation Pilot Plant (WIPP) Transportation Alternatives, DOE/WIPP 93-058, U.S. Department of Energy, Washington, DC, February 1994.

DOE 1995h Dixson, A.L., "Shipment Mobility/Accountability Collection System (Database)," request for information provided by Andrew L. Dixson, Science Applications International Corporation, Oak Ridge, TN for the U.S. Department of Energy (EM-561), Washington, DC, 1995.

DOE 1995i DOE, Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling, DOE/EIS-0161, Volume 1, Office of Reconfiguration, U.S. Department of Energy, Washington, DC, October 1995.

DOE 1995p DOE, Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, DOE/EIS-0203-F, Volume 1, Appendix C, Office of Environmental Management, Idaho Operations Office, U.S. Department of Energy, Idaho Falls, ID, April 1995.

DOE 1995q DOE, Estimating the Cold War Mortgage, the 1995 Baseline Environmental Management Report, DOE/EM-0232, Volume II: Site Summaries, March 1995.

DOE 1995w DOE, Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, DOE/EIS-0203-F, Volume 1, Appendix F, Office of Environmental Management, Idaho Operations Office, U.S. Department of Energy, Idaho Falls, ID, April 1995.

DOE 1995cc DOE, *Waste Management Draft Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste,* DOE/EIS-0200-D, *Volume I of IV, U.S. Department of Energy, Office of Environmental Management, Washington, DC,* August 1995.

DOE 1995gg DOE, *1995 National Mixed Waste Inventory Report (Database),* Office of Waste Management and Office of Environmental Restoration, U.S. Department of Energy, Washington, DC, November 8, 1995.

DOE 1995hh DOE, *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement*, DOE/EIS-0228, U.S. Department of Energy, Albuquerque Operations Office, Los Alamos Area Office, Albuquerque, NM, August 1995.

DOE 1995kk ORNL, Integrated Data Base for 1994: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, DOE/RW-0006, prepared under Contract DE-AC05-84OR 21400 by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Office of Environmental Management, Washington, DC, Revision 11, November 29, 1995.

DOE 1996a DOE, Storage and Disposition of Weapons-Usable Fissile Materials Draft Programmatic Environmental Impact Statement, DOE/EIS-0229-D, Volume I, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, February 1996.

DOE 1996h DOE, Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement, DOE/EIS-0249F, Volume I, U.S. Department of Energy, Office of Nuclear Energy, Science and Technology, Washington, DC, April 1996.

DOE 1996j DOE, Analysis of Stockpile Management Alternatives in Support of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM, July 1996.

DOE 1996k DOE, Analysis of Stockpile Management Preferred Alternatives Report in support of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, U.S. Department of Energy, Washington, DC, July 1996.

DOE 1996m DOE, Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement, DOE/EIS-0240, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, June 1996.

DOL 1991a DOL, Local Area Unemployment Statistics Annual Averages for 1990, Bureau of Labor Statistics, Washington, DC, 1991.

DOL 1995a DOL, Local Area Unemployment Statistics Annual Averages for 1994, Bureau of Labor Statistics, Washington, DC, May 18, 1995.

ED 1982a Johnson, C.J., "Environmental and Health Effects of the Nuclear Industry and Nuclear Weapons: A Current Evaluation," *Ecology of Disease*, prepared by Carl J. Johnson, Department of Preventative Medicine and Biometrics, University of Colorado School of Medicine, Denver, Co, Pergamon Press Ltd., Great Britain, 1982.

EPA 1977a EPA, User's Manual For Single Source (CRSTER) Model, EPA-450/2-77-013, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, NC, July 1977.

EPA 1981a Bowers, J. F., and A. J. Anderson, An Evaluation Study for the Industrial Source Complex (ISC) Dispersion Model, EPA-450/4-81-002, prepared under Contract 68-02-3323 Work No. 5 by H. E. Cramer Company, Inc., Salt Lake City, UT, for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Source Receptor Analysis Branch, Research Triangle Park, NC, January 1981.

EPA 1981b Bogen and Goldin, Population Exposure to External Natural Radiation Background in the United States, PB81-233082, Office of Radiation Programs, Environmental Protection Agency, Washington, DC, April 1981.

EPA 1982a Bowers, J.F., A. J. Anderson, and W. R. Hargraves, Tests of the Industrial Source Complex (ISC) Dispersion Model at the Armco Middletown, Ohio, Steel Mill, EPA-450/4-82-006, prepared under Contract 68-02-3323 by H. E. Cramer Company, Inc., University of Utah Research Park, Salt Lake City, UT for U.S. Environmental Protection Agency, Source Receptor Analysis Branch, Research Triangle Park, NC, February 1982.

EPA 1992f EPA, User's Guide for the Industrial Source Complex (ISC2) Dispersion Models, EPA-450/4-92-008a, Volume I - User Instructions, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Technical Support Division, Research Triangle Park, NC, March 1992.

Epidemiology 1993a Hiatt, R.A., N. Krieger, R.W. Sagebiel, W.H. Clark, and M.C. Mihm, "Surveillance Bias and the Excess Risk of Malignant Melanoma Among Employees of the Lawrence Livermore National Laboratory," Epidemiology, pp 43-47, 1993.

Epidemiology 1995a Dupree, E.A., J.P. Watkins, J.N. Ingle, P.W. Wallace, C.M. West, and W.G. Tankersley, "Lung Cancer Risk and Uranium Dust Exposure in Four Uranium Processing Operations," Epidemiology, Vol. 6, pp 370-375, 1995.

EPRI 1983a TRC Environmental Consultants, Inc., Overview, Results, and Conclusion for the EPRI Plume Model Validation and Development Project: Plains Site, Research Project 1616-1, EPRI-EA-3074, prepared for Electric Power Research Institute, Palo Alto, CA, May 1983.

EPRI 1985a TRC Environmental Consultants, Inc., Summary of Results and Conclusions for the EPRI Plume Model Validation and Development Project: Moderately Complex Terrain Site, Research Project 1616-1, EPRI-EA-3755, prepared for Electric Power Research Institute, Palo Alto, CA, May 1985.

EPRI 1988a TRC Environmental Consultants, Inc., Urban Power Plant Plume Studies, Research Project 2736-1, EPRI-EA-5463, prepared for Electric Power Research Institute, Palo Alto, CA, January 1988.

ER 1980a Polednak, A.P., "Mortality Among Men Occupationally Exposed to Phosgene in 1943-1945," Environmental Research, Vol. 22, pp 357-367, Medical and Health Sciences Division, Oak Ridge Associated Universities, Oak Ridge, TN, Academic Press, Inc., 1980.

ER 1981a Stebbings, Jr., J.H. and G.L. Voelz, "Morbidity and Mortality in Los Alamos County, New Mexico," *Environ Research, Vol. 25, pp 86-105, Academic Press, Inc.*, 1981.

ESRI 1995a Environmental Systems Research Institute, "ArcView Version 2.1," Socioeconomic regional economic area and region of influence maps, 1995.

FEMA 1983a Federal Emergency Management Agency, "Flood Insurance Rate Map City of North Las Vegas, Nevada," Washington, DC, 1983.

GRI 1992a Gale Research, Inc., Weather of U.S. Cities, Detroit, MI, 4th Edition, 1992.

GTI 1995a Geo Trans, Inc., A Fracture/Porous Media of Tritium Transport in the Underground Weapons Testing Areas: Nevada Test Site, Boulder, CO, 1995.

HNUS 1995a Halliburton NUS Corporation, Health Risk Data for Tritium Supply and Recycling Programmatic EIS, prepared for the U. S. Department of Energy, DP-43, Washington, DC, February 1995.

HNUS 1996a *Maltese, J.G., W.E. Joyce, A.L. Toblin, and S.R. Tammara, Supporting Documentation for the Accident Impacts Presented in the Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management, Topical Report, HNUS Report No. ARP-96-042, Halliburton NUS Corporation, Gaithersburg, MD, July 1996.*

HP 1983c Acquavella, J.F., G. Wilkinson, G. Tietjen, C. Key, J. Stebbings, and G. Voelz, "A Melanoma Case Control Study at the Los Alamos National Laboratory," Health Physics, Vol. 45, No. 3. pp 587-592, September 1983.

HP 1985a Acquavella, J.F., L.D. Wiggs, R.J. Waxweiler, D.G. MacDonell, G.L. Tietjan, and G.S. Wilkinson, "Mortality Among Workers at the Pantex Weapons Facility," Health Physics, Vol. 48. No. 6, pp 735-746, 1985.

HP 1990c Rallison, M.L., T.M. Lotz, M. Bishop, W. Divine, K. Haywood, J.L. Lyon, and W. Stevens, "Cohort Study of Thyroid Disease Near the Nevada Test Site: A Preliminary Report," Health Physics, Vol. 59, No. 5, pp 739-746, Health Physics Society, Pergamon Press, November 1990.

HP 1991a Voelz, G.L. and J.N.P. Lawrence, "A 42-y Medical Follow-Up of Manhattan Project Plutonium Workers," Health Physics, Vol. 61, No. 2, pp. 181-190, August 1991.

HP 1994a Wiggs, L.D., E.R. Johnson, C.A. Cox-DeVore, and G.L. Voelz, "Mortality Through 1990 Among White Male Workers at the Los Alamos National Laboratory. Considering Exposures to Plutonium and External Ionizing Radiation," Health Physics, Vol. 67, pp 577-588, 1994.

HP 1995a Till, J.E., S.L. Simon, R. Kerber, et al., "The Utah Thyroid Cohort Study: Analysis of the Dosimetry Results," Health Physics, Vol. 68, pp 472-483, 1995.

IARC 1984a Cragle, D.L., D.R. Hollis, T.H Newport, and C.M. Shy, "A Retrospective Cohort Mortality Study Among Workers Occupationally Exposed to Metallic Nickel Powder at the Oak Ridge Gaseous Diffusion Plant," Nickel in the Human Environment, IARC Scientific Publications No. 53, Editorial Board: F.W. Sunderman, Jr. Editor-in-Chief, A. Aitio, A. Berlin, C. Bishop, E. Buringh, W. Davis, M. Gounar, P.C. Jacquignon, E. Mastromatteo, J.P. Rigaut, C. Rosenfeld, R. Saracci, and A. Sors. International Agency for Research on Cancer, Lyon, Oxford University Press, New York, 1984.

ICBO 1994a 1994 Uniform Building Code© *1994. Reproduced with the permission of the publisher, the International Conference of Building Officials.*

***ICRP 1991a** Smith, H. (Editor), 1990 Recommendations of the International Commission on Radiological Protection, Annals of the ICRP, ICRP Publication 60, published for The International Commission on Radiological Protection by Pergamon Press, NY, 1991.*

***JAMA 1975a** Rallison, M.L., B.M. Dobyns, F.R. Keating, J.E. Rall, and F.H. Tyler, "Thyroid Nodularity in Children," Journal of the American Medical Association, Vol. 233, pp 1069-1072, 1975.*

***JAMA 1980a** Caldwell, G.G., D.B. Kelley, C.W. Heath, Jr., Journal of the American Medical Association, Vol. 244, No. 14, pp 1575-1578, October 3, 1980.*

***JAMA 1983a** Caldwell, G.G., D. Kelley, M. Zack, H. Falk, C.W. Heath, Jr., "Mortality and Cancer Frequency Among Military Nuclear Test (Smoky) Participants, 1957 through 1979," Journal of the American Medical Association , Vol. 250, No. 5, pp 620-624, August 5, 1983.*

***JAMA 1984a** Caldwell, G.G., D.B. Kelley, C.W. Heath, Jr., and M. Zack, "Polycythemia Vera Among Participants of a Nuclear Weapons Test," Journal of the American Medical Association, Vol. 252, No. 5, pp 662-664, August 3, 1984.*

***JAMA 1984b** Johnson, C.J., "Cancer Incidence in an Area of Radioactive Fallout Downwind from the Nevada Test Site," Journal of the American Medical Association, Vol. 251, No. 2, pp 230-236, January 13, 1984.*

JAMA 1991a *Journal of American Medical Association, Vol. 265, No. 11, pp 1397-1402, 1403-1408, March 20, 1991.*

JAMA 1993a *Kerber, R.A., J.E. Till, S.L. Simon, J.L. Lyon, D.C. Thomas, S. Preston-Martin, M.L. Rallison, R.D. Lloyd, and W.Stevens, "A Cohort Study of Thyroid Disease in Relation to Fallout From Nuclear Weapons Testing," Journal of American Medical Association, Vol. 271, No. 17, pp 2076-2082, November 3, 1993.*

JAMA 1994a *Dworkin, H.J., "Nuclear Weapons Testing Fallout and Thyroid Disease," Journal of American Medical Association, Vol. 271, No. 11, pp 825-826, March 16, 1994.*

JAMA 1994b *Lapp, R.E., "Nuclear Weapons Testing Fallout and Thyroid Disease," Journal of the American Medical Association, Vol. 271, No. 11, p. 826, March 16, 1994.*

JOM 1979a *Hadjimichael, C.C., A.M. Ostfeld, D.A. D'Atri, et al., "A Long-Term Mortality Study of Workers Occupationally Exposed to Metallic Nickel at the Oak Ridge Gaseous Diffusion Plant," Journal of Occupational Medicine, Vol. 21, pp 799-806, 1979.*

JOM 1981a *Polednak, A.P. and E.L. Frome, "Mortality Among Men Employed Between 1943 and 1947 at a Uranium-Processing Plant," Journal of Occupational Medicine, Vol. 23, No. 3, pp 169-178, March 1981.*

JOM 1984a *Cragle, D.L., D.R. Hollis, J.R. Qualters, W.G. Tankersley, and S.A. Fry, "A Mortality Study of Men Exposed to Elemental Mercury," Journal of Occupational Medicine, Vol. 26, No. 11, pp 817-821, November 1984.*

JOM 1987a *Carpenter, A.V., W.D. Flanders, E.L. Frome, D.J. Crawford-Brown, and S.A. Fry, "CNS Cancers and Radiation Exposure: A Case-Control Study Among Workers at Two Nuclear Facilities," Journal of Occupational Medicine, Vol. 29, No. 7, 601-604, July 1987.*

JRSS 1989a *Gardner, M.J., "Review of Reported Increase of Childhood Cancer in the Vicinity of Nuclear Installations in the United Kingdom," JR Stat Sec A, Vol. 152, No. pp 307-325, 1989.*

KC ABA 1986a *Allied Bendix Aerospace, Kansas City Plant Site Development Plan, BDX-613-2976R, Technical Communications, Bendix Kansas City Division, U.S. Department of Energy, Kansas City, MO, Revised December 1986.*

KC ASAC 1991a *Allied Signal Aerospace Company (ASAC), Annual Site Environmental Report for Calendar Year 1990, KCP-613-4578, U.S. Department of Energy, Kansas City, MO, May 1991.*

KC ASI 1995a *Allied Signal Inc., (ASI), KCP II, Complex 2010 Stockpile Stewardship and Management Programmatic Environmental Impact Statement Nonnuclear Alternative Data Report, Kansas City Division, August 4, 1995.*

KC City 1995a *"Statistical City Data for Regional Economic Area/Region of Influence, Kansas City Plant," Kansas City, MO, 1995.*

KC County 1995a *"Statistical County Data for Regional Economic Area/Region of Influence, Kansas City Plant," Kansas City, MO, 1995.*

KC DOE 1989a *DOE, Environmental Assessment Environmental Restoration Program Kansas City Plant, Kansas City, Missouri, DOE/AL, March 1989.*

KC DOE 1990a *DOE, Environmental Assessment Completion of Flood Protection Works Bannister Road Federal Complex Kansas City, Missouri, prepared by Planning Division, Environmental Resources Branch, U.S. Department of Energy, Kansas City Plant, Kansas City, MO, September 1990.*

KC DOE 1995a *ASI., 1994 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1 , prepared for the U.S. Department of Energy, Kansas City Area Office, October 23, 1995.*

KC School 1995a *"Statistical Data for Regional Economic Area/Region of Influence, Kansas City Plant," Kansas City, MO, 1995.*

KC USGS 1975a *USGS, "Geological Survey Grandview Quadrangle--Missouri," 1:24 000, Revised 1975.*

KCP 1991a:1 *ASAC, "No Action Alternative Datacall," PEIS request for information provided by Kansas City Plant, Kansas City, MO, November 1991.*

KCP 1991a:2 *ASAC, "No Action Alternative--Water Resources," PEIS request for information provided by Kansas City Plant, Kansas City, MO, November 1991.*

KCP 1991a:3 *ASAC, "No Action Alternative--Biological Resources," PEIS request for information provided by Kansas City Plant, Kansas City, MO, November 1991.*

KCP 1993a:1 *Jeffries, J.E. (Site Contact), "Comments--Nonnuclear Consolidation Environmental Assessment," PEIS request for information provided by Allied Signal Aerospace Company, U.S. Department of Energy, Kansas City Division, Kansas City, MO, to T.Uko, Reconfiguration Manager, Kansas City Area Office, Kansas City, MO, February 26, 1993.*

KCP 1995a:1 *KCP, "Affected Environment: No Action Data Call Response," Kansas City Plant response to the draft Affected Environment section provided to site representatives by the U.S. Department of Energy, April 1995.*

KCP 1995a:2 *KCP, "Data Resolution Comments," compilation of correspondence with Kansas City Plant clarifying in the Nonnuclear Alternative Data Package (KC ASI 1995a), 1995.*

KCP 1995a:3 *KCP and Albuquerque Operations Office, "Comments on Draft Versions of the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," (Version 3 and later), 1995.*

KCP 1995a:4 *Gentile, C., "Kansas City Plant RCRA Part B Permit Application," PEIS request for information provided by Allied Signal, Inc., Kansas City Plant, Kansas City, MO, October 9, 1995.*

LA BLM 1990a *USGS, "Surface Management Status Los Alamos, New Mexico, 1:100 000-Scale Metric Topographic Map," 10x60 quadrangle, edited and published by the Bureau of Land Management, 1990.*

LA City 1995a *"Statistical City Data for Regional Economic Area/Region of Influence, Los Alamos National Laboratory," Los Alamos, NM, 1995.*

LA County 1995a *"Statistical County Data for Regional Economic Area/Region of Influence, Los Alamos National Laboratory," Los Alamos, NM, 1995.*

LA DOE 1979a *DOE, Final Environmental Impact Statement, Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico, DOE/EIS-0018, Washington, DC, December 1979.*

LA NERP 1981a *White, G.C., Biotelemetry Studies on Elk, LA-8529-NERP, Los Alamos National Laboratory, Los Alamos, NM, 1981.*

LA School 1995b *"Statistical School Data for Regional Economic Area/Region of Influence, Los Alamos National Laboratory," Los Alamos, NM, 1995.*

LA USDA 1987c *USDA, Santa Fe National Forest Plan, Forest Service, South Western Region, Santa Fe National Forest, Santa Fe, NM, July 1987.*

LA USDA 1990a *USDA, "New Mexico State and Federal Natural Resource Recreation Map," Forest Service, Army Corps of Engineers; Interior Bureau of Land Management, Fish and Wildlife Service, National Park Service and State of New Mexico Departments of Game and Fish; Parks and Recreation; and Tourism and Travel Division, 1990.*

LA Wiggs 1987a *Wiggs, L.D., "Mortality Among Females Employed by the Los Alamos National Laboratory: An Epidemiologic Investigation," Doctoral dissertation, University of Oklahoma, 1987.*

Lancet 1981a *Austin, D.F., P.J. Reynolds, M.A. Snyder, M.W. Biggs, and H.A. Stubbs, "Malignant Melanoma Among Employees of Lawrence Livermore National Laboratory," Lancet, Vol. 2, pp. 712-716, 1981.*

Lancet 1982a *Acquavella, J.F., G.S. Wilkinson, G.L. Tietjen, Key, C.R., and G.L. Voelz, "Malignant*

Melanoma Incidence at the Los Alamos National Laboratory," The Lancet, pp 883-884, April 17, 1982.

Lancet 1987a *Schneider, J.S., R.W. Sagebiel, D.H. Moore, and G.M. Lawton, "Melanoma Surveillance and Earlier Diagnosis," The Lancet, p 1435, 1987.*

LANL 1984a *Purtymun, W. D., Hydrologic Characteristics of the Main Aquifer in the Los Alamos Area: Development of Ground Water Supplies, LA-9957-MS, UC-11, prepared under Contract W-7405-ENG-38 by Los Alamos National Laboratory, Los Alamos, NM, January 1984.*

LANL 1985a *Voelz, G.L., G.S. Wilkinson, J.W. Healy, J.F. McInroy, G.L. Tietjen, "Mortality Study of Los Alamos Workers with Higher Exposures to Plutonium," Report No. LA-UR-83-85, Los Alamos National Laboratory, 1985.*

LANL 1987a *LANL, "Maps Area 3, Technical Sites, Los Alamos and White Rock, Los Alamos,", Visitor's Guide, Los Alamos National Laboratory, NM, 1987.*

LANL 1987b *LANL, Environmental Surveillance at Los Alamos During 1986, LA-10992-ENV, Environmental Surveillance Group, Las Alamos National Laboratory, Los Alamos, NM, April 1987.*

LANL 1987c *Gardner, J.N., and L. House, Seismic Hazards Investigations at Los Alamos National Laboratory, 1984 to 1985, LA-11072-MS, prepared by Los Alamos National Laboratory, Los Alamos, NM, October 1987.*

LANL 1990a *LANL, 1989 Waste Management Site Plan, Los Alamos National Laboratory, Los Alamos, NM, March 1990.*

LANL 1990b *LANL, 1990 Site Development Plan Technical Site Information, LA-CP-90-405, Facility Engineering Division Planning Group, ICF Kaiser Engineers, Inc., Los Alamos, NM and Royston Hanamoto Alley and Abey, Mt. Valley, CA, September 1990.*

LANL 1991a *LANL, "Structural Location Maps," Facility Engineering Division, Los Alamos National Laboratory, Los Alamos, NM, 1991.*

LANL 1991b:6 *LANL, "Employee Residential Distribution," PEIS request for information provided by S. L. Coonley, Site Contact, U. S. Department of Energy, Los Alamos National Laboratory, Los Alamos, NM, November 1991.*

LANL 1992a:6 *Seay, G., LANL Site Contact, unpublished material, 1992.*

LANL 1992c *Travis, J.R., Atlas of the Breeding Birds of Los Alamos County, New Mexico, LA-12206, Los Alamos National Laboratory, Los Alamos, NM, October 1992.*

LANL 1993b *LANL, Environmental Surveillance at Los Alamos During 1991, LA-12572-ENV, UC-902, prepared by Los Alamos National Laboratory, Los Alamos, NM, August 1993.*

LANL 1994a *LANL, Environmental Surveillance at Los Alamos During 1992, LA-12764-ENV, prepared by Los Alamos National Laboratory, Los Alamos, NM, July 1994.*

LANL 1994b *LANL, Standard Data Report 1993 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1, prepared by Los Alamos National Laboratory for the U. S. Department of Energy, Office of Environmental Management, Waste Minimization Division, EM-334, November 4, 1994.*

LANL 1995a *LANL, Proposed Site Treatment Plan for Mixed Waste, Los Alamos National Laboratory, Los Alamos, NM, March 24, 1995.*

LANL 1995b:1 *LANL, "Affected Environment: No Action Data Call Response," LANL response to the draft Affected Environment section provided to site representatives by the U.S. Department of Energy, April 1995.*

LANL 1995b:3 *LANL, "Data Resolution Comments," compilation of correspondence with LANL clarifying data in the Nonnuclear, High Explosives, Secondary Manufacturing, and Pit Manufacturing Alternative Data Packages. (LANL 1995c; LANL 1995d LANL 1995e; LANL 1995g), 1995.*

LANL 1995b:4 *LANL and Albuquerque Operations Office, "Comments on Draft Versions of the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," (Version 3 and later), 1995.*

LANL 1995b:6 *Neal, T. (Program Manager), "Worker Dose for Pit Fabrication," PEIS request for information provided by Tim Neal, Materials and Process Technologies, Los Alamos National Laboratory, Los Alamos, NM, December 20, 1995.*

LANL 1995c *LANL, Stockpile Stewardship and Management Programmatic Environmental Impact Statement Alternative Report Nonnuclear Production at Los Alamos National Laboratory, LA-CP-95-184, compiled by the Los Alamos SSM PEIS Team, Los Alamos National Laboratory, Los Alamos, August 4, 1995.*

LANL 1995d *LANL, Stockpile Stewardship and Management Programmatic Environmental Impact Statement (SSM PEIS) Alternative Report High Explosives Production at Los Alamos National Laboratory, LA-CP-95-181, compiled by the Los Alamos SSM PEIS Team, Los Alamos National Laboratory, Los Alamos, August 4, 1995.*

LANL 1995e *Tubesing, P.K., R. A. Patterson, P.S. Dunn, S.R. Bingert, D.K. Korzekwa, Stockpile Stewardship and Management Programmatic Environmental Impact Statement Expanded Data Call*

Addendum to the Los Alamos Alternative for Secondary Manufacturing (LA-CP-95-108), LA-UR-95-2113, August 4, 1995.

LANL 1995g *LANL, Stockpile Stewardship & Management Programmatic Environmental Impact Statement Expanded Data Call Addendum to the Alternative Report for Pit Manufacturing at Los Alamos National Laboratory, LA-UR-95-2670, prepared by members of the Los Alamos National Laboratory SSM PEIS Pit Working Team, September 12, 1995.*

LANL 1995i *Risberg, D., Draft Biological and Floodplain/Wetland Assessment for the Dual-Axis Radiographic Hydrodynamics Test Facility (DARHT), LAUR-95-649, Los Alamos National Laboratory, Los Alamos, NM, February 1995.*

LANL 1995j *Keller, D.C. and D. Risberg, Draft Biological and Floodplain/Wetland Assessment for the Dual-Axis Radiographic Hydrodynamics Test Facility (DARHT) , LAUR-95-647, Los Alamos National Laboratory, Los Alamos, NM, July 1995.*

LANL 1995r *LANL, Water Supply at Los Alamos During 1993, LA-12951-RP, Progress Report, prepared under contract W-7405-ENG-36 for the U.S. Department of Energy, October 1995.*

LANL 1995s *LANL, Environmental Surveillance at Los Alamos During 1993 , LA-12973-ENV, prepared by Los Alamos National Laboratory, Los Alamos, NM, October 1995.*

LANL 1995t *LANL, Los Alamos National Laboratory Institutional Plan FY 1996-2001, Los Alamos National Laboratory, Los Alamos, NM, October 1995.*

LANL 1996e:1 *LANL, "Comments on the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," DOE/EIS-0236, February 1996.*

LANL 1996e:2 *LANL, "Species of Interest Table 4.6-1 to the LANL Site Wide EIS Special Status Species Potentially Occurring on Los Alamos National Laboratory," 1996.*

LL City 1995a *"Statistical City Data for Regional Economic Area/Region of Influence, Lawrence Livermore National Laboratory," Livermore, CA, 1995.*

LL County 1995a *"Statistical County Data for Regional Economic Area/Region of Influence, Lawrence Livermore National Laboratory," Livermore, CA, 1995.*

LL DOE 1981a *Busby, C. I., D. M. Garaventa, and L. S. Kobori, A Cultural Resource Inventory of Lawrence Livermore National Laboratory's Site 300, Alameda and San Joaquin Counties, California, EPD-01055, prepared by Basin Research Associates, Inc., Hayward, CA for the University of California under Contract W-7405-ENG 48 with the Department of Energy, May 1981.*

LL DOE 1992c *DOE and University of California, Final Environmental Impact Statement and*

Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, DOE/EIS-0157, Volume I, prepared for U.S. Department of Energy, Washington, DC, August 1992.

LL DOE 1992d *DOE and University of California, Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, DOE/EIS-0157, Volume II, prepared for U.S. Department of Energy, Washington, DC, August 1992.*

LL School 1995b *"Statistical School Data for Regional Economic Area/Region of Influence, Lawrence Livermore National Laboratory," Livermore, CA, 1995.*

LL USDA 1966a *Welch, L.E., R.C. Huff, R.A. Dierking, T.D. Cook, L.A. Bates, and W.F. Andrews, Soil Survey of the Alameda Area California, U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Washington Agricultural Experiment Station, 1966.*

LL USDA 1988a *USDA, Soil Survey Alameda Area, California, Soil Conservation Survey, 1988.*

LL USGS 1981a *USGS, "Altamont Quadrangle: 7.5 Minute Series Topographic Map," U.S. Geological Survey, U.S. Department of the Interior, 1981.*

LL USGS 1989a *USGS, "Stockton, California: 1:100 000-" 30x60 minute quadrangle, 37121-E1-TM-100, U.S. Department of Interior, 1989.*

LLNL 1983a *Raber, E. and D.W. Carpenter (Editors), An Evaluation of the Hydrogeology and Groundwater Chemistry Associated with Landfills at LLNL's Site 300 , UCRL-53416, Lawrence Livermore National Laboratory, University of California, Livermore, CA, June 1983.*

LLNL 1984a *Carpenter, D.W., J.J. Sweeney, P.W. Kasameyer, N.R. Burkhard, K.G. Knauss, and R.J. Shlemon, Geology of the Lawrence Livermore National Laboratory Site and Adjacent Areas, UCRL-53316, Lawrence Livermore National Laboratory, University of California, Livermore, CA, August 1984.*

LLNL 1984b *Austin, D.F. and P.J. Reynolds, "A Case-Control Study of Malignant Melanoma Among Lawrence Livermore National Laboratory Employees," Lawrence Livermore National Laboratory Report 1984, UCRL-15629, Lawrence Livermore National Laboratory, Livermore, CA, 1984.*

LLNL 1984c *Hiatt, R.A. and B. Fireman, Malignant Melanoma in the Kaiser Foundation Health Plan of Northern California: A Comparison of Incidence and Measures of Health Care Utilization Between the Lawrence Livermore National Laboratory and Surrounding Health Plan Groups, UCRL-15591 S/C 4787901, Department of Medical Methods Research, Kaiser Foundation Research Institute, Oakland, CA, February 1984.*

LLNL 1985a *Shy, C.M., H. Checkoway, and E.G. Marshall, "Malignant Melanoma at a Scientific Laboratory. A Synthesis of Reviewer's Comments on the Austin and Reynolds' Study of Employees at the Lawrence Livermore National Laboratory," UCRL-15737, Lawrence Livermore National Laboratory Report 1985, 1985.*

LLNL 1991b *LLNL, Site 300 Site Development Plan, UCRL-AR-106744, Livermore, CA, April 1991.*

LLNL 1991d *Carpenter, D.W., J.R. Copland, A.L. Lamarre, R.S. Mateik, M.J. Taffett, and W.M. Wade, Investigation of Holocene Faulting Near Closed Landfill Pit 6, Lawrence Livermore National Laboratory Site 300, UCRL-ID-106316, Environmental Protection, Environmental Restoration Series, by Science Applications International Corporation, Pleasanton, CA, Weiss Associates, Emeryville, CA, and Lawrence Livermore National Laboratory, University of California, Environmental Restoration Division, Livermore, CA, April 1991.*

LLNL 1992a:1 *Zahn, K., LLNL Site Contact, "Aquatic Resources," PEIS request for information provided by U.S. Department of Energy, Lawrence Livermore National Laboratory, Livermore, CA, May 4, 1992.*

LLNL 1992a:3 *Zahn, K., LLNL Site Contact, "Biotic Resources," PEIS request for information provided U.S. Department of Energy, Lawrence Livermore National Laboratory, Livermore, CA, 1992.*

LLNL 1993b *Wilt, G.C. (Editor), Environmental Report 1992, UCRL-50027-92, prepared by the U.S. Department of Energy, Lawrence Livermore National Laboratory, Livermore, CA, 1993.*

LLNL 1994a *Wilt, G. C. (Editor), Environmental Report 1993, UCRL-50027-93, prepared by the U. S. Department of Energy, Lawrence Livermore National Laboratory, Livermore, CA, September 1, 1994.*

LLNL 1994e *Moore, D.H., H.W. Patterson, F. Hatch, D. Discher, J.S. Schneider, and D. Bennett, "Workplace Investigation of Increased Diagnosis of Malignant Melanoma Among Employees of Lawrence Livermore National Laboratory," Lawrence Livermore National Laboratory Report 1994, UCRL-LR-106723,Lawrence Livermore National Laboratory, Livermore, CA, 1994.*

LLNL 1995b *LLNL, 1993 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1, prepared by Lawrence Livermore National Laboratory, Livermore, CA, January 13, 1995.*

LLNL 1995c *LLNL Stockpile Stewardship and Management Programmatic Environmental Impact Statement for Manufacture of Canned Secondary Assemblies and Radiation Cases at Lawrence Livermore National Laboratory, Data Report, SST-95-06-002, Rev 2, August 4, 1995.*

LLNL 1995d *LLNL, Waste Management Plan FY1995 Update in Accordance with DOE Order*

5820.2A, UCRL-AR-111731-95, prepared by Environmental Protection Department, Hazardous Waste Management Division, Lawrence Livermore National Laboratory, University of California, Livermore, CA, 1995.

LLNL 1995e *LLNL, Stockpile Stewardship and Management Programmatic Environmental Impact Statement (PEIS) - Canned Secondary Assembly and Case Manufacturing Facility Data Report, SST 95-07-006, Rev. 1, July 17, 1995.*

LLNL 1995f *Spellman, G., Stockpile Stewardship and Management Programmatic Environmental Impact Statement Nonnuclear Working Group Nonnuclear Alternative Report, UCRL-PROP-121323 Final, proposal from Lawrence Livermore National Laboratory, Livermore, CA, August 4, 1995.*

LLNL 1995h *DOE, Federal Facility Compliance Act Proposed Site Treatment Plan for Lawrence Livermore National Laboratory, prepared for the State of California, California Environmental Protection Agency, Department of Toxic Substances Control, Hazardous Waste Management Program, Sacramento, CA by the U.S. Department of Energy, Oakland Operations Office, Oakland, CA, March 1995.*

LLNL 1995i:1 *LLNL, "Affected Environment: No Action Data Call Response," LLNL response to the draft Affected Environment section provided to site representatives by the U.S. Department of Energy, April 1995.*

LLNL 1995i:2 *LLNL, "Data Resolution Comments," compilation of correspondence with LLNL clarifying data in the Secondary Manufacturing, Nonnuclear, and High Explosives Alternative Data Packages, (LLNL 1995c; LLNL 1995f; LLNL 1995j), 1995.*

LLNL 1995i:3 *LLNL and Albuquerque Operations Office, "Comments on Draft Versions of the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," (Version 3 and later), 1995.*

LLNL 1995i:5 *LLNL, "Annual Emissions Estimate of Toxic Air Contaminants for LLNL, SNL-CA, and Site 300," PEIS request for information provided by Lawrence Livermore National Laboratory, Livermore, Ca, May 24, 1995.*

LLNL 1995j *Kolb, J.R., R.L. Atkins, D. Loftus, C.O. Pruneda, and R.L. Simpson, High Explosives Input Data Stockpile Stewardship and Management Programmatic Environmental Impact Statement (SSMPEIS) LLNL Proposed Alternative, UCRL-PROP-121403, Lawrence Livermore National Laboratory, Livermore, CA, July 20, 1995.*

LLNL 1995k *LLNL, 1994 Site Development Plan, UCRL-LR-110253-94, Lawrence Livermore National Laboratory, Livermore, CA, 1995.*

LLNL 1995m *LLNL, National Ignition Facility Site Requirements, NIF-LLNL-93-089.L-116083-1,* *Lawrence Livermore National Laboratory, Livermore, CA, July 1995.*

LLNL 1995n *LLNL, Environmental Management Programmatic Environmental Impact Statement Affected Environment for Lawrence Livermore National Laboratory, Revision 2 Draft, Livermore, CA, May 24, 1995.*

LLNL 1995o *LLNL, Institutional Plan FY 1996 - 2001 Lawrence Livermore National Laboratory, UCAR-10076-14, University of California, Lawrence Livermore National Laboratory, Livermore, CA, October 1995.*

LLNL 1996i:2 *LLNL, "Comments on the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," DOE/EIS-0236, Lawrence Livermore National Laboratory, Livermore, CA, February 1996.*

LLNL1996i:3 *Kato, T., "Special Status Species List," Database, PEIS request for information provided by Lawrence Livermore National Laboratory, Livermore, CA, Revision 4, May 31, 1996.*

McNally 1985a *Handy Railroad Atlas of the United States, Rand McNally, 1985.*

McNally 1990a *Standard Highway Mileage Guide, Rand McNally and Company, 1990.*

MO DNR 1992a *Missouri Department of Natural Resources, "Acceptable Ambient Levels of Clean Air Act Air Toxics and SARA Title III Chemicals," June 15, 1992.*

MO DNR 1994a *Missouri Department of Natural Resources, "Missouri Air Quality Standards," Environment Reporter, 10 CSR 10-6.010, pp 3-4, Amended January 31, 1994.*

MO DNR 1995a *Missouri Department of Natural Resources, "Acceptable Ambient Levels for Missouri," Missouri Air Pollution Control Program, June 16, 1995.*

NAS 1972a *National Academy of Sciences and National Research Council, The Effects on Populations of Exposure to Low Levels of Ionizing Radiation, Report of the Advisory Committee on the Biological Effects of Ionizing Radiations, Division of Medical Sciences, 1972.*

NAS 1985a *National Academy of Sciences and National Research Council, Mortality of Nuclear Weapons Test Participants, National Academy Press, Washington, DC, 1985.*

NAS 1990a *Committee on the Biological Effects of Ionizing Radiations, Health Effects of Exposure to Low Levels of Ionizing Radiation BEIR V, Board of Radiation Effects Research, Commission on Life Sciences, National Academy of Sciences and National Research Council, National Academy Press, Washington, DC, 1990.*

NCDC 1995a *National Climatic Data Center, "National Weather Service Station Airways Surface*

Observations Digital Data for 1994," National Weather Station Database, Asheville, NC, 1995.

NCRP 1987a *National Council on Radiation Protection and Measurements, Ionizing Radiation Exposure of the Population of the United States, NCRP Report No. 93, Pergamon Press, Elmsford, NY, September 1, 1987.*

NEJM 1979a *Lyon, J.L., M.R. Klauber, J.W. Gardner, and K.S. Udall, "Childhood Leukemias Associated with Fallout from Nuclear Testing," New England Journal of Medicine, Vol. 300, No. 8, pp 397-402, 1979.*

NIOSH 1972a *Karches, G.J., J.R. Lynch, and J. Lucas, "Health Hazard Evaluation, Bendix Corporation, Kansas City, MO," Report No. HHE-72-22-31-34-24, Unique Identifier NIOSH/00027221, Health Evaluation Services Branch, NIOSH, Cincinnati, OH, 1972.*

NIOSH 1990a *National Institute for Occupational Safety and Health, Pocket Guide to Chemical Hazards, Publication No. 90-117, prepared by the U.S. Department of Health and Human Services, Public Health Service Centers for Disease Control, National Institute for Occupational Safety and Health, Washington, DC, June 1990.*

NM DGF 1990b *New Mexico Department of Game and Fish, Handbook of Species Endangered in New Mexico, Sante Fe, NM, 1990.*

NM DGF 1995a *New Mexico Department of Game and Fish, New Mexican Wildlife of Special Concern, New Mexico Conservation Services Division, March 1995.*

NM DOH 1993a *Athas, W.F. and C.R. Key, "Los Alamos Cancer Rate Study: Phase I, Cancer Incidence in Los Alamos County, 1970-1990," 1993.*

NM DOH 1994a *Athas, W., "Continuation Application; Los Alamos Cancer Study, Project Year 4," New Mexico Department of Health, November 2, 1994.*

NM DOH 1996a *Athas, W., "Investigation of Excess Thyroid Cancer Incidence in Los Alamos County," Draft Report, New Mexico Department of Health, 1996.*

NM EIB 1995a *New Mexico Environmental Improvement Board, "Title 20: Environmental Protection, Chapter 2: Air Quality [Statewide], Part 72: Construction Permits," New Mexico Air Quality Control Regulations, Santa Fe, NM, November 30, 1995.*

NM EIB 1996a *New Mexico Environmental Improvement Board, "Title 20: Environmental Protection, Chapter 2: Air Quality [Statewide], Part 3:Ambient Air Quality Standards," New Mexico Air Quality Control Regulations, Santa Fe, NM, January 10, 1996.*

NM FRCD 1995a *Sivinski, R. and K. Lightfoot (Editors), Inventory of Rare and Endangered Plants* *of New Mexico, Miscellaneous Publication No. 4, New Mexico Forestry and Resources Conservation Division, Energy, Minerals and Natural Resources Department, Santa Fe, NM, Third Edition, August 1995.*

***NOAA 1994a** National Oceanic and Atmospheric Administration (NOAA), Local Climatological Data Annual Summaries for 1993, Part III--Central Region, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, NC, 1994.*

***NOAA 1994c** NOAA, Local Climatological Data Annual Summaries for 1993, Part II--Southern Region, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, NC, 1994.*

***NOAA 1994d** NOAA, Local Climatological Data Annual Summaries for 1993, Part IV--Western Region, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, NC, 1994.*

***NRC 1977b** NRC, Regulatory Guide 1.109 Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, prepared by the Office of Standards Development, U.S. Nuclear Regulatory Commission, Washington, DC, October 1977.*

***NRC 1986a** Ramsdell, J.V. and G.L. Andrews, Tornado Climatology of the Contiguous United States, NUREG/CR-4461, prepared by Pacific Northwest Laboratory, Richland, WA, for the U.S. Nuclear Regulatory Commission, Washington, DC, 1986.*

***NRC 1987c** NRC, Paleontological Collecting, prepared by the Committee on Guidelines for Paleontological Collecting, Board on Earth Sciences, Commission on Physical Sciences, Mathematics, and Resources, National Research Council; National Academy Press, Washington, DC, 1987.*

***NRC 1992a** NRC, Directory of Certificates of Compliance for Radioactive Materials Packages, NUREG-0383, Volume 2, Division of Safeguards and Transportation, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC, Revision 15, October 1992.*

***NSC 1994a** National Safety Council, Accident Facts, Washington, DC, 1994 Edition.*

***NT City 1995a** "Statistical City Data for Regional Economic Area/Region of Influence, Nevada Test Site," Las Vegas, NV, 1995.*

***NT County 1993a** District Board of Health of Clark County, Air Pollution Control Regulations, Section 11--Ambient Air Quality Standards, Clark County, Las Vegas, NV, May 27, 1993.*

NT County 1995b *"Statistical County Data for Regional Economic Area/Region of Influence, Nevada Test Site," Las Vegas, NV, 1995.*

NT County 1995c:1 *Taipale, C., "Unpublished 1994 Air Monitoring Data Summaries," transmittal from Clark county Health District to M. Monarch, Argonne National Laboratory, Argonne IL, July 18, 1995.*

NT DOE 1983a *Bowen, J.L. and R.T. Egami, Atmospheric Overview for the Nevada Nuclear Waste Storage Investigations, Nevada Test Site, Nye County, Nevada, NVO-269, prepared under Contract DE-AC08-80NV 10162 by the Desert Research Institute for the U.S. Department of Energy, Las Vegas, NV, 1983.*

NT DOE 1986b *DOE, Environmental Assessment, Yucca Mountain Site, Nevada Research and Development Area, Nevada, DOE/RW-0073, Volume 1, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, DC, May 1986.*

NT DOE 1988a *DOE, Environmental Survey Preliminary Report, Nevada Test Site, Mercury, Nevada, DOE/EH/OEV-15-P, prepared by Environment, Safety and Health, Office of Environmental Audit, Washington, DC, April 1988.*

NT DOE 1988d *Hunter, R.B. and P.A. Medica, Status of the Flora and Fauna on the Nevada Test Site, 1988, DOE/NV/10630-29, Nevada Operations Office, Las Vegas, NV, 1988.*

NT DOE 1988e *Shroba, R.R., D.R. Muhs, and J.N. Rosholt, Physical Properties and Radiometric Age Estimates of Surficial and Fracture-Fill Deposits Along a Portion of the Carpetbag Fault system, Nevada Test Site, Nye County, Nevada, DOE/NV/10583-1, prepared under Interagency Agreement DE-AI08-86NV10583 by the U.S. Geological Survey for the Nevada Operations Office, U.S. Department of Energy, Las Vegas, NV, July 1988.*

NT DOE 1989a *Chapman, J.B., Classification of Groundwater at the Nevada Test Site, prepared under Contract DE-AC08-85NV10384 by Water Resources Center, Desert Research Institute University of Nevada System prepared for the U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV, January 1989.*

NT DOE 1991b *McDowell, E.M. and S.C. Black (Editors), U.S. Department of Energy Nevada Operations Office Annual Site Environmental Report--1990, DOE/NV/10630-20, Volume 1, prepared by Reynolds Electrical & Engineering Company, Inc., Las Vegas, NV, under Contract DE-AC08-89NV10630 for U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV, September 1991.*

NT DOE 1992b *Sadler, W.R., M.E. Campana, R.L. Jacobson, and N.L. Ingraham, A Deuterium-Calibrated, Discrete-State Compartment Model of Regional Groundwater Flow, Nevada Test Site and Vicinity, DOE/NV/10845-09, prepared by Water Resources Center, Desert Research Institute,* *University of Nevada System, for the U.S. Department of Energy, March 1992.*

NT DOE 1992d *Black, S.C., A.R. Latham and Y.E. Townsend, (Editors), U.S. Department of Energy Nevada Field Office Annual Site Environmental Report--1991, DOE/NV/10630-33, Volume 1, prepared under Contract DE-AC08-89NV 10630, by Reynolds Electrical & Engineering Company, Inc., Las Vegas, for the U.S. Department of Energy, Nevada Field Office, Las Vegas, NV, September 1992.*

NT DOE 1993b *DOE, Technical Information Package Proposal for Reconfiguration of Nuclear Weapons Complex at the Nevada Test Site--Environment, Safety & Health, Volume 4, submitted by the U.S. Department of Energy, Nevada Operations Office, to the U.S. Department of Energy, Deputy Assistant Secretary, Office Weapons Complex Reconfiguration, Washington, DC, September 15, 1993.*

NT DOE 1993e *Black, S.C., A.R. Latham, and Y.E. Townsend, (Editors), U.S. Department of Energy Nevada Field Office Annual Site Environmental Report - 1992, DOE/NV/10630-66 UC-600, prepared under Contract DE-AC08-89NV10630 by Reynolds Electrical & Engineering Co., Inc., Las Vegas, NV 89193-8521 for the U.S. Department of Energy, Nevada Operations Office, September 1993.*

NT DOE 1994b *Reynolds Electrical & Engineering Co., Inc., U.S. Department of Energy Nevada Field Office Annual Site Environmental Report--1993, DOE/NV/11432-123, Volume 1, prepared for the U.S. Department of Energy, Nevada Operations Office, NV, September 1994.*

NT DOE 1994d *DOE, Nevada Test Site Development Plan, Las Vegas, NV, September 21, 1994.*

NT DOE 1994f *Reynolds Electrical & Engineering Co., Inc., 1993 Annual Report on Waste Generation and Waste Minimization Progress, Waste Management Division, U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV, October 31, 1994.*

NT DOE 1994g *DOE, Nevada Site Development Plan, Part 2 North Las Vegas and Remote Sensing Laboratory Sites, Las Vegas, NV, 1994.*

NT DOE 1995b *Raytheon Services Nevada, SSM PEIS Assembly/Disassembly Nevada Test Site Alternative, Volumes 1 and 2, August 4, 1995.*

NT DOE 1995f *Raytheon Services Nevada, SSM PEIS Pit Reuse Nevada Test Site Alternative, August 4, 1995.*

NT DOE 1995g *DOE, Environmental Assessment for Construction of the Proposed Nevada Support Facility at the U.S. Department of Energy North Las Vegas Facility, DOE/EA-0955, January 1995.*

NT DOE 1995i *Greger, O.D., "Status of Horses, Deer, and Birds on the Nevada Test Site," Draft Status of the Flora and Fauna on the Nevada Test Site, DOE/NV.11432-195, Reynolds Electrical Engineering Co., Inc., Las Vegas, NV, 1995.*

***NT DOE 1995j** Reynolds Electrical & Engineering Co., Inc., 1994 Baseline Biological Studies for the Device Assembly Facility at the Nevada Test Site, DOE/NV/11432-177, UC-600, prepared for the U. S. Department of Energy, Las Vegas, NV, February 1995.*

***NT DOE 1996b** DOE, Nevada Test Site Site Treatment Plan and Federal Facility Compliance Act Consent Order, DOE/NV-397, prepared by the U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV, Revision 2, March 1996.*

***NT DOE 1996c** DOE, Final Environmental Impact Statement for the Nevada Test Site and Off-site Locations in the State of Nevada, DOE/EIS 0243, Volume 1, 1996.*

***NT DOI 1991a** Hallock, L.L., "Ash Meadows and Recovery Efforts for its Endangered Aquatic Species," Endangered Species Technical Bulletin, Vol. XVI, No. 4, National Fisheries Research Center-Seattle, Reno, NV, Substation for U.S. Department of the Interior, Fish and Wildlife Service, April 1991.*

***NT DOI 1992b** Harlow, D.L., Field Supervisor, "Biological Opinion on Nevada Test Site Activities," 1-5-91-F-225, PEIS request for information provided by David L. Harlow, U.S. Department of the Interior, Fish and Wildlife Service, Fish and Wildlife Enhancement, Reno Field Office, Reno, NV, May 20, 1992.*

***NT DOI 1995a** Mendoza, C.H., "Listed Endangered and Threatened and Candidate Species that May Occur on the Nevada Test Site," 1-5-95-SP-264, PEIS request for information provided by Carlos H. Mendoza, State Supervisor, U. S. Department of the Interior, Fish and Wildlife Service, Nevada State Office, Reno, NV, June 23, 1995.*

***NT EG&G 1987a** EG&G Energy Measurements, Site Survey, Nevada Test Site, 1987.*

***NT EG&G 1991a** EG&G Energy Measurements, The Distribution and Abundance of Desert Tortoises on the Nevada Test Site, EGG 10617-2081, Santa Barbara Operations, Goleta, CA, January 1991.*

***NT ERDA 1976a** O'Farrell, T.P. and L.A.Emery, Ecology of the Nevada Test Site: A Narrative Summary and Annotated Bibliography, NVO-167, prepared under Contract AT(29-2)-1253 by Applied Ecology & Physiology Center, Desert Research Institute, University of Nevada System, Boulder City, NV, for the U.S. Energy Research & Development Administration Nevada Operations, Modification 19, Nye County, NV, May 1976.*

***NT ERDA 1977a** ERDA, Final Environmental Impact Statement Nevada Test Site Nye County, Nevada, ERDA-1551, UC-2,11, prepared by the U.S. Energy Research and Development Administration, September 1977.*

***NT Greger 1992a** Greger, P.D., Bird List for the Nevada Test Site, Basic Environmental Compliance* *and Monitoring Program, University of California, Mercury, NV, 1992.*

NT Greger nda *Greger, P.D. and E.M. Romney, Wildlife Utilization of Natural Springs and Man-made Water Sources at the Nevada Test Site, BECAMP Objective 3 - Task 3 UCLA Laboratory of Biomechanical and Environmental Sciences, Mercury, NV, n.d.*

NT Hunter 1991a *Hunter, R., "Invasion on the Nevada Test Site: Present Status of Browus B. Tectorum with Notes on their Relationship to Disturbance and Altitude," Great Basin Naturalist, 1991.*

NT LLNL 1976a *Borg, I.Y., R. Stone, H.B. Levy and L.D. Ramspott, Information Pertinent to the Migration of Radionuclides in Ground Water at the Nevada Test Site Part 1: Review and Analysis of Existing Information, UCRL-52078 Pt. 1, prepared by Lawrence Livermore National Laboratory, University of California, Livermore, CA, May 25, 1976.*

NT LVVWD 1994a *Avon, L. and T.J. Durbin, Hydrologic Evaluation of Recent Water-Level Decline at Devil's Hole, Cooperative Water Project Report No. 12, Las Vegas Valley Water District, Las Vegas, NV, 1994.*

NT NPS 1983a *National Park Service, "Great Basin Timber Mountain Caldera, Nye County, Nevada," Natural Landmark Brief, compiled by the Wildlife and Vegetation Division, U.S. Department of the Interior, September 1983.*

NT REECO 1990a *Engineering-Science, Project Report of Air Quality Study at the Nevada Test Site, Mercury, Nevada, report prepared under Task Order 30-CUC-01-0, submitted to Reynolds Electrical and Engineering Co, Las Vegas, NV, November 30, 1990.*

NT REECO 1994a *Reynolds Electrical and Engineering Company, Inc., Site Book for Waste Management, prepared by Waste Operations Department, P. O. Box 98521, Las Vegas, NV, prepared for the U.S. Department of Energy, May 1994.*

NT REECO 1995a *Reynolds Electrical and Engineering Company, Inc., Waste Management Plan for the Nevada Test Site, prepared by Waste Operations Department, U. S. Department of Energy, Nevada Operations Office, Las Vegas, NV, February 1995.*

NT School 1995b *"Statistical School Data for Regional Economic Area/Region of Influence, Nevada Test Site," Las Vegas, NV, 1995.*

NT SNL 1986a *Long, J.W., Component Ground Motion at the Nevada Test Site from Pahute Mesa Underground Nuclear Explosions, SAND 86-0439, Sandia National Laboratories, Albuquerque, NM, 1986.*

NT USAF 1993a *USAF, Final Environmental Impact Statement Space Nuclear Thermal Propulsion*

Program Particle Bed Reactor Propulsion Technology Development and Validation, May 1993.

NT USGS 1975a *Winograd, I.J., and W. Thordarson, Hydrogeologic and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site, Geological Survey Professional Paper 712-C, prepared on behalf of the U.S. Atomic Energy Commission, 1975.*

NT USGS 1988a *Harrill, J.R., J.S. Gates, and J.M. Thomas, Major Ground-Water Flow Systems in the Great Basin Region of Nevada, Utah, and Adjacent States, Hydrologic Investigations Atlas HA-694-C, U.S. Geologic Survey, Reston, VA, 1988.*

NT USGS 1994a *Laczniak, R.J., J.C. Cole, D.A. Sawyer, and D.A. Trudeau, Summary of Hydrogeologic Controls on Ground Water Flow at the Nevada Test Site, Nye County, Nevada, USGS WRIR 94-XXXX, U.S. Geological Survey, 1994.*

NTS 1990a:1 *Unknown, "Mammal List for the Nevada Test Site," Basic Environmental Compliance and Monitoring Program, April 25, 1990.*

NTS 1990a:2 *Unknown, "Reptile List for the Nevada Test," Basic Environmental Compliance and Monitoring Program, April 25, 1990.*

NTS 1991a:1 *NTS, "Employee Residential Distribution," PEIS Datacall, November 1991.*

NTS 1992a:6 *Elle, D.R. (Site Contact), "Biotic Resources of the Nevada Test Site," PEIS request for information provided by U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV, February 19, 1992.*

NTS 1993a:4 *Raytheon Services Nevada, "No Action Data Package," PEIS request for information provided by George W. Kronsbein, Engineering Division, U.S. Department of Energy, Nevada Test Site, 1993.*

NTS 1995a:1 *NTS, "Affected Environment: No Action Data Call Response," Nevada Test Site response to the draft Affected Environment section provided to site representatives by the U.S. Department of Energy, April 1995.*

NTS 1995a:2 *NTS, "Data Resolution Comments," compilation of correspondence with Nevada Test Site clarifying data in the Assembly/Disassembly Alternative Data Package (NT DOE 1995b), 1995.*

NTS 1995a:3 *NTS and Albuquerque Operations Office, "Comments on Draft Versions of the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," (Version 3 and later), 1995.*

NTS 1995a:4 *Lazaroff, G., "National Ignition Facility Siting Proposal," request for information* *provided by EG&G, North Las Vegas Facility, Las Vegas, NV to C. Burke, Argonne National Laboratory, Argonne, IL, June 22, 1995.*

NTS 1995a:5 *White, R., request for information provided by Raytheon Services, Nevada Operations Office, Las Vegas, NV to F. Kirchner, Argonne National Laboratory, Argonne, IL, August 7, 1995.*

NTS 1996a:1 *NTS, "Comments on the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," DOE/EIS-0236, February 1996.*

Nuttli 1990a *Nuttli, O.W., The Effect of Earthquakes in the Central United States, Second Edition, Second Edition, Center for Earthquake Studies, Southeast Missouri State University, Cape Girardeau, MO, May 1990.*

NV DCNR 1992a *Nevada Department of Conservation and Natural Resources, Air Quality Operating Permits Issued to the U.S. Department of Energy Nevada Operations Office, Division of Forestry, Department of Conservation and Natural Resources, Carson City, NV, 1992.*

NV DCNR 1995a *Nevada Department of Conservation and Natural Resources, Nevada Administrative Code Chapter 445B Air Pollution, compiled by the State Environmental Commission in cooperation with the Division of Environmental Protection's Bureau of Air Quality, Carson City, NV, 1995.*

NV FWS 1989a *FWS, "Endangered, Threatened, and Sensitive Plants of Nevada," computer printout, U.S. Fish and Wildlife Service, Reno Field Station, Reno, NV, February 13, 1989.*

NV NHP 1995a *Nevada Natural Heritage Program, "Nevada's Sensitive Species," Carson City, NV, Revised July 31, 1995.*

OR City 1990a *City of Oak Ridge, "Land Use Plan," Area Maps, April 1990.*

OR City 1991a *City of Oak Ridge, "Land Use Plan--Oak Ridge Area, Oak Ridge, Tennessee," Maps, Revised, April 8, 1991.*

OR City 1995b *"Statistical City Data for Regional Economic Area/Region of Influence, Oak Ridge Reservation," Oak Ridge, TN, 1995.*

OR County 1995a *"Statistical County Data for Regional Economic Area/Region of Influence, Oak Ridge Reservation," Oak Ridge, TN, 1995.*

OR DOE 1987a *Martin Marietta Energy Systems (MMES), Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1986, ES/ESH-1/V1, Volume 1, prepared under Contract DE-AC05-84OR 21400 by Environmental and Safety Activities and Environmental Management Staffs Oak Ridge Operations for the U.S. Department of*

Energy, Oak Ridge, TN, April 1987.

***OR DOE 1989a** MMES, Oak Ridge Reservation Site Development and Facilities Utilization Plan, DOE/OR-885, prepared under Contract DE-AC05-84OR 21400 for the U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN, June 1989.*

***OR DOE 1990a** MMES, Oak Ridge Reservation Environmental Report for 1989, ES/ESH-13/V1, Volume 1, prepared under Contract DE-AC05-84OR21400 by the Office of Environmental Compliance Documentation and Environmental Management Staff for the U.S. Department of Energy, Oak Ridge, TN, October 1990.*

***OR DOE 1991b** DOE, Oak Ridge Reservation Environmental Report for 1990, ES/ESH-18/V1, Volume 1, prepared under Contract DE-AC05-85OR 21400 by Environmental, Safety, and Health Compliance and Environmental Management Staff of the Oak Ridge Operations for the U.S. Department of Energy, Oak Ridge, TN, September 1991.*

***OR DOE 1991c** DOE, Oak Ridge Reservation Nuclear Weapons Complex Reconfiguration Site Proposal, Executive Summary, Oak Ridge, TN, 1991.*

***OR DOE 1991f** MMES, Oak Ridge Reservation Site Development and Facilities Utilization Plan 1990 Update, DOE/OR-885/R1, prepared under Contract DE-AC05-84OR 21400 by Site and Facilities Planning, for the U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, TN, June 1991.*

***OR DOE 1992c** DOE, Oak Ridge Reservation Environmental Report for 1991, ES/ESH-22/V1, Volume 1, prepared under Contract DE-AC05-84OR 21400 by Environmental, Safety and Health Compliance and Environmental Management Staffs of the Oak Ridge Y-12 Plant, Oak Ridge National Laboratory, and Oak Ridge K-25 Site, for the U.S. Department of Energy, Oak Ridge, TN, October 1992.*

***OR DOE 1993a** DOE, Oak Ridge Reservation Environmental Report for 1992, ES/ESH-31/V1, Volume 1, prepared under Contract DE-AC05-84OR 21400 by Environmental, Safety and Health Compliance and Environmental Management Staffs of the Oak Ridge Y-12 Plant, Oak Ridge National Laboratory, and Oak Ridge K-25 Site, for the U.S. Department of Energy, Oak Ridge, TN, June 1993.*

***OR DOE 1993b** DOE, Oak Ridge Reservation Environmental Report for 1992, ES/ESH-31/V2, Volume 2, prepared under Contract DE-AC05-84OR 21400 by Environmental, Safety and Health Compliance and Environmental Management Staffs of the Oak Ridge Y-12 Plant, Oak Ridge National Laboratory, and Oak Ridge K-25 Site, for the U.S. Department of Energy, Oak Ridge, TN, June 1993.*

***OR DOE 1993c** MMES, Tornado Special Study Report, ES/ESH-35, prepared under Contract DE-AC05-84OR 21400 by Martin Marietta Energy System for the U.S. Department of Energy, Oak Ridge, TN, June 14, 1993.*

OR DOE 1994a *DOE, Draft Site Treatment Plan for Mixed Wastes on the U.S. Department of Energy Oak Ridge Reservation, DOE/OR-2016/V1, DOE/OR-2016/V2, DOE/OR-2016/V3, August 1994.*

OR DOE 1994c *DOE, Oak Ridge Reservation Annual Site Environmental Report for 1993, ES/ESH-47, Volume 1, prepared under Contract DE-AC05-84OR 21400 by Environmental, Safety and Health Compliance and Environmental Management Staffs of the Oak Ridge Y-12 Plant, Oak Ridge National Laboratory, and Oak Ridge K-25 Site, for the U.S. Department of Energy, Oak Ridge, TN, November 1994.*

OR DOE 1994d *DOE, Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee, DOE/EA-0929, U.S. Department of Energy, Oak Ridge, TN, September 1994.*

OR DOE 1994f *MMES, Environmental Monitoring and Surveillance on the Oak Ridge Reservation: 1993 Data, ES/ESH-48, December 1994.*

OR DOE 1995e:1 *Trischman, S. (EM-321), "Low-Level Waste Disposal Assumption," memorandum from Program Manager, Oak Ridge/Chicago Operations Division, Office of Eastern Waste Management Operations Environmental Management to K. Gandee, MD-1, U.S. Department of Energy, Washington, DC, May 24, 1995.*

OR DOE 1995g *DOE, Proposed Site Treatment Plan for Mixed Waste on the U.S. Department of Energy Oak Ridge Reservation, DOE/OR-2030, Volumes 1 and 2, April, 1995.*

OR EG&G 1991a *Staub, W. P., Interim Report Y-12 Plant Generic Safety Analysis Report, Applied Physical Sciences Group, Energy Division, Oak Ridge National Laboratory, Oak Ridge, TN, September 30, 1991.*

OR FWS 1992b *Widlak, J., "Status Update on Possible Occurrence of Threatened and Endangered Species on the Oak Ridge Reservation," PEIS request for information provided by U.S. Fish and Wildlife Service, 1992.*

OR LMES 1995e *LMES, No Action Alternative and Phaseout Options for Long-Term Storage of Highly Enriched Uranium at the Oak Ridge Reservation, Y/ES-124, prepared by the Nuclear Materials Disposition Program Office, Y-12 Defense Programs, Lockeed Martin Energy Systems, Inc., Oak Ridge, TN for the U.S. Department of Energy, January 1995.*

OR LMES 1996i *Lockheed Martin Energy Systems (LMES), Stockpile Stewardship and Management Programmatic Environmental Impact Statement Data for the No Action and Phase-out Alternatives at the Oak Ridge Reservation, Y/ES-121/R1, Planning and Program Integration Office, Y-12 Plant Defense Programs, Oak Ridge, TN, July, 1996.*

OR MMES 1993d *MMES, "Treatment, Storage, Disposal Unit Capability Report--Oak Ridge*

National Laboratory," Waste Management Information System (Database), Hazardous Waste Remedial Actions Program, Oak Ridge, TN, 1993.

OR MMES 1993e *MMES, "Treatment, Storage, Disposal Unit Capability Report--Oak Ridge K-25 Site," Waste Management Information System (Database), Hazardous Waste Remedial Actions Program, Oak Ridge, TN, 1993.*

OR MMES 1993f *MMES, "Treatment, Storage, Disposal Unit Capability Report--Oak Ridge Y-12 Plant," Waste Management Information System (Database), Hazardous Waste Remedial Actions Program, Oak Ridge, TN, 1993.*

OR MMES 1995c *Energy Systems Waste Management Organization, Oak Ridge Reservation Waste Management Plan, ES/WM-30, prepared for U.S. Department of Energy, Office of Environmental Management, Environmental Restoration and Waste Management Programs, Oak Ridge, TN, February 1995.*

OR MMES 1996j *LMES, Stockpile Stewardship and Management Programmatic Environmental Impact Statement Y-12 Alternative Secondary Plant Design PEIS Data Report for Three Production Cases, Y/ES-076/R3, Planning and Program Integration Office, Y-12 Plant Defense Programs, Oak Ridge Reservation, Oak Ridge, TN, July, 1996.*

OR NERP 1991a *Cunningham, M. and L. Pounds, Resource Management Plan for the Oak Ridge Reservation Volume 28: Wetlands on the Oak Ridge Reservation, Volume 28, ORNL/NERP-5, prepared under Contract DE-AC05-84OR 21400 by Oak Ridge National Laboratory, for the Oak Ridge National Environmental Research Park, Environmental Sciences Division Publication No. 3765 Office of Health and Environmental Research, Oak Ridge, TN, December 1991.*

OR NERP 1993a *MMES, Pounds, L.R., P.D. Parr, and M.G. Ryon, Resource Management Plan for the Oak Ridge Reservation Volume 30: Oak Ridge National Environmental Research Park Natural Areas and Reference Areas - Oak Ridge Reservation Environmentally Sensitive Sites Containing Special Plants, Animals, and Communities, ORNL/NERP-8, prepared under Contract DE-AC05-84OR 21400 for Oak Ridge National Environmental Research Park, Office of Health and Environmental Research and Environmental Restoration Program, Program Interpretation and Administration, Regulatory Compliance Group, Oak Ridge, TN, 1993.*

OR NERP 1993b *Cunningham, M., L. Pounds, S. Oberholster, P. Parr, L. Edwards, B. Rosensteel, and L. Mann, Resource Management Plan for the Oak Ridge Reservation Volume 29: Rare Plants on the Oak Ridge Reservation, ORNL/NERP-7, Environmental Sciences Division Publication No. 4054, prepared under Contract DE-AC05-84OR 21400 by Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, for the Resource Management Organization and Oak Ridge National Environmental Research Park, Office of Health and Environmental Research, Oak Ridge, TN, August 1993.*

OR NERP nda *Parr, P. D. and J.W. Evans, Resource Management Plan for the Oak Ridge*

Reservation, unpublished Preliminary Draft, ORNL/NERP-6, prepared under Contract DE-AC05-84OR 21400 by Oak Ridge National Laboratory, Environmental Sciences Division, for the U.S. Department of Energy Oak Ridge, TN, n.d.

OR Robinson 1950a *Robinson, Jr., G.O., The Oak Ridge Story The Saga of People Who Share In History, Southern Publishers, Inc., Kingsport, TN, 1950.*

OR USGS 1986a *Lowery, J.F., P. H. Counts, H. L. Edmiston, and F. D. Edwards, Water Resources Data, Tennessee Water Year 1985, U.S. Geological Survey Water-Data Report TN-85-1, USGS/WRD/HD-86/21, prepared in cooperation with the Tennessee Department of Health and Environment, Office of Water Management; the Tennessee Valley Authority; and with other state, municipal and Federal agencies, TN, March 1986.*

ORNL 1981a *NUS, Environmental and Safety Report for Oak Ridge National Laboratory, ORNL-SUB-41B-38403C, NUS 3892, prepared by NUS Corporation Rockville, MD for the Oak Ridge National Laboratory, Oak Ridge, TN, September 30, 1981.*

ORNL 1981b *Loar, J.M., J.A. Solomon, and G.F. Cada, Technical Background Information for the ORNL Environmental and Safety Report: A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam, Volume 2, Publication No. 1852, ORNL/TM-7509/V2, prepared by Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN, October 1981.*

ORNL 1982a *Fitzpatrick, F.C., Oak Ridge National Laboratory Site Data for Safety Analysis Reports, ORNL/ENG/TM-19, prepared under Contract W-7405-eng-26 by Union carbide Corporation, Nuclear Division, Oak Ridge National Laboratory for the U.S. Department of Energy, Oak Ridge, TN, 1982.*

ORNL 1984b *Kitchings, J.T. and J.D. Story, Resource Management Plan for U.S. Department of Energy, Oak RidgeReservation, ORNL-6026/V16, Volume 16, prepared under Contract DE-AC05-84OR 21400 by the Oak Ridge National Laboratory, Oak Ridge, TN, July 1984.*

ORNL 1986a *MMES, Environmental Surveillance of the Oak Ridge Reservation and Surrounding Environs During 1985, ORNL-6271, prepared under Contract DE-AC05-84OR 21400 by Environment, Safety, and Health, Martin Marietta Energy Systems, Inc., Oak Ridge, TN, April 1986.*

ORNL 1987a *Parr, P. D., and L. R. Pounds, Resource Management Plan for the Oak Ridge Reservation, Volume 23, ORNL/ESH-1/V23, prepared under DE-AC05-84OR 21400 by Martin Marietta Energy System, Inc., for U.S. Department of Energy, Oak Ridge, TN, May 1987.*

ORNL 1988b *Lietzke, D.A., S.Y. Lee, and R.E. Lambert, Soils, Surficial Geology, and Geomorphology of the Bear Creek Valley Low-Level Waste Disposal Development and Demonstration Program Site, Publication No. 3017, Environmental Sciences Division, Oak Ridge*

National Laboratory, Oak Ridge, TN, 1988.

ORNL 1988c *Cada G. F., R. L. Kroodsma, and P. D. Parr, Ecology of the Oak Ridge Reservation, ORNL/TM-10939/V1 and V2, Oak Ridge, TN, 1988.*

ORR 1991a:4 *MMES, "Historical/Future ORR & Y-12 Plant Employment," response to PEIS datacall by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy, Oak Ridge Operation, Oak Ridge, TN, November 1991.*

ORR 1991a:8 *Williams, C.K. (MMES Site Contact), "Meteorological and Climatological Data," PEIS request for information supplied by U.S. Department of Energy, Oak Ridge National Laboratory, Oak Ridge, TN, 1991.*

ORR 1992a:6 *Butz, T.R. (Site Contact), "Y-12 Plant Accident History," August 14, 1992.*

ORR 1993a:11 *Johnson, M., (MMES Site Contact), "TSCA Container and Tank Storage Building K-1435," PEIS request for information provided by Mike Johnson, K-25 Martin Marietta, Oak Ridge, TN, November 11, 1993.*

ORR 1995a:1 *ORR, "Affected Environment: No Action Data Call Response," Oak Ridge Reservation response to the draft Affected Environment section provided to site representatives by the U.S. Department of Energy, April 1995.*

ORR 1995a:3 *ORR, "Data Resolution Comments," compilation of correspondence with Oak Ridge Reservation clarifying data in the Secondary Fabrication Alternative Data Package, 1995.*

ORR 1995a:4 *ORR and Albuquerque Operations Office, "Comments on the Draft Versions of the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," (Version 3 and later), 1995.*

ORR 1995a:6 *Perry, T. (DOE Site Contact), "Map of 100-year and 500-year Floodplains on the Y-12 Site," GCM/95-228, derived from 1993 aerial photography, the Tennessee Valley Authority, and other sources. Produced by Geographic Information Systems & Computer Modeling, Oak Ridge National Laboratory, PEIS request for information provided by Teresa Perry, Oak Ridge National Laboratory, Oak Ridge, TN, 1995.*

OTA 1989a *U.S. Congress--101st Cong., The Containment of Underground Nuclear Explosions, OTA-ISC-414, Office of Technology Assessment, Washington, DC, October 1989.*

Owen 1981a *Owen, G.N., "Earthquake Engineering of Large Underground Structure," Proceedings, Workshop on Seismic Performance of Underground Facilities, Atlanta, Ga, February 1981.*

PM 1986a *Hiatt, R.A. and B. Fireman, "The Possible Effect of Increased Surveillance on the*

Incidence of Malignant Melanoma," Prev Medicine, pp 652-660, 1986.

PX 1994a:2 *Greenly, G., "Employee Distribution for Pantex Plant Region of Influence--1994," PEIS request for information provided by George Greenly, Battelle Pantex Plant, Amarillo, TX, December 21, 1994.*

PX 1995a:2 *Pantex Plant, "Affected Environment: No Action Data Call Response," Pantex Plant's response to the draft Affected Environment section provided to site representatives by the U.S. Department of Energy, Amarillo TX, June 1995.*

PX 1995a:4 *Banner, E., "Emissions Update at Pantex Plant," U.S. Department of Energy, Amarillo TX, 1995.*

PX 1995a:5 *Pantex Plant, "Data Resolution Comments," compilation of correspondence with Pantex Plant clarifying data in the High Explosives, Pit Reuse, and Assembly/Disassembly Alternative Data Packages (PX DOE 1995e; PX DOE 1995k; PX MH 1995a), U.S. Department of Energy, Amarillo TX, 1995.*

PX 1995a:6 *Pantex Plant and Albuquerque Operations Office, "Comments on Draft Versions of the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," (Version 3 and later), U.S. Department of Energy, Amarillo TX, 1995.*

PX 1996e:1 *Pantex Plant, "Comments on the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," DOE/EIS-0236, U.S. Department of Energy, Amarillo TX, February 1996.*

PX City 1990a *Barnard Dunkelberg & Company, Airport Master Plan Update, Amarillo International Airport, Amarillo, Texas, prepared for the city of Amarillo through a grant from the Federal Aviation Administration, October 1990.*

PX City 1995a *"Statistical City Data for Regional Economic Area/Region of Influence, Pantex Plant," Amarillo, TX, 1995.*

PX County 1995a *"Statistical County Data for Regional Economic Area/Region of Influence, Pantex Plant," Amarillo, TX, 1995.*

PX DOE 1983a *DOE, Final Environmental Impact Statement Pantex Plant Site, Amarillo, Texas, DOE/EIS-0098, prepared by the U.S. Department of Energy, Washington, DC, October 1983.*

PX DOE 1991a *Pantex Plant and Panhandle 2000 Task Force, Panhandle 2000, Pantex Nuclear Weapons Complex Reconfiguration Proposal, Volume 8 Site Flexibility, U.S. Department of Energy, Amarillo TX, May 1991.*

PX DOE 1993c *Johnston, M.C. and J.K. Williams, Report: Floristic Survey Pantex Plant Site, Carson County, Texas 1993, prepared under Contract FFP009901 by Environmental Consulting, Austin, TX, for the U. S. Department of Energy, Pantex Plant, Amarillo, TX, December 1993.*

PX DOE 1994b *Seyffert, K. D., Checklist of Birds Pantex Plant Site Carson County, Texas 1994, Report, prepared under Contract FFP016902 Amarillo, TX, for the U. S. Department of Energy, Pantex Plant, Amarillo, TX, June 1994.*

PX DOE 1994c *Mazeroll, A.I., L.S. Boatman, and L.H. Boomershine, Report: Herpetofaunal Survey Pantex Plant Site, Carson County, Texas 1994, prepared under contract FFP019934 by Enviro Con for the U. S. Department of Energy, Pantex Plant, Amarillo, TX, 1994.*

PX DOE 1994d *Rylander, M.K., Report: Resident and Migratory Animals Survey Pantex Plant Site, Carson County Texas 1994, prepared under contract FFP011684 by Department of Biological Sciences, Texas Tech University, Lubbock, TX for the U. S. Department of Energy, Pantex Plant, Amarillo, TX, 1994.*

PX DOE 1995a:1 *Johnson, J.S., "Pantex Plant Land Use Status," PEIS request for information provided by Assistant Area Manager for Projects & Environmental Management, U.S. Department of Energy, Albuquerque Field Office, Amarillo Area Office, Amarillo, TX, 1995.*

PX DOE 1995d *Mason & Hanger-Silas Mason Co., Inc., 1994 Environmental Report for Pantex Plant, DOE/AL/65030-9506, U.S. Department of Energy, Amarillo, TX, June 1995.*

PX DOE 1995e *Hallett, S.G., R.J. Slape, Final SSM PEIS Alternative Report High Explosive Production at Pantex Plant, DOE-AL-65030-9517, prepared under Contract DE-AC04-91AL-65050 by Mason & Hanger--Silas Mason Co., Inc., for the U.S. Department of Energy, Pantex Plant, Amarillo, TX, August 1995.*

PX DOE 1995g *Battelle and Mason and Hangar-Silas Mason Company, Inc., Pantex Plant Site Development Plan -- FY 95, PLN14, U.S. Department of Energy, Pantex Plant, Amarillo, TX, 1995.*

PX DOE 1995i *Battelle and Mason and Hangar-Silas Mason Company, Inc., Environmental Information Document The Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components Environmental Impact Statement, January 1995.*

PX DOE 1995k *Mason & Hanger-Silas Mason Co., Inc., Data Report for Pantex Plant Pit Recertification, Requalification, and Type A Reuse , DOE-AL-65030-9521, prepared for the U.S. Department of Energy under Contract DE-AC-04-91AL-65030, August 1995.*

PX DOE 1996b *Battelle and Mason and Hangar-Silas Mason Company, Inc., Draft Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components, DOE/EIS-0225-D, Volume I, prepared for the U.S. Department of Energy,* *Washington, DC, March 1996.*

***PX EG&G 1988a** EG&G Energy Measurements, "Color Aerial Photographs of Pantex Plant: Various Scales," PERF 6218, Las Vegas, NV, November 30, 1988.*

***PX EG&G 1988b** EG&G Energy Measurements, "Color Aerial Photographs of Los Alamos National Laboratory and Pantex Plant: Various Scales," PERF 6219, Las Vegas, NV, November 30, 1988.*

***PX MH 1991c** Mason & Hanger-Silas Mason Company, Inc., Pantex Plant Site Environmental Report for Calendar Year 1990, MHSMP-91-06, prepared under Contract DE-AC04-76DP 00487 by Environmental Monitoring Section, Environmental Protection Department, Environment, Safety & Health Division, Amarillo, TX, July 1991.*

***PX MH 1994c** Mason and Hanger-Silas Mason Company, Inc., Pantex Plant Safety Analysis Report General Information Document, Draft 2, prepared by Pantex Plant, Amarillo, TX, Revision 1, June 10, 1994.*

***PX MH 1995a** Mason and Hanger-Silas Mason Company, Inc., SSM PEIS Data Report for Pantex Plant Assembly/Disassembly Operations, Pantex Plant, Amarillo, TX, August 1995.*

***PX MH 1995b** Mason and Hanger-Silas Mason Company, Inc., Basis for Interim Operation for the Pantex Plant Amarillo, Texas, prepared by Pantex Plant, Risk Management Department, Amarillo, TX, June 1995.*

***PX School 1995b** "Statistical School Data for Regional Economic Area/Region of Influence, Pantex Plant," Amarillo, TX, 1995.*

***PX USDA 1962a** Jacquot, L. L., Soil Survey, Carson County, Texas, Series 1959, No. 10, U.S. Department of Agriculture, Soil Conservation Service in cooperation with the Texas Agricultural Experiment Station, July 1962.*

***PX USDA 1980a** Pringle, F., Supplement to the Soil Survey of Carson County, Texas, U.S. Department of Agriculture, Soil Conservation Service, 1980.*

***PX USGS 1986a** USGS, "Amarillo--Texas: 1:100 000-Scale Metric Topographic Map," 30x60 minute series, 35101-A1-TM-100, U.S. Department of the Interior, U.S. Geological Survey, Reston, VA, 1986.*

***PX WDB 1993a** Peckham, D.S. and J.B. Ashworth, The High Plains Aquifer System of Texas, 1980 to 1990 Overview and Projections, Draft, prepared by Texas Water Development Board, Final in progress 1993.*

***RR 1989a** Gilbert, E.S., S.A. Fry, L.D. Wiggs, G.L. Voelz, D.L. Cragle, and G.R. Petersen, "Analyses* *of Combined Mortality Data on Workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Nuclear Weapons Plant," Radiation Research, Vol. 120, pp 19-35, Academic Press, Inc., 1989.*

***RR 1990a** Frome, E.L., D.L. Cragle, and R.W. McLain, "Poisson Regression Analysis of the Mortality Among a Cohort of World War II Nuclear Industry Workers," Radiation Research, Vol. 123, 138-152, 1990.*

***RR 1993a** Gilbert, E.S., D.L. Cragle, and L.D. Wiggs, "Updated Analyses of Combined Mortality Data for Workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Weapons Plant," Radiation Research, Vol. 136, pp 408-421, Academic Press, Inc., 1993.*

***RR 1995a** Cardis, E., E.S. Gilbert, L. Carpenter, G. Howe, I. Kato, B.K. Armstrong, V. Beral, G. Cowper, A. Douglas, J. Fix, S.A. Fry, J. Kaldor, C. Lave, L. Salmon, P.G. Smith, G.L. Voelz, and L.D. Wiggs," "Effects of Low Doses and Low Dose Rates of External Ionizing Radiation: Cancer Mortality Among Nuclear Industry Workers in Three Countries," Radiation Research, Vol. 142, pp 117-132, Radiation Research Society, 1995.*

***SAIC 1995a:1** SAIC, "Five-Year Summary of Hazardous and Nonhazardous Cargo Shipped by Commercial Carriers to and from Each of the Candidate Sites," PEIS request for information provided by Robert Morris, Transportation Analyst, Science Applications International Corporation, Oak Ridge, TN, April 26, 1995.*

***SAIC 1995a:2** SAIC, "Summary of all Hazardous Materials by Chemical Name to and from Selected Sites for 1994," PEIS request for information provided by Robert Morris, Transportation Analyst, Science Applications International Corporation, Oak Ridge, TN, April 5, 1995.*

***SC DHEC 1991a** South Carolina Department of Health and Environmental Control, Air Pollution Control Regulations (Regulation No. 62.5), Air Pollution Control Standards (Standard No. 8), Toxic Air Pollutants, Bureau of Air Quality Control, Columbia, SC, June 28, 1991.*

***SC DHEC 1992a** South Carolina Department of Health and Environmental Control, "Water Classifications and Standards," April 24, 1992.*

***SC DHEC 1992b** South Carolina Department of Health and Environmental Control, Air Pollution Control Regulations (Regulation No. 62.5), Air Pollution Control Standards (Standard No. 2), Ambient Air Quality Standards , Bureau of Air Quality Control, Columbia, SC, June 26, 1992.*

***SC WD 1995a** South Carolina Wildlife Department, Rare and Endangered Species of South Carolina, Nongame and Heritage Trust Section, Columbia, SC, September 11, 1995.*

***Science 1983a** Beck, H.L. and P.W. Krey, "Radiation Exposures in Utah from Nevada Nuclear Tests," Science, Vol 220, pp 18-24, 1983.*

***Science* 1984a** *Land, C.E., F.W. McKay, and S.G. Machado, "Childhood Leukemia and Fallout from the Nevada Nuclear Tests," Science, Vol. 223, pp 139-144, January 1984.*

***SN City* 1995a** *"Statistical City Data for Regional Economic Area/Region of Influence, Sandia National Laboratories," Albuquerque, NM, 1995.*

***SN County* 1995a** *"Statistical County Data for Regional Economic Area/Region of Influence, Sandia National Laboratories," Albuquerque, NM, 1995.*

***SN DOE* 1991b** *SNL, Land Use Permits, Facilities Geographical Information System, Sandia National Laboratories Plant Engineering, Albuquerque, NM, April 13, 1991.*

***SN DOE* 1992d** *DOE and University of California, Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, Volume II Appendices A-D, DOE/EIS-0157, prepared for U.S. Department of Energy, Washington, DC, August 1992.*

***SN ERDA* 1977a** *Energy Research Development Administration, Environmental Impact Assessment Sandia Laboratories , Albuquerque, New Mexico, EIA/MA 77-1, Division of Military Application, May 1977.*

***SN NPS* 1988a** *Mariah Associates, Inc., An Assessment of Cultural Resource Studies Conducted at Kirtland Air Force Base, Bernalillo County, New Mexico, prepared under Contract CX-1200-7-B014 with Funds Provided by the United States Air Force, Military Airlift Command, Kirtland Air Force Base Through the National Park Service, Interagency Archaeological Services, Denver, CO, June 1988.*

***SN School* 1995b** *"Statistical School Data for Regional Economic Area/Region of Influence, Sandia National Laboratories," Albuquerque, NM, 1995.*

***SN USAF* 1989a** *United States Air Force (USAF), Military Airlift Command Comprehensive Plan, Kirtland Air Force Base, Albuquerque, New Mexico, Directorate of Civil Engineering, DSC-PR-Washington, DC, October 30, 1989.*

SN USAF* 1990a *USAF, *Draft Environmental Impact Statement Proposed Closure of Los angeles Air Force Base, California and Relocation of Space Systems Division , July 1990.*

***SN USDA* 1977a** *USDA, Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico , Soil Conservation Service and Forest Service and the U.S. Department of the Interior, Bureau of Indian Affairs and Bureau of Land Management in cooperation with New Mexico Agricultural Experiment Station, 1977.*

***SN USGS* 1978a** *USGS, "Albuquerque, New Mexico," 30x60 Minute Series, U.S. Department of the*

Interior, Denver, CO, 1978.

***SN USGS 1979a** USGS, "Belen, New Mexico," 30x60 Minute Series, U.S. Department of the Interior, Denver, CO, 1979.*

***SNL 1979a** Vortman, L.J., Prediction of Ground Motion from Nuclear Weapons Test at Nevada Test Site, SAND79-1002, Sandia National Laboratories, Albuquerque, NM, 1979.*

***SNL 1982a** Rao, R.K., E.L. Wilmot, and R.E. Luna, Non-Radiological Impacts of Transporting Radioactive Material, SAND81-1703, prepared under Contract DE-AC04-76DP 00789 by NUS Corporation, Rockville, MD and Transportation Analysis and Information Division 4551, Transportation Technology Center, Sandia National Laboratories, Albuquerque, NM, February 1982.*

***SNL 1982b** Vortman, L.J., Effects of Ground Motion on Repository Depth, The Yucca Flat Data, SAND82-1647, Sandia National Laboratories, Albuquerque, NM, 1982.*

***SNL 1986a** Cashwell, J.W., K.S. Neuhauser, P.C. Reardon, and G.W. McNair, Transportation Impacts of the Commercial Radioactive Waste Management Program, SAND85-2715, prepared under Contract DE-AC04-76DP 00789 by Sandia National Laboratories, Albuquerque, NM and Livermore, CA for the U.S. Department of Energy, April 1986.*

***SNL 1990a** Fischer, N. T., Revision of Species Inventory Checklists for Sandia National Laboratories, Albuquerque Bernalillo County, New Mexico, SAND90-7098, Final Report, prepared by International Technology Corporation, Albuquerque, NM, for U.S. Department of Energy, Sandia National Laboratories, Albuquerque, NM, October 1990.*

***SNL 1991b:1** SNL, "Total Chemical Emissions by Building," PEIS request for information provided by Sandia National Laboratories, Albuquerque, NM, 1991.*

***SNL 1991c** Hwang, S.G., et al, 1990 Environmental Monitoring Report, SAND91-0592 UC-630, prepared under Contract DE-AC04-76D00789 by Sandia National Laboratories, Albuquerque, NM and Livermore, CA, for the U.S. Department of Energy, May 1991.*

***SNL 1992c SNL**, Sandia National Laboratories, Albuquerque Environmental Baseline Update, Albuquerque, NM, May 1992.*

***SNL 1993c** Hoagland, S.R. and K.J. Lord, Cultural Resources Regulatory Analysis, Area Overview, and Assessment of Previous Department of Energy and Kirtland Air Force Base Inventories for Sandia National Laboratories, New Mexico, SAND92-7345, prepared under Sandia Contract 44-2121 by Chambers Group, Inc., Santa Ana, CA for Sandia National Laboratories, Albuquerque, NM, January 1993.*

***SNL 1994a** Culp, T. A., C. F. Cheng, W. Cox, N. Durand, M. Irwin, A. Jones, F. Lauffer, M. Lincoln,* *Y. McClellan, K. Molley, and T. Wolff, 1993 Site Environmental Report Sandia National Laboratories, Albuquerque, New Mexico, SAND94-1293, UC-630, prepared under Contract DE-AC04-94AL 85000 by Sandia National Laboratories, Albuquerque, New Mexico and Livermore, CA, for the U.S. Department of Energy, November 1994.*

***SNL 1995b:1** SNL, "Affected Environment: No Action Data Call Response," Sandia National Laboratories response to the draft Affected Environment section provided to site representatives by the U.S. Department of Energy, April 1995.*

***SNL 1995b:4** SNL, "Data Resolution Comments," compilation of correspondence with Sandia National Laboratories clarifying data in the Nonnuclear Alternative Data Package (SNL 1995e), 1995.*

***SNL 1995b:5** SNL and Albuquerque Operations Office, "Comments on the Draft Versions of the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," (Version 3 and later), 1995.*

***SNL 1995c** SNL/NM, Compliance Order and Site Treatment Plan for Mixed Waste Sandia National Laboratories/New Mexico , prepared by Waste Management and Regulatory Projects Department, October 6, 1995.*

***SNL 1995d SNL**, Standard Data Report 1993 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1, prepared by Sandia National Laboratories, Albuquerque, NM, January 13, 1995.*

***SNL 1995e SNL**, Stockpile Stewardship and Management Programmatic Environmental Impact Statement Nonnuclear Alternative Proposal , Sandia National Laboratories, Albuquerque, NM, August 2, 1995.*

***SNL 1995f SNL,** Standard Data Report 1994 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1 , prepared by Sandia National Laboratories, Albuquerque, NM, October 23, 1995.*

***SNL 1995g** Shyr, L. (Editor), 1994 Site Environmental Report Sandia National Laboratories, Albuquerque, NewMexico, SAND95-1953, prepared under Contract DE-AC04-94AL 85000 by Sandia National Laboratories, Albuquerque, NM and Livermore, CA, for the U.S. Department of Energy, September 1995.*

***SNL 1995h** IT Corporation, Sensitive Species Survey Results Environmental Restoration Project Sandia National Laboratories, New Mexico , prepared for Sandia National Laboratories/New Mexico, Albuquerque, NM, February 1995.*

***SNL 1995i** SNL, Sandia National Laboratories Institutional Plan FY 1996-2001, Sandia National*

Laboratories, October 1995.

SNL 1996a *Johnson, K., J. Keller, C. Ekdahl, R. Krajcik, L. Salazar, E. Kelly, and R. Paulsen, Stockpile Surveillance: Past and Future, SAND95-2751, UC-700, prepared under Contract DE-AC04-94AL85000 by Sandia National Laboratories, Albuquerque, NM and Livermore, CA for the U.S. Department of Energy, Washington, DC, September 1985. Reprint January 1996.*

Socio 1996b *"Compilation of Models/Projections Used in the Preparation of Data for the Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," July 1996.*

SR City 1995a *"Statistical City Data for Regional Economic Area/Region of Influence, Savannah River Site," Aiken, SC, 1995.*

SR County 1995a *"Statistical County Data for Regional Economic Area/Region of Influence, Savannah River Site," Aiken, SC, 1995.*

SR DOE 1982a *DOE, Final Environmental Impact Statement, Defense Waste Processing Facility Savannah River Plant, DOE/EIS-0082, Savannah River Plant, Aiken, SC, February 1982.*

SR DOE 1987b *DOE, Final Environmental Impact Statement, Alternative Cooling Water Systems, DOE/EIS-0121, Savannah River Plant, Aiken, SC, October 1987.*

SR DOE 1990a *DOE, Final Environmental Impact Statement Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina, DOE/EIS-0147, Volume I, U.S. Department of Energy, Washington, DC, December 1990.*

SR DOE 1991b *DOE, Proposal for the Nuclear Weapons Complex Reconfiguration Site, prepared by Savannah River Operations, Aiken, SC for the U.S. Department of Energy, Office of the Assistant Secretary for Defense Programs, Washington, DC, 1991.*

SR DOE 1991e *NUS Corporation and RDN, Inc., American Indian Religious Freedom Act (AIRFA) Compliance at the Savannah River Site, prepared for the U.S. Department of Energy, Savannah River Operations Office, Aiken, SC, 1991.*

SR DOE 1993c *DOE, Environmental Assessment for the Centralization and Upgrading of the Sanitary Wastewater System at the Savannah River Site , DOE/EA-0878, September 1993.*

SR DOE 1994a *DOE, Final F-Canyon Plutonium Solutions Environmental Impact Statement, DOE/ EIS-0219, U.S. Department of Energy, Savannah River Site, Aiken, SC, December 1994.*

SR DOE 1994b *DOE, Final Environmental Impact Statement Defense Waste Processing Facility, DOE/EIS-0082-S, U.S. Department of Energy, Savannah River Site, Aiken, SC, November 1994.*

SR DOE 1994c *WSRC, 1993 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1, prepared by Westinghouse Savannah River Company, Waste Minimization and Pollution Prevention Group for the U.S. Department of Energy, Savannah River Site, Aiken, SC, October 28, 1994.*

SR DOE 1995b *DOE, Savannah River Site Waste Management Final Environmental Impact Statement, DOE/EIS-0217, Volume I, U.S. Department of Energy, Savannah River Site, Aiken, SC, July 1995.*

SR DOE 1995c *DOE, Savannah River Site Waste Management Final Environmental Impact Statement, DOE/EIS-0217, Volume II, U.S. Department of Energy, Savannah River Site, Aiken, SC, July 1995.*

SR DOE 1995e *DOE, Final Environmental Impact Statement Interim Management of Nuclear Materials, DOE/EIS-0220, U.S. Department of Energy, Savannah River Site, Aiken, SC, October 1995.*

SR duPont 1984b *Sauer, H. andAssociates, "Mortality Trends in Counties Near the Savannah River Plant, 1949-1978," Technical Report, prepared in fulfillment of Purchase Order No. AX 522037H for E.I. DuPont de Nemours and Company, Inc., Savannah River Site, Aiken, SC, 1984.*

SR duPont 1988a *Stephenson, D.E., August 1988 Savannah River Plant Earthquake, DPST-88-84, prepared under Contract DE-AC09-76SR00001 by E.I. du Pont De Nemours & Co., Savannah River Laboratory, Aiken, SC, for the U.S. Department of Energy, September 1988.*

SR MMES 1993a *MMES, "Treatment, Storage, Disposal Unit Capability Report" Waste Management Information System (Database), Hazardous Waste Remedial Actions Program, Oak Ridge, TN, 1993.*

SR NERP 1989a *Schalles, J.F., R.R. Sharitz, J.W. Gibbons, G.J. Leversee, and J.N. Knox, Carolina Bays of the Savannah River Plant, SRO-NERP-18, Savannah River Plant National Environmental Research Park Program, Aiken, SC, March 1989.*

SR NERP 1990b *Knox, J.N. and R.R. Sharitz, Endangered, Threatened, and Rare Vascular Flora of the Savannah River Plant, SRO-NERP-20, prepared by Division of Wetland Ecology, Savannah River Ecology Laboratory, for the Savannah River Site, National Environmental Research Park Program, Aiken, SC, March 1990.*

SR School 1995b *"Statistical School Data for Regional Economic Area/Region of Influence, Savannah River Site," Aiken, SC, 1995.*

SR USDA 1990a *Rogers, V. A., Soil Survey of Savannah River Plant Area, Parts of Aiken, Barnwell, and Allendale Counties, South Carolina, prepared by the U.S. Department of Agriculture, Soil*

Conservation Service in cooperation with U. S. Department of Energy; U.S. Department of Agriculture Forest Service; South Carolina Agricultural Experiment Station; and South Carolina Land Resources Conservation Commission, June 1990.

***SR USGS 1982a** USGS, "Barnwell, South Carolina--Georgia: 1:100 000-Scale Metric Topographic Map," 30x60 Minute Series, 33081-A1-TM-100, U.S. Department of the Interior, U.S. Geological Survey, Reston, VA, Edited 1982.*

***SRS 1991a:3** WSRC Site Contact, "Employee Residential Distribution," PEIS request for information provided U.S. Department of Energy, Savannah River Plant, Aiken, SC, November 1991.*

***SRS 1993a:4** Dukes, M.D., "SCDHEC Regulation No. 62.5 Standard No. 8, Compliance Modeling Input/Output Data (U)," ESH-ESS-93-0305, request for information provided by Environmental Support Section, Westinghouse Savannah River Company, Aiken, SC, to James A. Joy, P.E. Chief, Bureau of Air Quality Control, South Carolina Department of Health and Environmental Control, Columbia, SC, September 29, 1993.*

***SRS 1995a:1** SRS, "Affected Environment: No Action Data Call Response," Savannah River Site response to the draft Affected Environment section provided to site representatives by the U.S. Department of Energy, April 1995.*

***SRS 1995a:2** SRS, "No Action, Upgrade, Phaseout," U.S. Department of Energy, Savannah River Site, Aiken, SC, 1995.*

***SRS 1995a:10** Stewart, J., "Sitewide Total Emissions of Criteria Pollutants," SRT-ETS-95-0369, PEIS request for information provided by Westinghouse Savannah River Company, Aiken, SC, August 16, 1995.*

***SRS 1995a:11** Hanson, D., "Groundwater Data for H-Area at Savannah River Site," computer printout, PEIS request for information provided by Exploration Resources, Westinghouse Savannah River Company, Aiken, SC, August 30, 1995.*

***SRS 1996a:2** SRS, "Comments on the Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," DOE/EIS-0236, U.S. Department of Energy, Savannah River Site, Aiken, SC, February 1996.*

***TIH 1985a** Polednak, A.P. and D.R. Hollis, "Mortality and Causes of Death Among Workers Exposed to Phosgene in 1943-1945," Toxicol Ind Health, Vol. 1, pp 137-147, 1985.*

***TMM 1993a** Tennessee Medical Management, Inc., "Cancer Mortality and Incidence," presented to the Oak Ridge Health Agreement Steering Panel, February 18, 1993.*

***TN DEC 1994a** Tennessee Department of Environment and Conservation, "Chapter 1200-3-3-*

Ambient Air Quality Standards," prepared by the Bureau of Environment, Division of Air Pollution Control, Nashville, TN, 1994.

TN DEC 1995a *Tennessee Department of Environment and Conservation, "Rare Vertebrates of the State of Tennessee," Division of Natural Heritage, Nashville, TN, August 2, 1995.*

TN DEC 1995b *Tennessee Department of Environment and Conservation, "Rare Invertebrates of the State of Tennessee," Division of Natural Heritage, Nashville, TN, August 2, 1995.*

TN DEC 1995c *Tennessee Department of Environment and Conservation, "Rare Plants of the State of Tennessee," Tennessee Rare Plant Protection Program, Division of Natural Heritage, Nashville, TN, August 2, 1995.*

TN DEC 1995d *Tennessee Department of Environment and Conservation, "Tennessee County Distribution Records for Endangered, Threatened, and Status Review Species," Division of Ecological Services, Nashville, TN, prepared in cooperation with the U.S. Fish and Wildlife Service, January 20, 1995.*

TN DHE 1984a *Word, J. E., Oak Ridge Pilot Study, presented by the Commissioner, State of Tennessee, Department of Health and Environment, Nashville, TN, 1984.*

TN DHE 1991a *Tennessee Department of Health and Environment, "Hazardous Air Pollution Review and Evaluation Including Public Law 101-549," memorandum from Harold E. Hodges to APC Program Chiefs, Nashville, TN, August 1, 1991.*

TN USGS 1979a *USGS and TVA, "Oak Ridge, Tennessee--1:100 000-Scale Metric Topographic Map," 30x60 Minute Series, N3600-W8400/30x60, produced in cooperation with the U.S. Department of the Interior, U.S. Geological Survey, Denver, CO by Tennessee Valley Authority, Chattanooga, TN, 1979.*

TN USGS 1981a *USGS and TVA, "Watts Bar Lake, Tennessee--1:100 000-Scale Metric Topographic Map," 30x60 Minute Series, N3530-W8400/30x60, produced in cooperation with the U.S. Department of the Interior, Geological Survey, Washington, DC by Tennessee Valley Authority, Chattanooga, TN, 1981.*

TN WRA 1995a *Todd, R. M., "Tennessee Commercial Fishing," PEIS request for information provided by Fisheries Biologist, Tennessee Wildlife Resources Agency, Nashville, TN, May 17, 1995.*

TN WRC 1991a *Tennessee Wildlife Resources Commission, Proclamation--Wildlife in Need of Management , Proc. 86-29, March 2, 1991.*

TN WRC 1991b *Tennessee Wildlife Resources Commission, Proclamation--Endangered or Threatened Species , Proc. 86-30, March 2, 1991.*

TTI 1996b *Tetra Tech, Inc., Chemical Health Effects Technical Reference, July 1996.*

TX ACB 1987a *Texas Air Control Board, Regulation III (31 TAC Chapter 113) Control of Air Pollution from Toxic Materials, Revised August 14, 1987.*

TX ACB 1993a *Texas Air Control Board, "General Provisions - The National Primary and Secondary Ambient Air Quality Standards," Title 31 Pt. III Ch. 101.21, March 15, 1993.*

TX DOH 1994a *Texas Department of Health, "Study of Cancer in Selected Counties Near the Pantex Nuclear Weapons Plant," Texas Department of Health, Cancer Registry Division, Austin, TX, 1994.*

TX NRCC 1992a *Texas Natural Resource Conservation Commission and Air Control Board, Regulation II (30 TAC Chapter 112) Control of Air Pollution from Sulfur Compounds, Air Quality Planning Division, Austin, TX, Revised September 18, 1992.*

TX NRCC 1995a *Texas Natural Resources Conservation Commission, "List of Effects Screening Levels (ESLs)," PEIS request for information provided by Health Effects Staff, April 1, 1995.*

TX PWD 1993a *Texas Parks and Wildlife Department, Special Animal List, Texas Natural Heritage Program, October 19, 1993.*

TX PWD 1995a *Texas Parks and Wildlife Department, Special Animal List, Texas Natural Heritage Program, October 19, 1995.*

TX PWD 1995b *Texas Parks and Wildlife Department, Special Plant List, Texas Natural Heritage Program, February 1995.*

USDA 1977a *Garrison, G.A., A.J. Byugstad, D.A. Duncan, M.E. Lewis, and D.R. Smith, Vegetation and Environmental Features of Forest and Range Ecosystems, U.S. Department of Agriculture, Forest Service, Washington, DC, 1977.*

USGS 1972a *USGS, National Atlas, Scale 1:2 000 000, Department of the Interior, Washington, DC, revised 1972.*

VDL 1990a *van der Leeden, F., F.L. Troise, and D.K. Todd, The Water Encyclopedia, Geraghty & Miller Ground-Water Series, Second Edition, Lewis Publishers, Chelsea, MI, 1990.*

WJM 1985a *Reynolds, P. and D.F. Austin, "Cancer Incidence among Employees of the Lawrence Livermore National Laboratory 1969 - 1980," The Western Journal of Medicine, Vol. 142, No. 2, pp. 214-218, 1985.*

WSRC 1989e *Wike, L. D., W.L. Specht, H. E. Mackey, M. H. Paller, E. W. Wilde, and A. S. Dicks,* *Reactor Operation Environmental Information Document, Volume II Ecology, WSRC-RP-89-816, prepared under Contract DE-AC09-88SR 18035 by Environmental Sciences Section, Westinghouse Savannah River Company for the U.S. Department of Energy, Savannah River Site, Aiken, SC, December 1989.*

WSRC 1990b *Parker, M.J. and R.J. Kurezeja, October 1, 1989 Tornado at the Savannah River Site, WSRC-RP-89-1288, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC, January 1990.*

WSRC 1991a *WSRC, Tritium in the Savannah River Site Environment, WSRC-RP-90-424-1, Revision 1, U.S. Department of Energy, Savannah River Site, Aiken, SC, May 1991.*

WSRC 1992a *WSRC, Savannah River Site Environmental Report for 1991, WSRC-TR-92-186, prepared under Contract DC-AC09-89SR 18035, for U.S. Department of Energy, Savannah River Site, Aiken, SC, 1992.*

WSRC 1992c *CDM Federal Programs Corporation, Final Report Groundwater Modeling for the Nuclear Weapons Complex Reconfiguration Site at the Savannah River Site Aiken, South Carolina, 7901-003-RT-BBXZ, prepared for Westinghouse Savannah River Company, Aiken, SC, May 27, 1992.*

WSRC 1992h *Parker, M.J., et al, The 1987-1991 Savannah River Site Meteorological Data Base (U), WSRC-RP-92-598, Westinghouse Savannah River Company, Aiken SC, May 19, 1992.*

WSRC 1993a *Arnett, M. W., L. K. Karapalatakis, and A. R. Mamatey, (Editors), Savannah River Site Environmental Report for 1992, WSRC-TR-93-075, prepared by Westinghouse Savannah River Company under Contract DE-AC09-89SR 18035 for the U.S. Department of Energy, Savannah River Site, Aiken, SC, 1993.*

WSRC 1993b *Wike, L.D., Savannah River Site Ecology Environmental Information Document, WSRC-TR-93-496, prepared under Contract DE-AC09-89SR18035 by the Westinghouse Savannah River Company, Aiken, SC, September 1993.*

WSRC 1994c *WSRC, Savannah River Site FY 1994 Predecisional Draft Solid Waste Management Plan, WSRC-RP-93-1448, Revision 2, March 29, 1994.*

WSRC 1994d *Arnett, M.W., L.K. Karapatakis, and A.R. Mamatey, Savannah River Site Environmental Report for 1993, WSRC-TR-94-075, prepared under Contract DE-AC09-89SR 18035 by Westinghouse Savannah River Company for the U.S. Department of Energy, Savannah River Site, Aiken, SC, 1994.*

WSRC 1995a *WSRC, P roposed Site Treatment Plan, Volumes I and II, WSRC-TR-94-0608, May 30, 1995.*

WSRC 1995b *WSRC, Proposed Site Treatment Plan Reference Document, WSRC-TR-94-0608, May 30, 1995.*

WSRC 1995c *WSRC, Stockpile Stewardship and Management Programmatic Environmental Impact Statement Draft of Alternative Report for Pit Manufacturing at Savannah River Site, NMP-PLS-950176-DV, December 4, 1995.*

The References are obtained from a database that contains references common to the Programmatic Environmental Impact Statement for Tritium Supply and Recycling, the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement, and the Disposition of Surplus Highly Enriched Uranium Environmental Impact Statement. Therefore, the list of references may include perceived gaps in references. For example, NT DOE 1993c may not appear, while NT DOE 1993b and NT DOE 1993d both do. These gaps occur because the references are all a part of a larger set of references, not all of which appear in this Programmatic Environmental Impact Statement.

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B.A., English, California State University, Los Angeles, CA
Years of Experience: 3

Feldt, Al, Environmental Protection Specialist, DP-45, DOE
B.A., Economics, 1971, American University, Washington, DC
Years of Experience: 20

Felkner, Ira Cecil, Hazardous Chemical Assessments Technical Lead, SRA Technologies, Inc.
Ph.D., Microbiology/Biochemistry, 1966, University of Texas, Austin, TX
M.A., Bacteriology/Genetics, 1960, University of Texas, Austin, TX
B.A., Zoology/Chemistry, 1958, University of Texas, Austin, TX
Years of Experience: 37

Fisher, Michael, Technical Coordinator Volume III, Tetra Tech, Inc.
M.E., Nuclear Engineering, 1974, University of Virginia
B.S., Science and Engineering, 1968, U.S. Military Academy, West Point, NY
Years of Experience: 27

Fleming, William R., Technical Coordinator for Social Sciences, SRA Technologies, Inc.
Ph.D., Public Policy, 1987, Florida State University, Tallahassee, FL
M.P.A., Urban Administration and Planning, 1979, Florida Atlantic University, Boca Raton, FL
B.A., Political Science, 1976, Saint Leo College, Saint Leo, FL
Years of Experience: 14

Fontenelle, Samantha, Document Reviewer, Tetra Tech, Inc.
M.A., Environmental Studies/Risk Assessment, 1994, Sangamon State University, Springfield, IL
B.A., Environmental Science, 1992, University of Virginia, Charlottesville, VA
Years of Experience: 3

Fulca, Michael J., Technical Analyst and Data Coordinator, Lamb Associates, Inc.
M.S., Engineering Management, 1995, Catholic University of America, Washington D.C.
B.A., Mathematics, 1975, College of the Holy Cross, Worcester, MA
Years of Experience: 20

Gerard, Thomas A., Regulatory Technical Analyst and HE Fabrication Lead, SRA Technologies, Inc.
M.B.A., Management, 1989, Golden Gate University, San Francisco, CA
M.S., Civil Engineering, 1976, California Institute of Technology, Pasadena, CA
B.S., Engineering, 1970, U.S. Military Academy, West Point, NY
Years of Experience: 24

Grant, Johnnie W., Waste Management Technical Lead, Lamb Associates, Inc.
M.S., Physics, 1978, Arizona State University, Tempe, AZ
B.S., Physics and Engineering, 1969, U.S. Military Academy, West Point, NY
Years of Experience: 25

Goins, Charissa, Volume IV Document Coordinator, Tetra Tech, Inc.

B.A., Political Science, 1991, University of Oklahoma, Norman, OK
Years of Experience: 6

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M.S., Management, 1972, Rensselaer Polytechnic Institute, Troy, NY
B.S., Engineering, 1968, Rensselaer Polytechnic Institute, Troy, NY
Years of Experience: 28

Howard, Rob, Cumulative Impacts Technical Lead, Tetra Tech, Inc.
B.S., Civil Engineering, 1992, Virginia Polytechnic Institute and State University, Blacksburg, VA
Years of Experience: 4

Jackson, Frederick W., PEIS Project Task Manager, Tetra Tech, Inc.
B.S., Natural Resources, 1975, The Ohio State University, Columbus, OH
Years of Experience: 20

Jacobs, Maryce M., Hazardous Chemical Group Member, SRA Technologies, Inc.
M.B.A., Business Administration, 1991, Strayer College, Washington, DC
Ph.D., Biological Chemistry, 1971, University of California at Los Angeles, Los Angeles, CA
B.S., Chemistry, 1966, New Mexico State University
Years of Experience: 24

Jones, Russell S., Hazardous Chemical Group Member, SRA Technologies, Inc.
Ph.D., Plant Physiology, 1985, University of Arkansas, Fayetteville, AR
M.S., Plant Physiology/Soils, 1979, North Carolina State University, Raleigh, NC
B.A., Biology, 1974, Mansfield University, Mansfield, PA
Years of Experience: 16

Joyce, William E., Human Health Technical Lead, Halliburton NUS Corp.
B.S.Ch.E., Chemical Engineering, 1968, University of Connecticut, Storrs, CT
Years of Experience: 26

Karnovitz, Alan F., Socioeconomics Technical Lead, Tetra Tech, Inc.
M.P.P., Public Policy, 1981, Wharton School, University of Pennsylvania, Philadelphia, PA
B.S., Biology of Natural Resources, 1979, University of California, Berkeley, CA
Years of Experience: 12

Leichter, Irving, Waste Management Group Member, SRA Technologies, Inc.
M.S., Meteorology, 1974, South Dakota School of Mines and Technology, Rapid City, SD
B.S., Meteorology and Oceanography, 1972, New York University, New York, NY
Years of Experience: 22

MacConnell, James M., Biotic Resources Group Member, Halliburton NUS Corp.
B.S., Zoology, 1974, University of Maryland, College Park, MD
Years of Experience: 21

Magette, Thomas E., P.E., Program Manager, Tetra Tech, Inc.
M.S., Nuclear Engineering, 1979, University of Tennessee, Knoxville, TN
B.S., Nuclear Engineering, 1977, University of Tennessee, Knoxville, TN
Years of Experience: 19

Maltese, Jasper G., Human Health Technical Lead, Halliburton NUS Corp.
M.S., Operations Research, 1970, George Washington University, Washington, DC
B.S., Mathematics, 1961, Fairleigh Dickinson University, Rutherford, NJ
Years of Experience: 33

Miller, James D., Jr., Project Security Officer, SRA Technologies, Inc.
M.S., Nuclear Engineering, 1972, University of New Mexico, Albuquerque, NM
B.S., Electrical Engineering/Computer Science, 1970, University of New Mexico, Albuquerque, NM
Years of Experience: 23

Morgan, Lynn, Water Resources Technical Lead, Tetra Tech, Inc.
B.S., Geology, 1994, West Virginia University, Morgantown, WV
Years of Experience: 2

Minnoch, John K., Jr., Intersite Transportation Technical Lead, SRA Technologies, Inc.
M.B.A., Finance, 1972, University of Utah, Salt Lake City, UT
B.S., Air Science, 1960, Oklahoma State University, Stillwater, OK
Years of Experience: 32

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M.P.H., Epidemiology/Biostatistics, 1994, The George Washington University, Washington, DC
B.S., Chemistry, 1990, Hobart College, Geneva, NY
Years of Experience: 3

Olson, David G., PEIS QA Representative, Halliburton NUS Corp.
B.S., Chemistry, 1963, Duquesne University, Pittsburgh, PA
Years of Experience: 29

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M.R.P., Regional Planning, 1988, University of Pennsylvania, Philadelphia, PA
M.S., Development Economics, 1987, University of Pennsylvania, Philadelphia, PA
B.A., English, 1980, DePauw University, Greencastle, IN
Years of Experience: 11

Rose, James J., PEIS Document Manager, DP-45, DOE
J.D., 1994, Columbus School of Law, Catholic University, Washington, DC
B.S., Ocean Engineering, 1983, U.S. Naval Academy, Annapolis, MD
Years of Experience: 12

Sarrel, Rachel S., Comment Database Manager, Tetra Tech Inc.
M.S., Environmental Science, 1995, State University of New York College of Environmental Science and Forestry, Syracuse, N.Y.
B.A., Environmental Studies, 1993, State University of New York at Binghamton, Binghamton, N.Y.
Years of Experience: 1

Schinner, James R., Biotic Resources Technical Lead, Halliburton NUS Corp.
Ph.D., Wildlife Management, 1974, Michigan State University, East Lansing, MI
B.S., Zoology, 1967, University of Cincinnati, Cincinnati, OH
Years of Experience: 22

Schlegel, Robert L., Radiological Health Risk Assessment Group Member, Halliburton NUS Corp.
M.S., Nuclear Engineering, 1961, Columbia University, New York, NY
B.S., Chemical Engineering, 1959, Massachusetts Institute of Technology, Cambridge, MA
Years of Experience: 30

Silhanek, Jay S., Waste Management Group Member, Lamb Associates, Inc.
M.P.H., Health Physics, 1961, University of Michigan, Ann Arbor, MI
M.S., Sanitary Engineering, 1957, University of Wisconsin, Madison, WI
B.S., Civil Engineering, 1956, Case Western Reserve, Cleveland, OH
Years of Experience: 37

Slemmons, Hazel C., Halliburton NUS Deputy Technical Coordinator, Halliburton NUS Corp.
B.S., Business Administration, 1986, University of Maryland, College Park, MD
A.A., Management/Marketing, 1983, Montgomery College, Rockville, MD
Years of Experience: 10

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B.S., Civil Engineering, 1987, Carnegie Mellon University, Pittsburgh, PA
Years of Experience: 8

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B.S., Industrial Engineering, Management Systems, 1958, General Motors Institute, Flint, MI
Years of Experience: 38

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M.B.A., Management, 1964, Hofstra University, Hempstead, NY
B.S., Electrical Engineering, 1960, Rutgers University, New Brunswick, NJ
Years of Experience: 34

Swedock, Robert D., Project Definition Technical Lead, Lamb Associates, Inc.
M.S., Civil Engineering, 1975, Stanford University, Stanford, CA
B.S., Military Science, 1968, U.S. Military Academy, West Point, NY
Years of Experience: 26

Tammara, Rao S.R., Intersite Transportation Group Member, Halliburton NUS Corp.
M.S., Environmental Engineering (Pollution Control), 1976, University of Maryland, College Park, MD
M.S., Chemical/Nuclear Engineering, 1970, University of Maryland, College Park, MD
M. Tech (M.S.), Chemical Engineering, Plant Design, 1968, Osmania University, India
B. Sci (B.S.), Mathematics, Physics and Chemistry, 1961, Osmania University, India
Years of Experience: 28

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M.B.A., 1979, University of Colorado, Boulder, CO
B.G.S., Business, 1973, University of Nebraska, Omaha, NE
Years of Experience: 30

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M.S., Chemical Engineering, 1970, University of Maryland, College Park, MD
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M.S., Environmental Science, 1991, University of Cincinnati, Cincinnati, OH
B.S., Atmospheric Science, 1985, National Taiwan University, Taiwan
Years of Experience: 7

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B.S., Environmental Studies, 1994, Radford University, Radford, VA
Years of Experience: 2

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B.S., Nuclear Engineering, 1991, University of Florida, Gainesville, FL
Years of Experience: 4

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M.B.A., Business Administration, 1972, Oklahoma State University, Tulsa, OK
M.S., Physics, 1970, Oklahoma State University, Tulsa, OK
B.A., Physics and Mathematics, 1968, Friends University, Wichita, KS
Years of Experience: 24

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M.S., Nuclear Physics, 1987, Naval Postgraduate School, Monterey, CA

B.S., Nuclear Engineering, 1978, Pennsylvania State University, State College, PA
Years of Experience: 26

Williams, Kathleen A., Land Resources Technical Lead, Comment Response Document Lead, Tetra Tech, Inc.
B.S., General Engineering, 1992, University of Maryland, College Park, MD
Years of Experience: 3

CHAPTER 8: LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THIS STATEMENT WERE SENT

This chapter lists agencies, organizations, and persons who requested Volumes I, II, III, and IV of the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* . Not listed are the organizations and persons who requested only the Summary or Volumes II, III, or IV.

Federal-Elected Officials Representing Affected Areas

States

Arizona
California
Georgia
Kansas
Missouri
Nevada
New Mexico
South Carolina
Tennessee
Texas
Utah

Governors Representing Affected Areas

States

Arizona
California
Georgia
Kansas
Missouri
Nevada
New Mexico
South Carolina
Tennessee
Texas
Utah

State Elected Officials Representing Affected Areas

States

Arizona
California
Georgia
Kansas
Missouri
Nevada
New Mexico
South Carolina
Tennessee
Texas
Utah

NEPA State Single Points of Contact

States

Arizona
California
Georgia
Kansas
Missouri
Nevada
New Mexico
South Carolina
Tennessee
Texas
Utah

Native American Groups

Agua Caliente Tribal Council, CA
All Indian Pueblo Council, NM
Alturas Rancheria, CA
Amah Tribal Band
Augustine Band of Cahuilla Mission, CA
Barona General Business, CA

Battle Mountain Band Council, NV
Benton Paiute Indian Tribe, CA
Berry Creek Rancheria, CA
Big Pine Paiute Tribe, CA
Big Sandy Rancheria, CA
Big Valley Rancheria, CA
Bishop Indian Tribe Council, CA
Blue Lake Rancheria, CA
Bridgeport Indian Colony, CA
Buena Vista Rancheria, CA
Bureau of Indian Affairs
Cabazon Indians of California, CA
Cahuilla Band of Mission Indians, CA
Carson Colony Council, NV
Carson Community Council, NV
Cawtawba Indian Nation, SC
Cedarville Rancheria, CA
Chemehuevi Paiute Tribe, NV
Chemehuevi Paiute Tribal Council, NV
Chicken Ranch Rancheria, CA
Cloverdale Rancheria, CA
Coast Indian Community of the Resighini, CA
Cochiti Pueblo, NM
Colusa Rancheria, CA
Cortina Rancheria, CA
Council of the Te-Moak, NV
Coyote Valley Reservation, CA
Cuyapaipe Band of Mission Indians, CA
Dresslerville Community Council, NV
Dry Creek Rancheria, CA
Duckwater Shoshone Indian Tribe, NV
Elem Indian Colony of Pomo Indians
Elk Valley Rancheria, CA
Elko Band Council, NV
Ely Colony Tribal Council, CA
Fallon Business Council, NV
Fort Independence Paiute Tribe, NV
Fort McDermitt Paiute-Shoshone Tribes, NV
Greenville Rancheria, CA
Grindstone Rancheria, CA
Guidiville Rancheria, CA
Hoopa Valley Indian Reservation, CA
Hopland Reservation, CA
Isleta Pueblo, NM
Jackson Rancheria, CA

Jamul Band of Mission Indians, CA
Jemez Pueblo, NM
Jicarilla Apache Tribe, NM
Karuk Tribe of California, CA
La Jolla Band of Mission Indians, CA
La Posta Band of Mission Indians, CA
Las Vegas Indian Colony, NV
Laytonville Rancheria, CA
Lone Pine Paiute/Shoshone Tribe, CA
Los Coyotes Band of Mission Indians, CA
Lytton Rancheria, CA
Manchester/Point Arena Rancheria, CA
Manzanita General Council, CA
Mesa Grande Band of Mission Indians, CA
Mescalero Apache Tribe, NM
Middletown Rancheria, CA
Moapa Paiute Indian Tribe, NW
Mooretown Rancheria, CA
Morongo Band of Mission Indians, CA
Nambe Pueblo, NM
National Congress of American Indians, DC
North Fork Rancheria, CA
Northwestern Band of Shoshoni Nation
Pahrump Paiute Indian Tribe, NV
Pala Band of Mission Indians, CA
Pascua Yagui Tribal Council, NV
Pauma Band of Mission Indians, CA
Pinoleville Rancheria, CA
Pit River Tribal Council, NV
Pojoaque Pueblo, NM
Potter Valley Rancheria, CA
Pyramid Lake Paiute Tribal Council, NV
Quartz Valley Indian Reservation, CA
Ramah Navajo Chapter, NM
Ramona Band of Cahuilla Indians, CA
Redding Rancheria, CA
Redwood Valley Rancheria, CA
Reno/Sparks Tribal Council, NV
Rincon Band of Cahuilla Indians, CA
Robinson Rancheria, CA
Rohnerville Rancheria, CA
Rumsey Rancheria, CA
San Felipe Pueblo, NM
San Ildefonso Pueblo
San Juan Pueblo, NM

San Manuel Band of Mission Indians, CA
San Pasqual General Council, CA
Santa Ana Pueblo, NM
Santa Clara Pueblo, NM
Santa Rosa Rancheria, CA
Santa Ynez Band of Mission Indians, CA
Santa Ysabel Band of Mission Indians, CA
Santa Domingo Pueblo, NM
Scotts Valley Band Band of Pomo Indians, CA
Sherwood Valley Rancheria, CA
Shingle Springs Rancheria, CA
Shoshone Bannock Tribe, NV
Shoshone Paiute Business Council, NV
Smith River Rancheria, CA
Soboba Band of Mission Indians, CA
South Fork Band Council, NV
Stewart Community Council, NV
Stewarts Point Rancheria, CA
Summit Lake Paiute Council, NV
Susanville Rancheria, CA
Sycuan Business Committee, CA
Table Bluff Rancheria, CA
Table Mountain Rancheria, CA
Tesuque Pueblo, NM
Timbisha Shoshone Tribe, CA
Torres-Martinez Band of Mission Indians, CA
Trinidad Rancheria, CA
Tule River Reservation, CA
Tuolumne Me-Wuk Rancheria, CA
Twenty Nine Palms Band of Mission Indians, CA
Walker River Paiute Tribal Council, NV
Washoe Tribal of Nevada and California, NV
Wells Indian Colony Band Council, NV
Western Shoshone Elders Council, NV
Western Shoshone National Council, NV
Winnemucca Indian Colony, NV
Woodfords Community Council, CA
Yerington Paiute Tribal Council, NV
Yomba Shoshone Indian Tribe, NV
Ysleta del Sur Pueblo, TX
Yurok Tribe, CA
Zia Pueblo, NM
Zuni Pueblo, NM

Mayors Representing Affected Areas

California

Livermore
Oakland
Manteca
Pleasanton
Tracy

Georgia

Atlanta
Augusta
Bath
Blyth
Evans
Girard
Harlem
Hephzibah
Keysville
Martinez
Millen
Sardis
Savannah
Statesboro
Thomson
Waynesboro
Wrens

Kansas

Kansas City
Leawood
Lenexa
Merriam
Mission Hill
Olathe
Overland Park
Prairie Village
Shawnee

Nevada

Alamo
Amargosa Valley
Ash Springs
Beatty
Blue Diamond
Henderson
Hiko
Indian Springs
Las Vegas
North Las Vegas
Pahrump
Warm Spring

New Mexico

Albuquerque
Espanola
Santa Fe

South Carolina

Aiken
Allendale
Augusta
Bamberg
Barnwell
Batesburg
Blackville
Beech Island
Columbia
Denmark
Edgefield
Estill
Gaston
Gloverville
Graniteville
Hampton
Jackson
Johston
Leesville
Monmorenci

New Ellenton
North
North Augusta
Norway
Orangeburg
Owdoms
Pelion
Perry
Salley
Saluda
Springfield
Sycamore
Trenton
Vanville
Wagener
Windsor
Williston

Tennessee

Andersonville
Alcoa
Allardt
Athens
Bethel
Blaine
Briceville
Caryville
Clarkrange
Clinton
Coalfield
Corrytown
Crossville
Dandridge
Decatur
Deer Lodge
Elgin
Etowah
Town of Farragut
Fairfield Glade
Fairview
Friendsville
Gatlinburg
Grandview

Greenback
Harriman
Halls Crossroads
Huntsville
Jacksonboro
Jamestown
Jefferson City
Jellico
Karns
Kingston
Knoxville
Kodak
La Follette
Lake City
Lancing
Lenoir City
Loudon
Louisville
Luttrell
Madisonville
Maryville
Mascot
Maynardville
Midtown
New Market
New Tazwell
Niota
Norris
Oakdale
Oak Ridge
Old Washington
Oliver Springs
Oneida
Petros
Philadelphia
Pigeon Forge
Pomona
Powell
Rockford
Rockwood
Rutledge
Sevierville
Sharps Chapel
Solway
Speedwell

Spring City
Strawberry Plains
Sunbright
Sweetwater
Talbot
Tellico Plains
Ten Mile
Townsend
Washington
Vonore
Walland
Wartburg
Wildwood

Texas

Amarillo
Ashota
Borger
Bushland
Canyon
Channing
Clarendon
Claude
Cliffside
Conway
Dial
Dawn
Dumas
Electric City
Fritch
Goodnight
Groom
Happy
Hereford
Lake Tanglewood
Paloduro
Pampa
Pullman
Philips
Sanford
Skelleytown
Spearman
Silverton

Stinnett
Tulia
Vega
Washburn
Wildorado

Individuals Requesting Copies

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North Carolina

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New Mexico

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Diane Harrison
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John Martin
McGowan
Mary O'Brien
Joseph Ruggieri
Jewell Tidwell
Engelbrecht L. Tiesenhausen
Fred Toomey
Janene Zimmerman

New York

Jolie Lonner
Richard Powell

Ohio

John L. Hehmeyer
Floyd R. Hertweck

Paul Lamberger
Velma Shearer

Oregon

Larry Caldwell

Pennsylvania

Tyler Cyronak
Judith Joshrud
Joseph L. Redding, Jr
Mike Travis

Rhode Island

John Doherty

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Gail Jernigan
Donald Kepler
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William R. McDonell
Gary Mullis
Philip Permer
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Jim Willison
Steve Wilson

Tennessee

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Anne Banks Redwine
J.R. Barkman
Ken Bernander
Ralph Best
William Bibb
Alfred Boch
Harry Bryson
Robert B. Burditt
Walter Coin
Lesley T. Cusick
Spivey Douglass
William S. Dritt
Dan Fairfax
James C. Franklin
Annie Freeman
Douglas Greene
Gerald R. Guinn
Robert M. Hill
James Hodges
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Charles N. Jolly
P.H. Johson
John Jones, Jr.
Bill Leinart
Fred Maienshien
William T. Mee
W. Mccullough
R.W. Mitchell
John N. Napier
Ralph Newcomb
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Jim Phelps
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William E. Tewes

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William J. Yaggi

Texas

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Ben Brister
Curtis Broaddus
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Steven Bullard

Karen Bullion
Mae Burk
Richard Burke
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J. Frank Davis
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Robert Gleason
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Ronnie Hill
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Louis Keyser
F.C. Killebrew
Angela Kleffman
Reinhard Knerr
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CHAPTER 9: GLOSSARY

Absorbed dose: The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. Expressed in units of radiation absorbed dose or grays, where 1 radiation absorbed dose equals 0.01 gray. Also, see "radiation absorbed dose."

Accident sequence: An initiating event followed by system failures or operator errors, which can result in significant core damage, confinement system failure, and/or radionuclide releases.

Accountable weapon: The number of weapons associated with each missile or aircraft type limited by treaty. This does not include non-strategic nuclear forces, Department of Defense spares or spares needed to replace weapons disassembled by DOE surveillance testing.

Acute exposure: The exposure incurred during and shortly after a radiological release. Generally, the period of acute exposure ends when long-term interdiction is established, as necessary. For convenience, the period of acute exposure is normally assumed to end 1 week after the inception of a radiological accident.

Air pollutant: Any substance in air which could, if in high enough concentration, harm man, other animals, vegetation, or material. Pollutants may include almost any natural or artificial composition of matter capable of being airborne.

Air Quality Control Region (AQCR): Geographic subdivisions of the U.S., designed to deal with pollution on a regional or local level. Some regions span more than one state.

Air quality standards: The level of pollutants in the air prescribed by regulations that may not be exceeded during a specified time in a defined area.

Alpha activity: The emission of alpha particles by fissionable materials (uranium or plutonium).

Alpha particle: A positively charged particle, consisting of two protons and two neutrons, that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

Alpha wastes: Wastes containing radioactive isotopes which decay by producing alpha particles.

Ambient air: The surrounding atmosphere as it exists around people, plants, and structures. Air quality standards are used to provide a measure of the health-related and visual characteristics of the air.

American Indian Religious Freedom Act of 1978: This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

Anadromous Fish Conservation Act: This act seeks to enhance the conservation and development of the anadromous fishery resources of the United States that are subject to depletion from water resources development.

Aquatic biota: The sum total of living organisms within any designated aquatic area.

Aquifer: A saturated geologic unit through which significant quantities of water can migrate under natural hydraulic gradients.

Aquitard: A less-permeable geologic unit in a stratigraphic sequence. The unit is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

Archaeological sites (resources): Any location where humans have altered the terrain or discarded artifacts during either prehistoric or historic times.

Artifact: An object produced or shaped by human workmanship of archaeological or historical interest.

As low as reasonably achievable: A concept applied to the quantity of radioactivity released in routine operation of a nuclear system or facility, including "anticipated operational occurrences." It takes into account the state of technology, economics of improvements in relation to benefits to public health and safety, and other societal and economic considerations in relation to the use of nuclear energy in the public interest.

Atmospheric dispersion: The process of air pollutants being dispersed in the atmosphere. This occurs by the wind that carries the pollutants away from their source and by turbulent air motion that results from solar heating of the Earth's surface and air movement over rough terrain and surfaces.

Atomic Energy Act of 1954: This Act was originally enacted in 1946 and amended in 1954. For the purpose of this Programmatic Environmental Impact Statement "...a program for Government control of the possession, use, and production of atomic energy and special nuclear material whether owned by the Government or others, so directed as to make the maximum contribution to the common defense and security and the national welfare, and to provide continued assurance of the Government's ability to enter into and enforce agreements with nations or groups of nations for the control of special nuclear materials and atomic weapons..." (Section 3(c)).

Atomic Energy Commission: A five-member commission, established by the Atomic Energy Act of 1946, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the Nuclear Regulatory Commission and the Administrator of the Energy Research and

Development Administration. The Energy Research and Development Administration was later terminated and its functions vested by law in the Administrator were transferred to the Secretary of Energy.

B-25 Package: A container designed for the storage of low level waste.

Background radiation: Ionizing radiation present in the environment from cosmic rays and natural sources in the Earth; background radiation varies considerably with location. Also, see"natural radiation."

Badged worker: A worker equipped with an individual dosimeter who has the potential to be exposed to radiation.

Bald and Golden Eagle Protection Act: This act states that it is unlawful to take, pursue, molest, or disturb the American bald and golden eagle, their nests, or their eggs, anywhere in the United States.

Baseline: A quantitative expression of conditions, costs, schedule, or technical progress to serve as a base or standard for measurement during the performance of an effort; the established plan against which the status of resources and the progress of a project can be measured. For this Programmatic Environmental Impact Statement, the environmental baseline is the site environmental conditions as they are projected to occur in 2005.

Beamlets: Independent laser beams.

BEIR V: Biological Effects of Ionizing Radiation; referring to the fifth in a series of committee reports from the National Research Council.

Beryllium: An extremely lightweight, strong metal used in weapons systems.

Benthic: Plants and animals dwelling at the bottom of oceans, lakes, rivers, and other surface waters.

Best Available Control Technology (BACT): A term used in the Federal Clean Air Act that means the most stringent level of air pollutant control considering economics for a specific type of source based on demonstrated technology.

Beta particle: A charged particle emitted from the nucleus of an atom during radioactive decay. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron.

Beyond Evaluation Basis Accident (BEBA): An accident, generally with more severe impacts to onsite personnel and the public than a EBA or DBA, initiated by operational or external causes with an estimated probability of occurrence less than 10^{-6} per year and used for estimating the impacts of a planned new or modified facility and/or process. For those cases where a DBA is defined, these accidents are often referred to as Beyond Design Basis Accidents or Severe Accidents.

Biota (biotic): The plant and animal life of a region.

Boost: The process by which fusion of deuterium-tritium gas inside the pit of a nuclear weapon produces neutrons that increase the fission output of the primary.

Bremsstrahlung: The electromagnetic radiation produced by an accelerated charged particle, usually an electron.

Burial ground: A place for burying unwanted (i.e., radioactive) materials in which the earth acts as a receptacle to prevent the dispersion of wastes in the environment and the escape of radiation.

Burn: Fusion of two light nuclei (usually deuterium and tritium) to form a heavier nucleus (helium) accompanied by the release of neutrons and energy.

Calcination: The process of converting high-level waste to unconsolidated granules or powder. Calcined solid wastes are primarily salts and oxides of metals (heavy metals) and components of high level waste (also called calcining).

Caldera: A large crater formed by the collapse of the central part of a volcano.

Cancer: The name given to a group of diseases characterized by uncontrolled cellular growth with cells having invasive characteristics such that the disease can transfer from one organ to another.

Canned subassembly: The component of a nuclear weapon which contains the secondary uranium and lithium elements.

Capability-based deterrence: Deterrence based on the capability to respond to stockpile reliability and safety problems and to meet new requirements.

Capable fault: A fault that has exhibited one or more of the following characteristics (10 CFR 100, Appendix A):

1. Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years.
2. Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.
3. A structural relationship to a capable fault according to characteristics (1) or (2) of this paragraph such that movement on one could be reasonably expected to be accompanied by movement on the other.

Capacity factor: The ratio of the annual average power load of a power plant to its rated capacity.

Carbon adsorption: A unit physiochemical process in which organic and certain inorganic compounds in a liquid stream are absorbed on a bed of activated carbon; used in water or waste purification and chemical processing.

Carbon dioxide: A colorless, odorless, nonpoisonous gas that is a normal component of the ambient air; it is an expiration product of normal plant and animal life.

Carbon monoxide: A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

Carolina bay: Ovate, intermittently flooded depression of a type occurring on the Coastal Plain from New Jersey to Florida.

Cask (radioactive materials): A container that meets all applicable regulatory requirements for shipping spent nuclear fuel or high-level waste.

Cesium: A silver-white alkali metal. A radioactive isotope of cesium, cesium-137, is a common fission product.

Chemical oxygen demand: A measure of the quantity of chemically oxidizable components present in water.

Chronic exposure: Low-level radiation exposure incurred over a long period of time.

Claystone: A massive sedimentary rock made up largely of clay minerals having the composition of shale, but lacking its fine lamination.

Clean Air Act: This Act mandates and enforces air pollutant emissions standards for stationary sources and motor vehicles.

Clean Air Act Amendments of 1990: Expands the Environmental Protection Agency's enforcement powers and adds restrictions on air toxics, ozone depleting chemicals, stationary and mobile emissions sources, and emissions implicated in rain and global warming.

Clean Water Act of 1972, 1987: This Act regulates the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit as well as regulates discharges to or dredging of wetlands.

Climatology: The science that deals with climates and investigates their phenomena and causes.

Code of Federal Regulations: All Federal regulations in force are published in codified form in the Code of Federal Regulations.

Collective committed effective dose equivalent: The committed effective dose equivalent of radiation for a population.

Combined impact: Depending on the scope of the program concerned, a Programmatic Environmental Impact Statement may address more than one "Purpose and Need," each with its own set of alternatives. These several actions, however, may have common environments. The sum of these impacts with respect to the site concerned are combined impacts, as opposed to cumulative impacts, which incorporate the site-specific impacts of activities not otherwise related to the actions and alternatives in question.

Command disable: A subsystem of command and control features that destroys a weapon's ability to produce a nuclear yield.

Committed dose equivalent: The predicted total dose equivalent to a tissue or organ over a 50-year period after an intake of radionuclide into the body. It does not include external dose contributions. Committed dose equivalent is expressed in units of rem or Sievert. The committed effective dose equivalent is the sum of the committed dose equivalents to various tissues of the body, each multiplied by the appropriate weighting factor.

Common mode failure: A failure or defect affecting an entire class of weapon or weapon component: a particular concern with the enduring stockpile since it contains about seven weapon systems, many of which use components with common design features, or components manufactured using identical or similar processes.

Community (biotic): All plants and animals occupying a specific area under relatively similar conditions.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (or Superfund): This Act provides regulatory framework for remediation of past contamination from hazardous waste. If a site meets the Act's requirements for designation, it is ranked along with other "Superfund" sites and is listed on the National Priorities List. This ranking is the Environmental Protection Agency's way of determining which sites have the highest priority for cleanup.

Comprehensive Test Ban Treaty (CTBT): A proposed treaty prohibiting nuclear tests of all magnitudes.

Computational Modeling: The use of a computer to develop a mathematical model of a complex system or process and to provide conditions for testing it.

Conceptual design: Efforts to develop a project scope that will satisfy program needs; ensure project feasibility and attainable performance levels of the project for congressional consideration; develop project criteria and design parameters for all engineering disciplines; and identify applicable codes and standards, quality assurance requirements, environmental studies, construction materials, space allowances, energy conservation features, health, safety, safeguards, and security requirements and any other features or requirements necessary to describe the project.

Consumptive water use: The difference in the volume of water withdrawn from a body of water and the amount released back into the body of water.

Container: The metal envelope in the waste package that provides the primary containment function of the waste package and is designed to meet the containment requirements of 10 CFR 60.

Conventional weapon: A nonnuclear weapon.

Credible accident: An accident that has a probability of occurrence greater than or equal to one in a million years.

Cretaceous Period: Geologic time making up the end of the Mesozoic Era, dating from approximately 144 million to 66 million years ago.

Criteria pollutants: Six air pollutants for which national ambient air quality standards are established by the Environmental Protection Agency under title I of the *Federal Clean Air Act* : sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter (smaller than 10 microns in diameter), and lead.

Critical habitat: Defined in the Endangered Species Act of 1973 as "specific areas within the geographical area occupied by [an endangered or threatened] species..., essential to the conservation of the species and which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species... that are essential for the conservation of the species."

Cultural resources: Archaeological sites, architectural features, traditional use areas, and Native American sacred sites or special use areas.

Cumulative impacts: In an Environmental Impact Statement, the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal), private industry, or individuals undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Curie: A unit of radioactivity equal to 37 billion disintegrations per second; also a quantity of any nuclide or mixture of nuclides having 1 curie of radioactivity.

Decay heat (radioactivity): The heat produced by the decay of certain radionuclides.

Decay (radioactive): The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous transformation of an unstable nuclide into a different nuclide or into a different energy state of the same nuclide; the emission of nuclear radiation (alpha, beta, or gamma radiation) is part of the process.

Decontamination: The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive or chemical contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

Deflagration: Rapid and powerful self-sustained burning of a propellant or explosive.

Delivery system (carrier): The military "vehicle" (e.g. ballistic or cruise missile, artillery shell, airplane, submarine) by which a nuclear weapon would be delivered; most warheads have been designed for specific delivery systems.

Demilitarization: An irreversible modification or destruction of a weapons component or part of a component to the extent required to prevent use in its original weapon purpose.

Depleted uranium: Uranium whose content of the isotope uranium-235 is less than 0.7 percent, which is the uranium-235 content of naturally occurring uranium.

Deposition: In geology, the laying down of potential rock-forming materials; sedimentation. In atmospheric transport, the settling out on ground and building surfaces of atmospheric aerosols and particles ("dry deposition") or their removal from the air to the ground by precipitation ("wet deposition" or "rainout").

Design laboratory: Department of Energy facilities involved in the design of nuclear weapons.

Deuterium: A nonradioactive isotope of the element hydrogen with one neutron and one proton in the atomic nucleus.

Direct economic effects: The initial increases in output from different sectors of the economy resulting from some new activity within a predefined geographic region.

Direct Effect Multiplier: The total change in regional earnings and employment in all related industries as a result of a one-dollar change in earnings and a one-job change in a given industry.

Direct jobs: The number of workers required at a site to implement an alternative.

Disposition: The ultimate "fate" or end use of a surplus Department of Energy facility following the transfer of the facility to the Office of the Assistant Secretary for Environmental Waste Management.

Dolomite: Calcium magnesium carbonate, a limestone-like mineral.

Dose: The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad.

Dose commitment: The dose an organ or tissue would receive during a specified period of time (e.g., 50 to 100 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a defined release, frequently over a year's time.

Dose equivalent: The product of absorbed dose in rad (or gray) and the effect of this type of radiation in tissue and a quality factor. Dose equivalent is expressed in units of rem or Sievert, where 1 rem equals 0.01 Sievert. The dose equivalent to an organ, tissue, or the whole body will be that received from the direct exposure plus the 50-year committed dose equivalent received from the radionuclides taken into the body during the year.

Dosimeter: A small device (instrument) carried by a radiation worker that measures cumulative radiation dose (e.g., film badge or ionization chamber).

Downthrow: The rocks on the side of a fault that have moved downward relative to the rocks on the other side of the fault.

Drainage basin: An aboveground area that supplies the water to a particular stream.

Drawdown: The height difference between the natural water level in a formation and the reduced water level in the formation caused by the withdrawal of groundwater.

Drinking-water standards: The prescribed level of constituents or characteristics in a drinking water supply that cannot be exceeded legally.

Dual use/dual benefit: Projects that have uses in or benefits for the defense sector and the private industry or civilian sector.

Effective dose equivalent: The summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides, and the effective dose equivalent due to penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem (or Sievert).

Effluent: A gas or fluid discharged into the environment.

Emission standards: Legally enforceable limits on the quantities and/or kinds of air contaminants that can be emitted into the atmosphere.

Empirical: Something that is based on actual measurement, observation, or experience rather than on theory.

Endangered species: Defined in the Endangered Species Act of 1973 as "any species which is in danger of extinction throughout all or a significant portion of its range."

Endangered Species Act of 1973: This Act requires Federal agencies, with the consultation and assistance of the Secretaries of the Interior and Commerce, to ensure that their actions will not likely jeopardize the continued existence of any endangered or threatened species or adversely affect the habitat of such species.

Enduring stockpile: Weapons types expected to be retained in the smaller stockpile for the foreseeable future.

Energetic material: Generic term for high explosives and propellants.

Enhanced experimental and computational capabilities: Include aboveground experimental capabilities to study technical issues regarding weapons primaries, specifically high-resolution, multiple-time, multiple-view hydrodynamic experiments using simulant material.

Enhanced weapons and materials surveillance technologies: Includes hydrodynamic testing on test units built, when possible, with aged stockpile components (with modified pits using simulant materials) to provide important data on the effects of aging on weapons safety and performance.

Entrainment: The involuntary capture and inclusion of organisms in streams of flowing water, a term often applied to the cooling water systems. The organisms involved may include phyto- and zoo-plankton, fish eggs and larvae (ichthyoplankton), shellfish larvae, and other forms of aquatic life.

Environment, safety, and health program: In the context of the Department of Energy, encompasses those Department of Energy requirements, activities, and functions in the conduct of all Department of Energy and Department of Energy-controlled operations that are concerned with: impacts to the biosphere; compliance with environmental laws, regulations, and standards controlling air, water, and soil pollution; limiting the risks to the well-being of both operating personnel and the general public to acceptably low levels; and protecting property adequately against accidental loss and damage. Typical activities and functions related to this program include, but are not limited to, environmental protection, occupational safety, fire protection, industrial hygiene, health physics, occupational medicine, and process and facilities safety, nuclear safety, emergency preparedness, quality assurance, and radioactive and hazardous waste management.

Environmental assessment: A written environmental analysis that is prepared pursuant to the National Environmental Policy Act to determine whether a Federal action would significantly affect the environment and thus require preparation of a more detailed environmental impact statement. If the action would not significantly affect the environment, then a finding of no significant impact is prepared.

Environmental impact statement: A document required of Federal agencies by the National Environmental Policy Act for major proposals significantly affecting the environment. A tool for decision-making, it describes the positive and negative effects of the undertaking and alternative actions.

Environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or environmental hazards due to a lack of political or economic strength.

Environmental survey: A documented, multidisciplined assessment (with sampling and analysis) of a facility to determine environmental conditions and to identify environmental problems requiring corrective action.

Eocene: A geologic epoch early in the Cenozoic Era, dating from approximately 54 to 38 million years ago.

Epicenter: The point on the Earth's surface directly above the focus of an earthquake.

Epidemiology: The science concerned with the study of events that determine and influence the frequency and distribution of disease, injury, and other health-related events and their causes in a defined human population.

Evaluation Basis Accident (EBA): An accident, generally with small impacts to the public, initiated by operational or external causes with an estimated probability of occurrence greater than 10^{-6} per year and used for estimating the impacts of a planned new or modified facility and/or process when a Safety Analysis Report, that would define a Design Basis Accident (DBA), has not been prepared. A DBA is used to establish the performance requirements of structures, systems, and components that are necessary to maintain them in a safe shutdown condition indefinitely or to prevent or mitigate the consequences of the DBA so that the public and onsite personnel are not exposed to radiation in excess of appropriate guideline values.

Explosion (conventional): A chemical reaction or change of state that occurs in an exceedingly short time with the generation of high temperatures and large quantities of gaseous reaction products.

Explosion (nuclear): An explosion for which the energy is produced by a nuclear transformation, either fission or fusion. The term typically implies the release of enormous amounts (kilotons) of energy.

Exposure limit: The level of exposure to a hazardous chemical (set by law or a standard) at which or below which adverse human health effects are not expected to occur:

- Reference dose is the chronic exposure dose (mg or kg per day) for a given hazardous chemical at which or below which adverse human non-cancer health effects are not expected to occur.
- Reference concentration is the chronic exposure concentration (mg/m3) for a given hazardous chemical at which or below which adverse human non-cancer health effects are not expected to occur.

Fault: A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred. A normal fault occurs when the hanging wall has been depressed in relation to the footwall. A reverse fault occurs when the hanging wall has been raised in relation to the footwall.

Finding of No Significant Impact: A document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded, will not have a significant effect on the human environment and will not require an environmental impact statement.

Fissile material: Plutonium-239, uranium-233, uranium-235, or any material containing any of the foregoing.

Fission: The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

Fission products: Nuclei formed by the fission of heavy elements (primary fission products); also, the nuclei formed by the decay of the primary fission products, many of which are radioactive.

Fissure: A long and narrow crack in the earth.

Floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas including at a minimum that area inundated by a 1-percent or greater chance flood in any given year. The base floodplain is defined as the 100-year (1.0 percent) floodplain. The critical action floodplain is defined as the 500-year (0.2 percent) floodplain.

Flux: Rate of flow through a unit area. See "neutron flux."

Formation: In geology, the primary unit of formal stratigraphic mapping or description. Most formations possess certain distinctive features.

Fossil: Impression or trace of an animal or plant of past geological ages that has been preserved in the earth's crust.

Fossiliferous: Containing a relatively large number of fossils.

Fugitive emissions: Emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

Fusion: Nuclear reaction in which light nuclei are fused together to form a heavier nucleus, accompanied by the release of immense amounts of energy and fast neutrons.

Fusion ignition: A thermonuclear burn condition created when laser beams ignite and fuse a target containing a mixture of hydrogen isotopes.

Galvin Report: A study conducted for the Department of Energy as a post-Cold War assessment of DOE's ten largest laboratories. The overall objective of the study was to examine options for change within these laboratories and to propose specific alternatives for redirecting the scientific and engineering resources of these instructions toward the economic, environmental, defense, scientific, and energy needs of the Nation.

Gamma rays: High-energy, short-wavelength, electromagnetic radiation accompanying fission and emitted from the nucleus of an atom. Gamma rays are very penetrating and can be stopped only by dense materials (such as lead) or a thick layer of shielding materials.

Gaussian plume: The distribution of material (a plume) in the atmosphere resulting from the release of pollutants from a stack or other source. The distribution of concentrations about the centerline of the plume, which is assumed to decrease as a function of its distance from the source and centerline (Gaussian distribution), depends on the mean wind speed and atmospheric stability.

Genetic effects: The outcome resulting from exposure to mutagenic chemicals or radiation which results in genetic changes in germ line or somatic cells.

- Effects on genetic material in germ line (sex cells) cause trait modifications that can be passed from parents to offspring.
- Effects on genetic material in somatic cells result in tissue or organ modifications (e.g. liver tumors) that do not pass from parents to offspring.

Geologic repository (mined geologic repository): A facility for the disposal of nuclear waste; the waste is isolated by placement in a continuous, stable geologic formation at depths greater than 300 meters.

Geology: The science that deals with the Earth: the materials, processes, environments, and history of the planet, including the rocks and their formation and structure.

Getter: Organic compounds used along with desiccants to control internal environments in nuclear weapons.

Glove box: An airtight box used to work with hazardous material, vented to a closed filtering system, having gloves attached inside of the box to protect the worker.

Groundwater: The supply of water found beneath the Earth's surface, usually in aquifers, which may supply wells and springs.

Half-life (radiological): The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; this varies for specific radioisotopes from millionths of a second to billions of years.

Hazard Index: A summation of the Hazard Quotients for all chemicals now being used at a site and those proposed to be added to yield cumulative levels for a site. A Hazard Index value of 1.0 or less means that no adverse human health effects (non-cancer) are expected to occur.

Hazard quotient: The value used as an assessment of non-cancer associated toxic effects of chemicals, e.g., kidney or liver dysfunction. It is independent of a cancer risk, which is calculated only for those chemicals identified as carcinogens.

Hazard chemical: Under 29 CFR 1910, Subpart Z, "hazardous chemicals" are defined as "any chemical which is a physical hazard or a health hazard." Physical hazards include combustible liquids, compressed gases, explosives, flammables, organic peroxides, oxidizers, pyrophorics, and reactives. A health hazard is any chemical for which there is good evidence that acute or chronic health effects occur in exposed employees. Hazardous chemicals include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, agents that act on the hematopoietic systm, and agents that damage the lungs, skin, eyes or mucous membranes.

Hazardous material: A material, including a hazardous substance, as defined by 49 CFR 171.8 which poses a risk to health, safety, and property when transported or handled.

Hazardous/toxic waste: Any solid waste (can also be semisolid or liquid, or contain gaseous material) having the characteristics of ignitability, corrosivity, toxicity, or reactivity, defined by the *Resource Conservation and Recovery Act and identified or listed in 40 CFR 261 or by the Toxic Substances Control Act* .

Heavy metals: *Metallic or semimetallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations.*

High efficiency particulate air filter: *A filter used to remove particulates from dry gaseous effluent streams.*

High energy pulsed power: *A technique used in compressing electrical energy and storing it at high levels and then releasing it to a target in a very short time.*

High explosives fabrication: *The ability to fabricate any chemical compound or mechanical mixture that, when subjected to heat, impact, fraction, friction, shock, or other suitable initiation stimulus, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressures in the surrounding medium.*

High-level waste: *The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid. High-level waste contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.*

Highly enriched uranium: *Uranium in which the abundance of the isotope uranium-235 is increased well above normal (naturally occurring) levels.*

Historic resources: *Archaeological sites, architectural structures, and objects produced after the advent of written history dating to the time of the first Euro-American contact in an area.*

Holocene: *The current epoch of geologic time, which began approximately 10,000 years ago.*

HT: *Tritiated hydrogen gas which emits a low-energy beta particle and has a half-life of 12.3 years.*

Hydraulic gradient: *The difference in hydraulic head at two points divided by the distance between two points.*

Hydrodynamic test: *High-explosive nonnuclear experiment to investigate hydrodynamic aspects of primary function up to mid to late stages of pit implosion.*

Hydrodynamics: *The study of the motion of a fluid and of the interactions of the fluid with its boundaries, especially in the case of an incompressible inviscid fluid.*

Hydrology: *The science dealing with the properties, distribution, and circulation of natural water systems.*

Hydronuclear experiment: *Very low-yield experiment (less than a few pounds of nuclear energy released) to assess primary performance and safety with normal detonation.*

Ignition: *Self-sustained fusion burn of light nuclei.*

Impingement: *The process by which aquatic organisms too large to pass through the screens of a water intake structure become caught on the screens and are unable to escape.*

Implosion: *The sudden inward compression and reduction in volume of fissionable material with ordinary explosives in a nuclear weapon.*

Incident-free risk: *The radiological or chemical impacts resulting from packages aboard vehicles in normal transport. This includes the radiation or hazardous chemical exposure of specific population groups such as crew, passengers, and bystanders.*

Indirect economic effects: *Indirect effects result from the need to supply industries experiencing direct economic effects with additional outputs to allow them to increase their production. The additional output from each directly affected industry requires inputs from other industries within a region (i.e., purchases of goods and services). This results in a multiplier effect to show the change in total economic activity resulting from a new activity in a region.*

Induced economic effects: *The spending of households resulting from direct and indirect economic effects. Increases in output from a new economic activity lead to an increase in household spending throughout the economy as firms increase their labor inputs.*

Indirect jobs: *Within a regional economic area, jobs generated or lost in related industries as a result of a change in direct employment.*

Inertial confinement fusion (ICF): *A laser initiated nuclear fusion using the inertial properties of the reactants as a confinement mechanism.*

Injection wells: *A well that takes water from the surface into the ground, either through gravity or by mechanical means.*

Insensitive high explosive: *A high explosive that is specifically formulated to be less sensitive to shock and other stimuli that might be encountered in an accident; usually based on the compound TATB (triaminotrinitrobenzene); insensitive high explosives have lower energy densities than conventional high explosives and thus more material is required to produce the same explosive energy.*

Interbedded: *Occurring between beds or lying in a bed parallel to other beds of a different material.*

Interim (permit) status: *Period during which treatment, storage, and disposal facilities coming under the Resource Conservation and Recovery Act of 1980 are temporarily permitted to operate while awaiting denial or issuance of a permanent permit.*

Intrusive pit reuse: *A process which involves opening of a pit, modifying internal surfaces and features, and reassembly.*

Ion: *An atom that has too many or too few electrons, causing it to be chemically active; an electron that is not associated (in orbit) with a nucleus.*

Ion exchange: *A unit physiochemical process that removes anions and cations, including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.*

Ionizing radiation: *Alpha particles, beta particles, gamma rays, x rays, neutrons, high speed electrons, high speed protons, and other particles or electromagnetic radiation that can displace electrons from atoms or molecules, thereby producing ions.*

Isotope: *An atom of a chemical element with a specific atomic number and atomic mass. Isotopes of the same element have the same number of protons but different numbers of neutrons and different atomic masses.*

Joint test assembly: *A nonnuclear test configuration, with diagnostic instrumentation, of a warhead or bomb.*

Joule: *A metric unit of energy, work, or heat, equivalent to 1 watt-second, 0.737 foot-pound, or 0.239 calories.*

Klystron: *An electron tube used for the generation of ultrahigh-frequency current.*

Lacustrine wetland: *Lakes, ponds, and other enclosed open waters at least 8 ha (20 acres) in extent and not dominated by trees, shrubs, and emergent vegetation.*

Large release: *A release of radioactive material that would result in doses greater than 25 rem to the whole body or 300 rem to the thyroid at 1.6 kilometer from the control perimeter (security fence) of a reactor facility.*

Laser*: A device that produces a beam of monochromatic (single-color) "light" in which the waves of light are all in phase. This condition creates a beam that has relatively little scattering and has a high concentration of energy per unit area.*

Latent fatalities: *Fatalities associated with acute and chronic environmental exposures to chemical or radiation.*

Limited-lifetime component: *A weapon component that decays with age and must be replaced periodically.*

Lithic: *Pertaining to stone or a stone tool.*

Loam: *A soil composed of a mixture of clay, silt, sand, and organic matter.*

Long-lived radionuclides: *Radioactive isotopes with half-lives greater than about 30 years.*

Low-level waste: *Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or "11e(2) by-product material" as defined by DOE Order 5820.2A, Radioactive Waste Management. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram. Some low-level waste is considered classified because of the nature of the generating process and/or constituents, because the waste would tell too much about the process.*

Manufacturing: see "production".

Maximum contaminant level: *The maximum permissible level of a contaminant in water delivered to any user of a public water system. Maximum contaminant levels are enforceable standards.*

Maximally exposed individual: *A hypothetical person who could potentially receive the maximum dose of radiation or hazardous chemicals.*

Megajoule*: A unit of heat, work, or energy equal to 1 million joules. See "Joule".*

Megawatt: *A unit of power equal to 1 million watts. Megawatt thermal is commonly used to define heat produced, while megawatt electric defines electricity produced.*

Meteorology: *The science dealing with the atmosphere and its phenomena, especially as relating to weather.*

Microelectronics: *Integrated circuits and electronic devices constructed of individual circuit elements with dimensions of micrometers (10-6 m) on a carrier with dimensions of a centimeter (10-2 m).*

Migration: *The natural movement of a material through the air, soil, or groundwater; also, seasonal movement of animals from one area to another.*

Migratory Bird Treaty Act: *This act states that it is unlawful to pursue, take, attempt to take, capture, possess, or kill any migratory bird, or any part, nest, or egg of any such bird other than permitted activities.*

Miller Report: *A report subsequently published by SNL as Stockpile Surveillance Past and Future (SAND 95-2751) that describes a number of weapons systems that have been in the Nation's stockpile. The report provides historical examples of some of the problems with systems and documents several examples of unanticipated problems that arose following deployment of a weapons system of the stockpile.*

Miocene Epoch: *Geologic time in the Cenozoic Era dating from 26 to 7 million years ago.*

Mix: *Mixing of materials, usually with different densities and velocities, that can adversely affect nuclear weapon performance.*

Mixed waste: *Waste that contains both "hazardous waste" and "radioactive waste" as defined in this glossary.*

Mock nuclear material: *Material that is nonradioactive and nonfissile but similar in density and other characteristics to nuclear material and is used in place of a weapon's nuclear parts in hydrodynamic experiments and flight tests.*

Modified Mercalli intensity: *A level on the modified Mercalli scale. A measure of the perceived intensity of earthquake ground shaking with 12 divisions, from I (not felt by people) to XII (damage nearly total).*

National Ambient Air Quality Standards: *Air quality standards established by the Clean Air Act, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.*

National Emission Standards for Hazardous Air Pollutants: *A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the Clean Air Act Amendments of 1977.*

National Environmental Policy Act of 1969: *This Act is the basic national charter for the protection of the environment. It requires the preparation of an environmental impact statement for every major Federal action that may significantly affect the quality of the human or natural environment. Its main purpose is to provide environmental information to decision makers and the public so that actions are based on an understanding of the potential environmental consequences of a proposed action and its reasonable alternatives.*

National Environmental Research Park: *An outdoor laboratory set aside for ecological research to study the environmental impacts of energy developments. National environmental research parks were established by the Department of Energy to provide protected land areas for research and education in the environmental sciences and to demonstrate the environmental compatibility of energy technology development and use.*

National Historic Preservation Act of 1966, as amended: *This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal code, if a proposed action might impact an historic property resource, it mandates consultation with the proper agencies.*

National Pollutant Discharge Elimination System: *Federal permitting system required for* *hazardous effluents regulated through the Clean Water Act, as amended.*

National Register of Historic Places: *A list maintained by the Secretary of the Interior of districts, sites, buildings, structures, and objects of prehistoric or historic local, state, or national significance. The list is expanded as authorized by Section 2(b) of the Historic Sites Act of 1935 (16 U.S.C. 462) and Section 101(a)(1)(A) of the National Historic Preservation Act of 1966, as amended.*

Neutron: *An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.*

Neutron flux: *The product of neutron number density and velocity (energy) giving an apparent number of neutrons flowing through a unit area per unit time.*

Nitrogen oxides: *Refers to the oxides of nitrogen, primarily NO (nitrogen oxide) and NO2 (nitrogen dioxide). These are produced in the combustion of fossil fuels and can constitute an air pollution problem. When nitrogen dioxide combines with volatile organic compounds, such as ammonia or carbon monoxide, ozone is produced.*

Nonattainment area: *An air quality control region (or portion thereof) in which the Environmental Protection Agency has determined that ambient air concentrations exceed national ambient air quality standards for one or more criteria pollutants.*

Nondestructive evaluation: *Test method that does not involve damage to or destruction of the test sample; includes the use of ultrasonics, radiography, magnetic flux, and other techniques.*

Nonintrusive modification pit *reuse: Process which includes modification to the external surfaces and features of the pit. The pit remains sealed with the possible exception of cutting the pit tube.*

Noninvasive imaging: *Imaging method that does not damage the test specimen; includes radiography, computed tomography, and other techniques.*

Nonnuclear component: *Any one of thousands of parts that do not contain radioactive or fissile material that are required in a nuclear weapon.*

Nonnuclear fabrication: *Ability to fabricate nonnuclear components and perform nonnuclear component surveillance.*

Nonproliferation: *Preventing the spread of nuclear weapons, nuclear weapon materials, and nuclear weapon technology.*

Nonproliferation Treaty: *A treaty with the aim of controlling the spread of nuclear weapons technologies, limiting the number of nuclear weapons states and pursuing, in good faith, effective* *measures relating to the cessation of the nuclear arms race. They treaty does not invoke stockpile reductions by nuclear states, and it does not address actions of nuclear states in maintaining their stockpiles.*

Nova: *A 10- beam, 100-TW neodymium glass fusion laser facility at Lawrence Livermore National Laboratory that was completed in 1984 and used for inertial confinement fusion target irradiation experiments.*

Nuclear assembly: *Collective term for the primary, secondary, and radiation case.*

Nuclear component: *A part of a nuclear weapon that contains fissionable or fusionable material.*

Nuclear facility: *A facility whose operations involve radioactive materials in such form and quantity that a nuclear hazard potentially exists to the employees or the general public. Included are facilities that: produce, process, or store radioactive liquid or solid waste, fissionable materials, or tritium; conduct separations operations; conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations. Incidental use of radioactive materials in a facility operation (e.g.,check sources, radioactive sources, and X-ray machines) does not necessarily require a facility to be included in this definition.*

Nuclear grade: *Material of a quality adequate for use in a nuclear application.*

Nuclear material: *Composite term applied to: (1) special nuclear material; (2) source material such as uranium or thorium or ores containing uranium or thorium; and (3) by-product material, which is any radioactive material that is made radioactive by exposure to the radiation incident to the process of producing or using special nuclear material.*

Nuclear Posture Review: *A report, led by the Department of Defense, which addressed possible changes in U.S. nuclear policy (e.g., deployment status, targeting, force structure) and which recommendations and decisions will likely dictate further changes in the U.S. nuclear weapons program. The nuclear posture review commits the U.S. to maintaining a safe and reliable nuclear deterrent.*

Nuclear production: *Production operations for components of nuclear weapons that are fabricated from nuclear materials, including plutonium and uranium.*

Nuclear reaction: *A reaction in which an atomic nucleus is transformed into another isotope of that respective nuclide, or into another element altogether; it is always accompanied by the liberation of either particles or energy.*

Nuclear warhead: *A warhead that contains fissionable and fusionable material, the nuclear assembly, and nonnuclear components packaged as a deliverable weapon.*

Nuclear weapon: *The general name given to any weapon in which the explosion results from the energy released by reactions involving atomic nuclei, either fission, fusion, or both.*

Nuclear Weapons Complex: *The sites supporting the research, development, design, manufacture, testing, assessment, certification and maintenance of the Nation's nuclear weapons and the subsequent dismantlement of retired weapons.*

Nuclide: *A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.*

Numerical simulation: *The use of mathematical algorithms and models of physical processes to calculationally simulate the behavior or performance of a device or complex system.*

Obsidian: *A black volcanic glass.*

Occupational Safety and Health Administration: *Oversees and regulates workplace health and safety, created by the Occupational Safety and Health Act of 1970.*

Offsite: *As used in this PEIS, the term denotes a location, facility, or activity occurring outside of the boundary of the entire DOE Complex site (ORR, SRS, Pantex, KCP, SNL, LANL, LLNL, or NTS). At sites which have detached remote locations (e.g., LLNL and Pantex) the term includes these boundaries or a part of the main site.*

Onsite: *As used in this PEIS, the term denotes a location or activity occurring somewhere within the boundary of the DOE Complex site (ORR, SRS, Pantex, KCP, SNL, LANL, LLNL, or NTS).*

Onsite population: *Department of Energy and contractor employees who are on duty, and badged onsite visitors.*

Operable unit: *A discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration or eliminates or mitigates a release, threat of release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units.*

Outfall: *The discharge point of a drain, sewer, or pipe as it empties into a body of water.*

Ozone: *The triatomic form of oxygen; in the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere ozone is considered an air pollutant.*

Packaging: *The assembly of components necessary to ensure compliance with Federal regulations. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle tie-down system and auxiliary equipment may be designated as part of the packaging.*

Paleontology: *The study of fossils.*

Paleozoic Era: *Geologic time dating from 570 million to 245 million years ago when seed-bearing plants, amphibians, and reptiles first appeared.*

Palustrine wetland: *Nontidal wetlands dominated by trees, shrubs, and emergent vegetation.*

Perched groundwater: *A body of groundwater of small lateral dimensions lying above a more extensive aquifer.*

Performance: The ability of a nuclear weapon or weapon system to operate in specified manner (e.g., yield, range, accuracy, radiation spectrum) under stated conditions. (Essentially equivalent to reliability.)

Permeability: geology, t *he ability of rock or soil to transmit a fluid.*

Person-rem: *The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a population segment.*

Physical setting: *The land and water form, vegetation, and structures that compose the landscape.*

Physics dealing with weapons primary: *Issues related to the reliability and safety of the primary high explosive and plutonium core, which is involved in the reaction up to the point where nuclear criticality is achieved. Without proper primary-stage function, the weapon secondary will not work.*

Physics dealing with weapons secondary: *Issues related to the implosion of the secondary portion of uranium and lithium, a nuclear reaction that results in the thermonuclear explosion.*

Pit: *The central core of a nuclear weapon containing plutonium-239 and/or highly enriched uranium that undergoes fission when compressed by high explosives. The pit and the high explosive are known as the primary of a nuclear weapon.*

Plasma: *An electrically neutral, gaseous mixture of positive and negative ions, sometimes called a fourth state of matter since it behaves differently from solids, liquids, and gases. High-temperature, high-density plasmas are created in nuclear weapons and inertial confinement fusion (ICF) experiments.*

Playa: *A basin or a closed depression found within a dry environment that may contain water on a seasonal basis.*

Pleistocene Epoch: *Geologic time that occurred approximately 11,000 to 2 million years ago.*

Pliocene Epoch: *Geologic time between the Miocene and the Pleistocene epochs approximately 2 to 7 million years ago.*

Plume: *The elongated pattern of contaminated air or water originating at a point source, such as a smokestack or a hazardous waste disposal site.*

Plume immersion: *Occurs when an individual is enveloped by a cloud of radioactive gaseous effluent and receives an external radiation dose.*

Plutonium: *A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombardment of uranium with neutrons and is used in the production of nuclear weapons.*

Potentiometric surface: *An imaginary surface defined by the level that water will rise to in a tightly-cased well.*

Pounds per square inch: *A measure of pressure; atmospheric pressure is about 14.7 pounds per square inch.*

Prehistoric: *Predating written history. In North America, also predating contact with Europeans.*

Prevention of Significant Deterioration: *Regulations established by the 1977 Clean Air Act Amendments to limit increases in criteria air pollutant concentrations above baseline.*

Prime farmland: *Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor without intolerable soil erosion, as determined by the Secretary of Agriculture (Farmland Protection Policy Act of 1981, 7 CFR 7, paragraph 658).*

Probable maximum flood: *Flood levels predicted for a scenario having hydrological conditions that maximize the flow of surface waters.*

Product realization: *The process that converts the nuclear assembly, nonnuclear components, subsystems, and system-level requirements into manufacturable designs and hardware.*

Production: Encompasses the fabrication, processing, assembly, and acceptance testing of nuclear weapons and nuclear weapon components, and is interchangeable with the term manufacturing.

Programmatic Environmental Impact Statement (PEIS): *A legal document prepared in accordance with the requirements of 102(2)(C) of NEPA which evaluates the environmental impacts of proposed Federal Actions that involve multiple decisions potentially affecting the environment at one or more sites.*

Project-specific EIS: *A legal document prepared in accordance with the requirements of 102(2)(C) of NEPA which evaluates the environmental impacts of a single action at a single site.*

Proliferation: *The spread of nuclear weapons and the materials and technologies used to produce them.*

Protected area: *An area encompassed by physical barriers, subject to access controls, surrounding material access areas, and meeting the standards of DOE Order 5632.1C, Protection and Control of Safeguards and Security Interests .*

Quality factor: *The principal modifying factor that is employed to derive dose equivalent from absorbed dose.*

Rad: *See "radiation absorbed dose."*

Radiation: *The particles or electromagnetic energy emitted from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced radiation.*

Radiation absorbed dose: *The basic unit of absorbed dose equal to the absorption of 0.01 joule per kilogram of absorbing material.*

Radioactive waste: *Materials from nuclear operations that are radioactive or are contaminated with radioactive materials, and for which use, reuse, or recovery are impractical.*

Radioactivity: *The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.*

Radioisotopes: *Radioactive nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons.*

Radionuclide: *A radioactive element characterized according to its atomic mass and atomic number which can be man-made or naturally occurring. Radionuclides can have a long life as soil or water pollutants, and are believed to have potentially mutagenic or carcinogenic effects on the human body.*

Radon: *Gaseous, radioactive element with the atomic number 86 resulting from the radioactive decay of radium. Radon occurs naturally in the environment, and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.*

RADTRAN: *A computer code combining user-determined meteorological, demographic, transportation, packaging, and material factors with health physics data to calculate the expected radiological consequences and accident risk of transporting radioactive material.*

Reasonably Available Control Technology (RACT): *The lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available as well as technologically and economically feasible.*

Receiving waters: *Rivers, lakes, oceans, or other bodies of water into which wastewaters are discharged.*

Recharge: *Replenishment of water to an aquifer.*

Record of Decision: *A document prepared in accordance with the requirements of 40 CFR 1505.2 that provides a concise public record of DOE's decision on a proposed action for which an EIS was prepared. A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative(s), factors balanced by DOE in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why they were not.*

Regional economic area*: A geographic area consisting of an economic node and the surrounding counties that are economically related and include the places of work and residences of the labor force. Each regional economic area is defined by the U.S. Bureau of Economic Analysis.*

Region of influence (ROI): *A site-specific geographic area that includes the counties where approximately 90 percent of the current DOE and/or contractor employees reside.*

Reliability: *The ability of a nuclear weapon, weapon system, or weapon component to perform its required function under stated conditions for a specified period of time. (Essentially equivalent to performance.)*

Rem: *See "roentgen equivalent man."*

Remediation: *The process, or a phase in the process, of rendering radioactive, hazardous, or mixed waste environmentally safe, whether through processing, entombment, or other methods.*

Replacement Pit Fabrication: *This function includes the fabrication, surveillance, and storage of the primary high explosive and plutonium core of a nuclear weapon.*

Replacement Secondary Fabrication: *This function includes the fabrication, surveillance, and storage of the secondary uranium and lithium portion of a nuclear weapon.*

Resource Conservation and Recovery Act, as amended: *The Act that provides "cradle to grave" regulatory program for hazardous waste which established, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.*

Retrofit: *To furnish (e.g., a weapon) with new parts, equipment, or features not available at the time of manufacture.*

Rhyolite: *A volcanic rock rich in silica; the volcanic equivalent of granite.*

Rightsizing: *Denotes the facility modification, rearrangement, and refurbishment necessary to size future weapon manufacturing facilities appropriately for the workload to be accomplished. In general, rightsizing involves reductions in the size of facilities, but not in their capabilities. Rightsizing is not driven by assumptions about future DOE budget levels, but rather is driven by the need to size facilities at the level necessary for long-term workload accomplishment.*

Riparian wetlands: *Wetlands on or around rivers and streams.*

Risk: *A quantitative or qualitative expression of possible loss that considers both the probability that a hazard will cause harm and the consequences of that event.*

Risk assessment (chemical or radiological): *The qualitative and quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the presence or potential presence and/or use of specific chemical or radiological materials.*

Roentgen: *A unit of exposure to ionizing X- or gamma radiation equal to or producing 1 electrostatic unit of charge per cubic centimeter of air. It is approximately equal to 1 rad.*

Roentgen equivalent man: *The unit of radiation dose for biological absorption: equal to the product of the absorbed dose, in rads, a quality factor which accounts for the variation in biological effectiveness of different types of radiation. Also known as "rem".*

Runoff: *The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually enters streams.*

Safe Drinking Water Act, as amended: *This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.*

Safe secure trailer: *A specially designed semitrailer, pulled by an armored tractor, which is used for the safe, secure transportation of cargo containing nuclear weapons or special nuclear material.*

Safety*: Minimizing the possibility that a nuclear weapon will be exposed to accidents and preventing the possibility of nuclear yield or plutonium dispersal should there be an accident involving a nuclear weapon.*

Safety Analysis Report: *A safety document providing a concise but complete description and safety evaluation of a site, design, normal and emergency operation, potential accidents, predicted consequences of such accidents, and the means proposed to prevent such accidents or mitigate their consequences. A safety analysis report is designated as final when it is based on final design information. Otherwise, it is designated as preliminary.*

Saltstone: *Low radioactivity fraction of high-level waste from the in-tank precipitation process mixed with cement, flyash, and slag to form a concrete block.*

Sandstone: *A sedimentary rock predominantly containing individual mineral grains visible to the unaided eye.*

Sanitary wastes: *Wastes generated by normal housekeeping activities, liquid or solid (includes sludge), which are not hazardous or radioactive.*

Sanitization: *An irreversible modification or destruction of a component or part of a component to the extent required to prevent revealing classified or otherwise controlled information.*

Scope: *In a document prepared pursuant to the National Environmental Policy Act of 1969, the range of actions, alternatives, and impacts to be considered.*

Scoping: *Involves the solicitation of comments from interested persons, groups, and agencies at public meetings, public workshops, in writing, electronically, or via fax to assist DOE in defining the proposed action, identifying alternatives, and developing preliminary issues to be addressed in an EIS.*

Scrubber: *An air pollution control device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.*

Sealed pit: *A nuclear weapon pit that is hermetically closed to protect nuclear materials from the environment. Note: This is the unclassified definition from the Weapons Program Classification Guide (CG-W-5). "Pit" is already defined in the glossary.*

Secondary: *See "weapon secondary."*

Security: *Minimizing the likelihood of unauthorized access to or loss of custody of a nuclear weapon or weapon system, and ensuring that the weapon can be recovered should unauthorized access or loss of custody occur.*

Sedimentation: *The settling out of soil and mineral solids from suspension in water.*

Seismic: *Pertaining to any earth vibration, especially an earthquake.*

Seismic zone: *An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: (1) Zone 0 - no damage; (2) Zone 1 - minor damage; corresponds to intensities V and VI of the modified Mercalli intensity scale; (3) Zone 2A - moderate damage; corresponds to intensity VII of the modified Mercalli intensity scale (eastern U.S.); (4) Zone 2B - slightly more damage than 2A (western U.S.); (5) Zone 3 - major damage; corresponds to intensity VII and higher of the modified Mercalli intensity* *scale; (6) Zone 4 - areas within Zone 3 determined by proximity to certain major fault systems.*

Seismicity: *The tendency for the occurrence of earthquakes.*

Self-aware weapon: *A stockpile weapon fitted with an integrated network of miniature "smart" sensors (sensing and measuring devices with built-in intelligence capabilities) and self-test features that monitor the weapon's environment (e.g., temperature, moisture, vibration), detect material decomposition products and corrosion, check cable continuity, determine the functionality of weapon subsystems, and alert a central location if any monitored parameters are outside the permitted range.*

Severe accident: *An accident with a frequency rate of less than 10-6 per year that would have more severe consequences than a design-basis accident, in terms of damage to the facility, offsite consequences, or both.*

Sewage: *The total of organic waste and wastewater generated by an industrial establishment or a community.*

Shielding: *Any material of obstruction (bulkheads, walls, or other constructions) that absorbs radiation in order to protect personnel or equipment.*

Short-lived nuclides: *Radioactive isotopes with half-lives no greater than about 30 years (e.g., cesium-137 and strontium-90).*

Shrink-swell potential: *Refers to the potential for soils to contract while drying and expand after wetting.*

Silt*: A sedimentary material consisting of fine mineral particles intermediate in size between sand and clay.*

Siltstone: *A sedimentary rock composed of fine textured minerals.*

Simulant material: *Materials used to modify a weapon pit to prevent the device from becoming critical.*

Site-Wide EIS: *A legal document prepared in accordance with the requirements of 102(2)(C) of NEPA which evaluates the environmental impacts of many actions at one large, multiple-facility DOE site. Site-wide EISs are used to support specific decisions.*

Source term: *The estimated quantities of radionuclides or chemical pollutants released to the environment.*

Special nuclear materials: *As defined in Section 11 of the Atomic Energy Act of 1954, special nuclear material means (1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and* *any other material which the Nuclear Regulatory Commission determines to be special nuclear material or (2) any material artificially enriched by any of the foregoing.*

Standardization (Epidemiology): *Techniques used to control the effects of differences (e.g., age) between populations when comparing disease experience. The two main methods are:*

- *Direct method, in which specific disease rates in the study population are averaged, using as weights the distribution of the comparison population.*
- *Indirect method, in which the specific disease rates in the comparison population are averaged, using as weights the distribution of the study population.*

START I and II: *Terms which refer to negotiations between the U.S. and Russia (the former Soviet Union during START I negotiations) aimed at limiting and reducing nuclear arms. START I discussions began in 1982 and eventually led to a ratified treaty in 1988. The START II protocol, which has not been fully ratified, will attempt to further reduce the acceptable levels of nuclear weapons ratified in START I.*

Steppe: *A semi-arid, grass-covered, and generally treeless plain.*

Stockpile assurance: *The umbrella term for stockpile management and stockpile stewardship; all the tasks required to ensure that the U.S. has a credible nuclear deterrent.*

Stockpile surveillance*: Routine and periodic examination, evaluation, and testing of stockpile weapons and weapon components to ensure that they conform to performance specifications and to identify and evaluate the effect of unexpected or age-related requirements.*

Strategic reserve: *That quantity of plutonium and highly enriched uranium reserved for future weapons use. For the purposes of this PEIS, strategic reserves of plutonium will be in the form of pits, and strategic reserves of highly enriched uranium will be in the form of canned secondary assemblies. Strategic reserves also include limited quantities of plutonium and highly enriched uranium metal maintained as working inventory at DOE laboratories.*

Stratigraphy: *Division of geology dealing with the definition and description of rocks and soils, especially sedimentary rocks.*

Strike: *The direction or trend that a structural surface (e.g., a bedding or fault plane) takes as it intersects the horizontal.*

Subcritical experiment: *A dynamic experiment that involves the use of special nuclear material and does not achieve a condition of criticality (i.e., no self-sustaining nuclear reaction).*

Superfund Amendments and Reauthorization Act of 1986: *Public Law 99-499 passed in 1986 which amends the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of*

1980. SARA more stringently defines hazardous waste cleanup standards and emphasizes remedies that permanently and significantly reduce the mobility, toxicity, or volume of wastes. Title III of SARA, the Emergency Planning and Community Right-to-Know Act , mandates establishment of community emergency planning programs, emergency notification, reporting of chemicals, and emission inventories.

Surface water: *Water on the Earth's surface, as distinguished from water in the ground (groundwater).*

System integration: *The process by which individual components are engineered into a system that meets performance requirements.*

Tertiary Period: *The first geologic period of the Cenozoic Era, dating from 66 million to about 3 million years ago. During this time, mammals became the dominant life form.*

Test readiness: *Maintaining the critical technologies, staff skills, and infrastructure to be able to resume nuclear testing if and when mandated by the President.*

Thermonuclear: *The process by which very high temperatures are used to bring about the fusion of light nuclei, such as deuterium and tritium, with the accompanying release of energy.*

Third Thirds waste: The Environmental Protection Agency *proposed the Third Thirds Rule, as required by the Hazardous and Solid Waste Amendments of 1984, to establish treatment standards and effective dates for all wastes (including characteristic wastes) for which treatment standards had not yet been promulgated (40 CFR 268.12), including derived-from wastes (i.e., multi-source leachage), and for mixed radioactive/hazardous wastes.*

Threatened species: *Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.*

Threshold limit values: *The recommended concentrations of contaminants workers may be exposed to according to the American Council of Governmental Industrial Hygienists.*

Tokamak: *A toroidal (doughnut-shaped) chamber for electromagnetic confinement of plasmas, used in fusion-related experiments and research.*

Toxic Substances Control Act of 1976: *This Act authorizes the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the Environmental Protection Agency before they are manufactured for commercial purposes.*

Transuranic waste: *Waste contaminated with alpha-emitting radionuclides with half-lives greater* *than 20 years and concentrations greater than 100 nanocuries/gram at time of assay.*

Tritium: *A radioactive isotope of the element hydrogen with two neutrons and one proton. Common symbols for the isotope are H-3 and T.*

Unconfined aquifer: *A permeable geological unit having the following properties: a water-filled pore space (saturated), the capability to transmit significant quantities of water under ordinary differences in pressure, and an upper water boundary that is at atmospheric pressure.*

Unreviewed safety question: *A proposed change, test, or experiment is considered to involve an unreviewed safety question if (1) the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety evaluated previously by safety analyses will be significantly increased or (2) a possibility for an accident or malfunction of a different type than any evaluated previously by safety analyses will be created that will result in significant safety consequences.*

Unsaturated zone (vadose): *A region in a porous medium in which the pore space is not filled with water.*

Unusual occurrence: *Any unusual or unplanned event that adversely affects or potentially affects the performance, reliability, or safety of a facility.*

Uranium: *A naturally occuring heavy, silvery-white metallic element (atomic number 92) with many radioactive isotopes. Uranium-235 is most commonly used as a fuel for nuclear fission. Another isotope, uranium-238, can be transformed into fissionable plutonium-239 following its capture of a neutron in a nuclear reactor.*

Vitrification: *A waste treatment process that uses glass (e.g., borosilicate glass) to encapsulate or immobilize radioactive wastes to prevent them from reacting with the surroundings in disposal sites.*

Volatile organic compounds: *A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures, such as benzene, chloroform, and methyl alcohol.*

War Reserve: *Operational weapons and materials designated as essential for national security needs.*

Warhead: *Collective term for the package of nuclear assembly and nonnuclear components that can be mated with a delivery vehicle or carrier to produce a deliverable nuclear weapon.*

Waste Isolation Pilot Plant: *A facility in southeastern New Mexico being developed as the disposal site for transuranic waste, not yet in operation.*

Waste minimization and pollution prevention: *An action that economically avoids or reduces the generation of waste and pollution by source reduction, reducing the toxicity of hazardous waste and* *pollution, improving energy use, or recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.*

Water table: *Water under the surface of the ground occurs in two zones, an upper unsaturated zone and the deeper saturated zone. The boundary between the two zones is the water table.*

Weaponization: *Converting the functional requirements for a weapon into integrated systems designs and prototype hardware.*

Weapon primary: *The crucial subsystem for weapon reliability and safety; the primary contains the main high explosive and the plutonium that comprise the principal safety concerns. Without proper primary-stage function, the secondary will not work.*

Weapon secondary: *Provides additional explosive energy release; composed of lithium deuteride and other materials. As the secondary implodes, the lithium in the isotopy form lithium-6. is converted to tritium by neutron interactions, and the tritium product in turn undergoes fusion with the deuterium to create the thermonuclear explosion.*

Weapons-grade: *Fissionable material in which the abundance of fissionable isotopes is high enough that the material is suitable for use in thermonuclear weapons.*

Weapons assembly/disassembly: *Assembly operations assembles piece parts into subassemblies using joining techniques such as welding, adhesive bonding, and mechanical joining. Disassembly takes retired weapons apart and recycles all materials of value.*

Weapons effects: *Deals with outputs of nuclear weapons and the associated effects on materials and the environment.*

Weapons laboratories: *Colloquial term for the three Department of Energy national laboratories--Los Alamos, Lawrence Livermore, and Sandia--that are responsible for the design, development, and stewardship of U.S. nuclear weapons.*

Weapon system: *Collective term for the nuclear assembly and nonnuclear components, subsytems, and systems that comprise a nuclear weapon.*

Weighting factor: *Represents the fraction of the total health risk resulting from uniform whole-body irradiation that could be contributed to that particular tissue.*

Wetland: *Land or areas exhibiting hydric soil conditions, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions.*

Whole-body dose: *Dose resulting from the uniform exposure of all organs and tissues in a human body. (Also, see "effective dose equivalent.")*

Wind rose: *A depiction of wind speed and direction frequency for a given period of time.*

Worker year: *Measurement of labor requirement equal to 1 full time worker employed for 1 year.*

X/Q (Chi/Q): *The relative calculated air concentration due to a specific air release; units are (sec/ m^3). For example, (Ci/m^3)/(Ci/sec)=(sec/m3) or (g/m^3)/(g/sec)=(sec/m^3).*

Yield: *The force in tons of TNT of a nuclear or thermonuclear explosion.*

Zero-based stockpile: *A nuclear weapons stockpile with zero nuclear weapons and therefore requiring no stockpile management effort.*

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Figure H.2.2-6 Nonhazardous Waste Management Plan at Savannah River Site.

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Chemicals and Units of Measure

Bq	Becquerel
C	Celsius
Ci	curie
$CC1_4$	carbon tetrachloride
cm	centimeters
CFC	chlorofluorocarbons
CO	carbon monoxide
dB	decibel
dBA	decibel A-weighted
DCE	1, 2-dichloroethylene
F	Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
ft^3/s	cubic feet per second
g	grams
gal	gallons
GPD	gallons per day
gpm	gallons per minute
GPY	gallons per year
ha	hectares
hr	hour
in	inches
kg	kilograms
km	kilometers
kV	kilovolts
kVA	kilovolt-ampere
kW	kilowatts
kWh	kilowatt hours
L	liters
lb	pounds
Li	lithium

m	meters
m^2	square meters
m^3	cubic meters
m^3/s	cubic meters per second
mCi	millicurie (one-thousandth of a curie)
mCi/ml	millicurie per milliliter
mg	milligram (one-thousandth of a gram)
mg/L	milligrams per liter
MGY	million gallons per year
mi	miles
MLY	million liters per year
mph	miles per hour
mrem	millirem (one-thousandth of a rem)
MVA	megavolt-ampere
MW	megawatt
MWe	megawatt electric
MWh	megawatt hour
MWt	megawatt thermal
nCi	nanocurie (one-billionth of a curie)
nCi/g	nanocuries per gram
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
O_3	ozone
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie (one-trillionth of a curie)
pCi/l	picocuries per liter
PM_{10}	particulate matter (less than 10 microns in diameter)
ppb	parts per billion
ppm	parts per million
rem	roentgen equivalent man
SO_2	sulfur dioxide
t	metric tons
TATB	triaminotrinitrobenzene

TCA	1, 1, 1-trichloroethane
TCE	trichloroethylene
TNT	trinitrotoluene
yd^3	cubic yards
yr	year
µCi	microcurie (one-millionth of a curie)
µCi/g	microcuries per gram
µg	microgram (one-millionth of a gram)
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
µ	micron or micrometer (one-millionth of a meter)

Metric Conversion Chart

To Convert Into Metric			To Convert Out of Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092903	square meters	square meters	10.7639	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons

cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Force					
dynes	0.00001	newtons	newtons	100,000	dynes
Temperature					
Fahrenheit	Subtract 32, then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

Metric Prefixes

Prefix	**Symbol**	**Multiplication Factor**
exa-	E	1 000 000 000 000 000 000 = 10 *18*
peta-	P	1 000 000 000 000 000 = 10 *15*
tera-	T	1 000 000 000 000 = 10 *12*
giga-	G	1 000 000 000 = 10 *9*
mega-	M	1 000 000 = 10 *6*

kilo-	k	1 000 = 10 *3*
hecto-	h	100 = 10 *2*
deka-	da	10 = 10 *1*
deci-	d	0.1 = 10 -*1*
centi-	c	0.01 = 10 -*2*
milli-	m	0.001 = 10 -*3*
micro-		0.000 001 = 10 -*6*
nano-	n	0.000 000 001 = 10 -*9*
pico-	p	0.000 000 000 001 = 10 -*12*
femto-	f	0.000 000 000 000 001 = 10 -*15*
atto-	a	0.000 000 000 000 000 001 = 10 -*18*

Volume II Acronyms and Abbreviations

A/D	assembly/disassembly
AEC	Atomic Energy Commission
AHF	Advanced Hydrotest Facility
AQCR	Air Quality Control Region
ARS	Advanced Radiation Source
BEBA	beyond evaluation basis accident
BEEF	Big Explosives Experimental Facility
BEIR	biological effects of ionizing radiation
CAA	*Clean Air Act*
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFF	Contained Firing Facility
CFR	Code of Federal Regulations
Complex	Nuclear Weapons Complex
CTBT	Comprehensive Test Ban Treaty
CWA	*Clean Water Act*
DARHT	Dual Axis Radiographic Hydrodynamic Test (Facility)
D&D	decontamination and decommissioning
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DP	DOE Office of the Assistant Secretary for Defense Programs
EA	environmental assessment
EBA	evaluation basis accident
EIS	environmental impact statement
EM	DOE Office of the Assistant Secretary for Environmental Management
EPA	Environmental Protection Agency
ES&H	environment, safety, and health
FONSI	Finding of No Significant Impact
FXR	Flash X-Ray (Facility)
HAP	hazardous air pollutants
HE	high explosives

HEPA	high efficiency particulate air (filter)
HEPPF	High Explosive Pulsed Power Facility
HEU	highly enriched uranium
HI	hazard index
HLW	high-level waste
HQ	hazard quotient
ICRP	International Commission on Radiological Protection
INEL	Idaho National Engineering Laboratory
IP	implementation plan
ICST	Industrial Complex Short-Term (model)
K-25	K-25 Site, Oak Ridge Reservation
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
NAAQS	National Ambient Air Quality Standards
NEPA	*National Environmental Policy Act*
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIF	National Ignition Facility
NLVF	North Las Vegas Facility
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPR	Nuclear Posture Review
NPT	Non-Proliferation Treaty
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
NWSM	Nuclear Weapon Stockpile Memorandum
NWSP	Nuclear Weapon Stockpile Plan
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
Pantex	Pantex Plant
PBFA II	Particle Beam Fusion Accelerator
PDD	Presidential Decision Directive

PEIS	programmatic environmental impact statement
PHERMEX	Pulsed High Energy Radiation Machine Emitting X-Rays (Facility)
PL	Public Law
R&D	research and development
RCRA	*Resource Conservation and Recovery Act*
RD&T	research, development, and testing
RIMS	Regional Input-Output Modeling System
ROD	Record of Decision
ROI	region of influence
SAR	Safety Analysis Report
SARA	Superfund Amendments and Reauthorization Act
SDWA	*Safe Drinking Water Act*
SMR	standardized mortality ratio
SHPO	State Historic Preservation Officer
SNL	Sandia National Laboratories/New Mexico
SRS	Savannah River Site
START	Strategic Arms Reduction Talks
TA	technical area
TLV-TWA	threshold limit value-time weighted average
TRU	transuranic
TSCA	*Toxic Substances Control Act*
TSP	total suspended particulates
USFWS	U.S. Fish and Wildlife Service
VOCs	volatile organic compounds
Y-12	Y-12 Plant, Oak Ridge Reservation
WIPP	Waste Isolation Pilot Plant

APPENDIX A: STOCKPILE STEWARDSHIP AND MANAGEMENT FACILITIES

The Nuclear Weapons Complex (Complex) comprises facilities located at eight major U.S. Department of Energy (DOE) sites, distributed over seven states. Summary descriptions of the Complex sites are presented in chapter 3. This appendix provides more detailed information.

The eight DOE sites described in appendix A include the Oak Ridge Reservation (ORR), the Savannah River Site (SRS), the Kansas City Plant (KCP), the Pantex Plant (Pantex), Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratories (SNL), and the Nevada Test Site (NTS). The first section of this appendix provides reference operating assumptions for each of these sites. Information provided includes specific site descriptions, current missions, and environmental regulatory compliance activities associated with ongoing DOE Office of the Assistant Secretary for Defense Programs (DP), and other DOE and non-DOE programs.

Detailed descriptions of the proposed stockpile stewardship projects can be found in the project-specific analyses contained in appendixes I, J, and K for the National Ignition Facility (NIF), Contained Firing Facility (CFF), and Atlas Facility, respectively.

The last section of this appendix provides detailed descriptions of the stockpile management alternatives. Each description includes specific information describing missions, assumptions, functional parameters, expected capabilities, process descriptions, special process requirements, utilities, chemicals used, operational resources, and transportation.

A.1 Reference Operating Assumptions

The reference base for this Programmatic Environmental Impact Statement (PEIS) is No Action, which is defined in chapter 3. Section 3.3 defines No Action for stewardship and section 3.4 defines No Action for management. No Action allows a comparison of stockpile stewardship and management alternatives for the candidate sites against the configuration as it would be expected to operate in 2005 and beyond, not against the current nuclear weapons facility configuration.

No Action assumes that all sites of the Complex would continue their current nuclear weapons-related missions with existing facilities that can comply with environment, safety, and health (ES&H) requirements, and at a production or research level that is consistent with current DOE guidance. The basic nuclear weapons missions assigned to the sites include researching, developing, and testing; maintaining nuclear weapons production and testing capability; processing and storing nuclear materials; operating an extensive transportation safeguards system to assure the safe, secure movement of weapons and strategic quantities of nuclear materials within the continental United States; and cooperating with the Department of Defense (DOD) in responding to nuclear accidents or incidents throughout the world.

Under No Action, the siting and construction of major new stockpile stewardship and management facilities would not occur, there would be no upgrades or modifications to existing facilities other than routine maintenance and repairs, no nuclear weapons missions would be transferred, and future support of the nuclear weapons stockpile would be provided within the confines of the existing Complex capabilities. Some mission requirements for maintenance of the weapons stockpile in the future would not be met under No Action; however, No Action includes those mission requirements as a comparison for the stockpile stewardship and management alternatives. The No Action alternative assumes that weapons Complex sites would continue existing waste management programs which currently support weapons work to meet legal requirements and commitments in formal agreements and would proceed with ongoing cleanup activities related to past weapons work at these sites. Production facilities and support roles at specific sites, however, would be downsized or eliminated in accordance with the reduced workload projected for 2005 and beyond. Facilities that could not comply with requirements would no longer be used.

Detailed reference descriptions of the affected sites follow. These descriptions include discussions of the site location, missions, facility operations, and environmental regulatory compliance. Seismic zone locations of alternative sites are shown in figure A.1-1.

A.1.1 Oak Ridge Reservation

Site Description.ORR consists of approximately 13,980 hectares (ha) (34,545 acres) of Federal-owned lands located directly to the west and south, but within the incorporated city limits of Oak Ridge, TN. The residential section of Oak Ridge forms the northern boundary of the reservation. The Tennessee Valley Authority's Melton Hill and Watts Bar reservoirs on the Clinch and Tennessee Rivers form the eastern, southern, and western boundaries. The city of Oak Ridge and ORR are within the region known as the Great Valley of the Tennessee River, which lies between the Cumberland and Great Smoky Mountains. About 16 kilometers (km) (10 miles [mi]) to the northwest, the Cumberland Mountains rise to an elevation of 914 meters (m) (3,000 feet [ft]) or more, while the Great Smoky Mountains National Park reaches to heights over 2,000 m (6,600 ft) some 113 km (70 mi) to the southeast. The largest city in the area, Knoxville, is located approximately 48 km (30 mi) to the southeast. Land use in the five-county area surrounding ORR varies from the heavily populated and highly developed urban areas around Knoxville to the sparsely populated areas immediately surrounding ORR. The largest single land use for each of the five counties is forestry; the second most common land use is agriculture. The locations of ORR and its principal facilities are shown in figures A.1.1-1 and A.1.1-2.

ORR is a Government-owned, contractor-operated reservation. The prime contractor manages the Y-12 Plant (Y-12), the K-25 site (formerly the Oak Ridge Gaseous Diffusion Plant), the Oak Ridge National Laboratory (ORNL), and most other properties on the reservation. Originally built in the early 1940s for large-scale production of fissionable material for the world's first nuclear weapon, ORR continues to be used today as a research, development, and manufacturing institution.

Y-12 Plant. Y-12 is situated on 328 ha (811 acres), 225 ha (630 acres) of which are enclosed by perimeter security fencing, at the eastern end of ORR in the location known as Bear Creek Valley. The majority of DP activities at ORR are conducted at Y-12. Primary missions include dismantling nuclear weapons components returned from the national arsenal, maintaining nuclear production capability, and providing stockpile support and storage for special nuclear materials. Y-12 also supports other Federal agencies through a Work for Others program. In addition, a technology transfer program has been established to support the U.S. industrial base by applying Y-12 expertise to a wide range of manufacturing problems. All of the current nuclear weapons have components produced at Y-12. The plant itself consists of 494 buildings containing more than 650,000 square meters (m*2*) (7,000,000 square feet [ft*2]*) of floor space.

Y-12 also provides processing of radioactive source materials and support for other Government agencies. Some 47 buildings containing approximately 140,000 m2 (1,500,000 ft*2*) of floorspace located on Y-12 grounds are utilized by ORNL in support of non-DP missions. ORNL employs some 450 people at Y-12. Also located on the Y-12 site are approximately 20 buildings containing 28,000 m2 (300,000 ft*2*) that house the DOE construction manager, the water plant maintenance contractor for ORR, and several organizations of the Oak Ridge Operations Office. These activities employ 175 people in DOE and 550 people in construction manager organizations.

K-25 Site. K-25 consists of approximately 688 ha (1,700 acres) and is located about 9.6 km (6 mi) northwest of Y-12. The site consists of 250 buildings with approximately 1,130,000 m2 (12,200,000 ft*2*) of floor space. The primary mission of K-25 has been providing enriched uranium for U.S. nuclear weapons and, later, providing uranium toll enrichment services for use in power reactor facilities around the world. Because of a lack of weapons or commercial requirements, the gaseous diffusion process at K-25 was permanently shut down in 1987. Today, K-25 serves as the operations center for environmental restoration and waste management programs. K-25 is also the home of DOE's Center for Environmental Technology and Center for Waste Management. Missions and activities include technology development, technology transfer, engineering technology, uranium enrichment support, and the central functions of business management, engineering, computing, and telecommunications.

Oak Ridge National Laboratory. ORNL is a large multipurpose research institution that consists of approximately 1,174 ha (2,900 acres) located 6.5 km (4 mi) southwest of Y-12. The site has approximately 240 buildings containing 250,000 m2 (2,700,000 ft*2*) of floor space. Missions and activities include energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education.

ORNL programs focus on basic and applied research, technology development, and technology that has been designated important to DOE and the Nation. It also performs work for non-DOE sponsors when such activities complement DOE missions and address significant national or international issues. ORNL facilities include a high-flux nuclear research reactor, chemical pilot plants, research laboratories, radioisotope production laboratories, accelerators, fusion test devices, and support facilities.

The onsite buildings and structures outside the major plant sites consist of the Scarboro Facility, the Central Training Facility, the Transportation Safeguards Division Maintenance Facility, and some ancillary structures. Most physical facilities used by the various plant protection and security groups are within the plant's fenced area; however, the target ranges are outside the fence but within the buffer zones of the main plant areas. Small-arms ranges are located on the eastern end of Y-12 and north of the western end of ORNL.

The offsite buildings and structures consist of the Oak Ridge Operations Office, the DOE Office of Scientific and Technical Information, the Oak Ridge Institute for Science and Education facilities, the American Museum of Science and Energy, the prime contractor's "Townsite" facilities, the National Oceanic and Atmospheric Administration's Atmospheric Turbulence and Diffusion Laboratory, and other buildings. With the exception of the Federal Office Building and space leased from the private sector, all buildings and structures used for DOE functions are situated on DOE-owned land.

The Oak Ridge National Environmental Research Park, established in 1980, consists of 5,500 ha (13,590 acres) on ORR. As one of seven DOE research parks, its purpose is to provide protected land areas for research and education in the environmental sciences and to demonstrate that energy technology development is compatible with a quality environment. There are 53 active environmental sciences research sites consisting of 1,442 ha (3,562 acres) on ORR. In addition, there are 15 inactive sites on 131 ha (323 acres).

The primary missions of the Oak Ridge Institute for Science and Education are to provide educational and research programs in the areas of health, environment, and energy for DOE, other Federal agencies, and private industry. The American Museum of Science and Energy is located at a site contiguous to the campus of Oak Ridge Institute for Science and Education. The museum contains historical displays and exhibits about energy in its various forms, as well as topical matter on the growth of the nuclear power industry.

The National Oceanic and Atmospheric Administration conducts meteorological and atmospheric diffusion research, that is supported by both itself and DOE, at the Atmospheric Turbulence and Diffusion Laboratory and field sites on ORR. This laboratory also provides services to DOE contractors and operates the weather instrument telemetering monitoring system for DOE.

Environmental Regulatory Setting. The policy of ORR is to conduct operations safely and to minimize any adverse impact of operations on the environment, ensuring incorporation of all local and national environmental-protection goals in the daily conduct of business. ORR consists of Y-12, ORNL, and K-25 and most permits and data on releases are reported by individual sites, with Y-12 being the most important site for making decisions in this PEIS. However, some environmental compliance agreements consider ORR to be a single Federal facility.

The Environmental Protection Agency (EPA) has delegated regulatory authority to the State of Tennessee for air, water, solid waste, hazardous waste, and mixed waste. The State of Tennessee and DOE have entered into a 5-year Oversight Agreement that was signed on May 13, 1991. That agreement has been extended for an additional 5 years until June 28, 2001. The purpose of this agreement is to assure Tennessee citizens that their health, safety, and the environment are being protected during ORR operations. The agreement reflects the obligations and agreements between DOE and the state regarding technical and financial support provided by DOE and the state for oversight of these activities. The agreement has provisions for modifications, as appropriate, to address community issues that may arise. The Tennessee Department of Environment and Conservation is the lead state agency for implementation of the agreement. This agency has established a DOE Oversight Division located in the city of Oak Ridge and is staffed with over 50 employees. The Oversight Division routinely visits the three ORR sites to attend formal meetings and briefings, to conduct walk throughs of buildings and grounds, or to conduct observations of site operations to ensure compliance with environmental regulations and DOE orders.

The remainder of this section summarizes the status of Y-12 compliance with the major environmental regulations.

National Environmental Policy Act. DOE finalized the environmental assessment (EA) for the *Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee,* in September 1994, and issued a Finding of No Significant Impact (FONSI). This EA analyzed the storage of a larger quantity of enriched uranium than historically had been stored at Y-12. In its FONSI, DOE decided to store no more than 500 metric tons (t) (550 short tons [tons]) of highly enriched uranium (HEU) and 7,105.9 t (7,833 tons) of low-enriched uranium at Y-12 on an interim basis until long-term storage and disposition decisions can be made and implemented.

Comprehensive Environmental Response, Compensation, and Liability Act. ORR was placed on the National Priorities List (NPL) on December 21, 1989, making the site subject to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). As a result, DOE, EPA, and the state developed a Federal Facility Agreement for environmental restoration activities at ORR effective January 1, 1992, to serve as the interagency agreement in accordance with Section 120 of CERCLA. The agreement is intended to integrate the corrective action processes of the *Resource Conservation and Recovery Act* (RCRA) and CERCLA. EPA, DOE, and the state have negotiated the agreement to ensure that the environmental impacts associated with past and present activities at ORR are thoroughly investigated and that appropriate remedial actions or corrective measures are taken.

The Federal Facility Agreement establishes a procedural framework and schedule for developing, implementing, and monitoring response actions at ORR in accordance with CERCLA, RCRA, the National Environmental Policy Act (NEPA), and applicable state laws. Response actions under the agreement will achieve comprehensive remediation of releases or threatened releases of hazardous substances, hazardous wastes, pollutants, or contaminants at or from ORR. The agreement coordinates responses and remedial activities necessary to protect human health and the environment and reduces duplication of corrective actions or administrative requirements under CERCLA and RCRA. The three parties to the agreement intend to consolidate the DOE CERCLA response obligations with the corrective action measures required under RCRA permits. The agreement also addresses technical standards for new and existing liquid low-level radioactive waste storage tanks.

Emergency Planning and Community Right-To-Know Act. Sections 311 and 312 of the act require reporting to local officials the inventories of hazardous chemicals and extremely hazardous substances. Y-12 reported inventories in 1993, which included 42 hazardous chemicals and 5 extremely hazardous substances.

Resource Conservation and Recovery Act. The three ORR sites each generate both RCRA hazardous waste and mixed waste. Y-12 conducts storage, treatment, and disposal of hazardous waste under RCRA Part B Permits, and interim-status provisions. The Hazardous and Solid Waste Amendments permit requirements for corrective actions, effective since October 25, 1986, have now been integrated into the Federal Facility Agreement previously mentioned under CERCLA.

Effective June 12, 1992, DOE and EPA completed a Federal Facilities Compliance Agreement to resolve the compliance issue of storing land-banned waste for extended periods. The agreement acknowledges that ORR is currently storing, and will continue to store, mixed waste subject to land disposal restrictions. It contains a compliance schedule that dictates the steps required to bring ORR facilities into compliance with respect to the management of mixed wastes and includes the strategies and plans for treatment of the backlog of land-banned waste.

In May 1991, a moratorium on offsite shipment of hazardous waste to non-DOE sites was placed on DOE facilities, including those on ORR. The moratorium was established to prevent waste containing any radioactive material from being shipped to a facility that is not licensed to handle it. The moratorium essentially requires all RCRA hazardous waste generated at ORR to be managed as mixed waste until appropriate procedures are developed and approved to ensure that waste streams are free of radioactivity above background levels. Such procedures have been prepared by each of the ORR sites. Y-12 received approval from DOE for four procedures certifying "No Rad Added" to allow offsite shipment of hazardous wastes.

Water quality data from the exit-pathway wells at the east end of Y-12 may indicate that the volatile organic compounds (VOCs) carbon tetrachloride and tetrachloroethane are being transported off ORR through the Maynardville Limestone at depths of 30 to 91 m (100 to 300 ft). The monitoring well is located in a general industrial area, and no drinking water wells have been identified in the area. Property owners in the area have been notified and provided with a status report.

The Federal Facility Compliance Act of 1992. This act is an amendment to RCRA. DOE published the Interim Mixed Waste Inventory Report in April 1993, annual updates, and periodic updates describing its inventory of mixed wastes and treatment capabilities. ORR prepared and submitted to the state in October 1993 a conceptual site treatment plan for ORR. In accordance with the *Federal Facility Compliance Act,* a Commissioner's Order issued on September 26, 1995, by the State of Tennessee, to become effective on October 2, 1995, included the Site-Specific Treatment Plan for Mixed Waste at ORR. This order allows ORR to store existing quantities of mixed waste and requires DOE to comply with a site treatment plan. The site treatment plan contains milestones and target dates for DOE to characterize and treat its inventory of mixed waste.

Clean Water Act. National Pollutant and Discharge Elimination System (NPDES) permits are required for each ORR facility. The Y-12 NPDES permit was issued April 28, 1995, and encompasses about 150 active point-source discharges requiring compliance monitoring. The new NPDES permit covers stormwater discharges, as well as point source discharges. The number of permitted-outfalls continues to decline as the outfalls are consolidated or eliminated, or as changes in implementation occur at the site. Through monitoring of discharges, DOE can demonstrate that Y-12 has achieved an NPDES permit compliance rate in 1993 of more than 99 percent.

Sanitary wastewater from Y-12 is discharged to the city of Oak Ridge under an industrial pretreatment permit. The Y-12 sanitary sewer upgrade project is an example of DOE corrective actions to achieve and maintain the Y-12 sanitary sewer collection system in regulatory compliance with the city of Oak Ridge sanitary sewer use ordinance and pretreatment permit. As part of the upgrade, a new monitoring station was completed in July 1994 and allows for more accurate monitoring of the sanitary sewage discharges by Y-12.

Activities are underway to reduce discharges of pollutants to surface waters of ORR. For example, two dechlorination systems were installed in late 1992 at key Y-12 outfalls on East Fork Poplar Creek to help control discharges of chlorine from noncontact cooling water systems and to help to eliminate chronic fish kills in the upper reaches of the creek. Additional efforts relating to reducing nonpoint-source pollutants to surface streams and cleaning up mercury pollution in the East Fork Poplar Creek are being implemented.

On January 17, 1992, Friends of the Earth, a nonprofit corporation, filed a lawsuit against DOE in Federal District Court in Knoxville, TN. The lawsuit alleged that DOE violated the NPDES permits because discharges of certain quantities of various pollutants into tributaries of the Clinch River exceeded the allowable discharge limits of the NPDES permits. Friends of the Earth filed a motion for summary judgment in October 1992, and DOE filed a cross-motion for denial of summary judgment in January 1993. Both motions are pending before the court. A second lawsuit was filed in Federal District Court by the Friends of the Earth in October 1995, alleging NPDES monitoring and reporting violations. This lawsuit is also pending.

Safe Drinking Water Act. The systems that supply drinking water to ORR are DOE-owned; therefore, ORR must comply with all Federal, state, and local requirements regarding the provision of safe drinking water. Section 1447 of the act mandates such compliance for each Federal agency having jurisdiction over a Federal-owned or Federal-maintained public water system. Y-12 receives water from a DOE-owned water treatment facility located northeast of Y-12. The Y-12 system is designated as a "nontransient, noncommunity" water distribution system and is subject to the Tennessee Regulations for Public Water Systems and Drinking Water Quality. These regulations allow distribution systems that do not perform water treatment to use the records sent to the state by the water-treatment facility from which water is received to demonstrate compliance with requirements.

Clean Air Act. Authority for enforcement of the act is shared between the state, for nonradioactive emission sources, and EPA, for radioactive emission sources. *Clean Air Act* (CAA) compliance is an integral part of the state air permit program which has issued air permits for construction and operating sources to all three ORR sites. Each site complies with Federal clean air regulations in addition to the State of Tennessee air-permit conditions. Major sources are appropriately permitted, and documentation of compliance is developed. All major emission sources are permitted by the state and are operating in compliance with those permits as of December 31, 1993. Y-12 has 94 active air permits covering 400 air emission points, and currently has about 290 documented exempt minor sources and about 350 exempt minor emission points.

ORR is also in full compliance with the requirements as set forth in 40 Code of Federal Regulations (CFR) 61, Subpart H (National Emission Standards for Emissions of Radionuclides Other than Radon from DOE Facilities), for sampling significant radionuclide emission points. Continuous emissions monitoring is performed at the K-25 incinerator and at 74 potential radiological exhaust stacks serving uranium-processing areas at Y-12. The stacks are equipped with continuous stack samplers, because these stacks are judged to have the potential to emit uranium emissions that could contribute greater than 0.1 mrem per year effective dose equivalent to an offsite individual. EPA certified that ORR had completed all of the actions required by the *May 1992 Federal Facility Compliance Agreement for Clean Air Act* (ORR Rad-NESHAP) and was considered to be in compliance with the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations. A subsequent inspection in September 1993 confirmed such compliance.

Y-12 is also subject to an NESHAP rule for machining beryllium and currently monitors four stacks that serve beryllium machining and handling areas to demonstrate compliance with the 10 grams per day emission limit. The total beryllium emitted from Y-12 in 1993 was less than 1 gram.

Toxic Substances Control Act. The *Toxic Substances Control Act* (TSCA) requires polychlorinated biphenyl (PCB) wastes to be disposed of within 1 year from the date the PCBs are removed from service. Because of a lack of available disposal avenues, radioactive wastes contaminated with PCBs are stored at ORR sites for periods exceeding 1 year. Unauthorized uses and storage of PCBs are covered under the equipment-specific agreements with EPA or the Uranium-Enrichment PCB Federal Facilities Compliance Agreement, signed February 20, 1992. This agreement between DOE and EPA provides a vehicle for resolution of PCB issues only at K-25. The K-25 incinerator is the only facility in the Nation permitted to incinerate RCRA, PCB, and radioactive waste. This agreement allows K-25 to store such wastes generated by K-25 for periods exceeding one year.

Radioactive wastes contaminated with PCBs older than 1 year are generated by other ORR facilities, particularly Y-12, and also are stored at K-25. Several compliance issues exist at Y-12, because the Federal Facilities Compliance Agreement does not include PCB storage at Y-12. Therefore, discussions are continuing with EPA towards a new agreement that would include Y-12 and ORNL, as well as K-25. The new agreement is tentatively entitled the Oak Ridge Reservation PCB Federal Facilities Compliance Agreement. Storage concerns addressed under the existing agreement for K-25 would be included in the proposed Federal Facilities Compliance Agreement for the entire ORR. The earliest anticipated date for issuance of the PCB Federal Facility Compliance Agreement is in 1996.

Federal Insecticide, Fungicide, and Rodenticide Act. The three ORR sites maintain procedures for the storage and application of pesticides. Individuals responsible for the application of materials regulated by the *Federal Insecticide, Fungicide, and Rodenticide Act* are certified through the University of Tennessee Department of Agriculture. Safrotin®, used for the control of roaches, is the only restricted-use pesticide used at Y-12. No violations were identified during the 1993 *Federal Insecticide, Fungicide, and Rodenticide Act* inspection.

A.1.2 Savannah River Site

Site Description. SRS, 19 km (12 mi) south of Aiken, SC, and approximately 26 km (16 mi) southeast of Augusta, GA, occupies 80,130 ha (198,000 acres) of land. Established in 1950, SRS has been involved for more than 40 years in tritium operations and other nuclear material production. Today, the site contains 15 major production, service, research, and development areas, not all of which are in operation at this time. The locations of SRS and its principal facilities are shown in figures A.1.2-1 and A.1.2-2.

The developed areas of the site account for less than 5 percent of the land use and more than 99 percent of the total capital investment. There are more than 3,000 facilities at SRS, including 740 buildings, with approximately 511,000 m^2 (5.5 million ft^2) of floor area.

Major nuclear facilities at SRS include fuel and target fabrication facilities, nuclear material production reactors, chemical separations plants, a uranium fuel processing area, liquid high level waste (HLW) tank farms, a waste vitrification facility, and the Savannah River Technology Center. SRS is in the process of stabilizing and storing various forms of plutonium. This effort, supported by the F-Canyon Plutonium Solutions Environmental Impact Statement (DOE/EIS-0219) and the ROD (FR 9824), converts this material to plutonium metal. The process in FB-Line began in November 1995 and the conversion process in F-Canyon was completed in April 1996. The metal product will be stored temporarily in one of the F-Area vaults (FB-Line, 235-F or 247-F). Tritium recycling facilities at SRS empty tritium from expired reservoirs, purify it to eliminate the helium decay product, and fill replacement reservoirs with specification tritium for nuclear stockpile weapons. Filled reservoirs are delivered to Pantex for weapons assembly, or directly to DOD as replacements for expired reservoirs. Historically, DOE has produced tritium at SRS, but has not produced any since 1988.

Tritium recycling operations will continue with the replacement tritium facility conducting the majority of these operations. As part of the nonnuclear consolidation, SRS received some of the tritium processing functions formerly performed at the Mound Plant in Miamisburg, OH.

The current missions at SRS are shown in table 3.2.3-1. These activities can be categorized as DP, Office of Environmental Management (EM), nuclear energy, and other activities.

Defense Program Activities. In the past, the SRS complex produced nuclear materials for DP. This complex consists of five reactors (the C-, K-, L-, P-, and R-Reactors) in addition to a fuel and target fabrication plant, two target and spent nuclear fuel chemical separations plants, a tritium-target processing facility, a heavy-water rework facility, and waste management facilities. The K-Reactor (the last operational reactor) was put into cold standby status in 1992 with no planned provision for restart. SRS is still conducting tritium recycling operations in support of stockpile requirements using tritium recovered from retired weapons as the tritium supply source. Based on the record of decision (ROD) for tritium supply and recycling, issued in December 1995, SRS will continue to perform tritium recycling operations and would be the site for accelerator production of tritium if that technology were selected in the future. In addition, SRS would be the site for a tritium extraction facility to support the commercial reactor option of supplying tritium.

Other Department of Energy Activities. EM is pursuing a 30-year plan to achieve full compliance with all applicable laws, regulations, and agreements; treat, store, and dispose of existing wastes; reduce generation of new wastes; cleanup inactive waste sites; remediate contaminated groundwater; and dispose of surplus facilities.

The Savannah River Technology Center provides technical support to all DOE operations at SRS. In this role, it provides process engineering development to reduce costs, waste generation, and radiation exposure. SRS continues to provide plutonium-238 required to support space programs and has an expanding mission to transfer unique technologies developed at the site to industry. SRS is also an active participant in the Strategic Environmental Research and Development Program formulated to develop technologies to mitigate environmental hazards at DOD and DOE sites.

Non-Department of Energy Activities. There are several facilities and operations at SRS that deal mainly with the ecological elements of the site. These are the Savannah River Forest Station, the Savannah River Ecology Laboratory, the South Carolina Wildlife and Marine Resources Department, the Institute of Archaeology and Anthropology, and the Soil Conservation Service.

Environmental Regulatory Setting. SRS had 544 construction and operating permits in 1993 that specified operating levels for each permitted source (WSRC 1994d:32). Completion of construction in progress and continued operation of permitted facilities are essential to overall SRS operations. Therefore, DOE emphasizes compliance with the terms of these permits as well as with applicable Federal and State of South Carolina environmental regulations and DOE orders related to environmental protection. SRS employed over 1,000 people devoted full-time to protecting the environment through environmental activities in 1993 while accomplishing SRS missions (WSRC 1994d:15). The remainder of this section summarizes the status of SRS compliance with the major environmental regulations.

National Environmental Policy Act. DOE has numerous NEPA documents affecting SRS proposed actions which are in various stages of completion as SRS complies with the requirements of NEPA and Council on Environmental Quality (CEQ) regulations. For example, DOE published the Savannah River Site Waste Management Final Environmental Impact Statement (DOE/EIS-0217) in July 1995, which recommended the moderate waste treatment configuration. This configuration would provide a balanced mix of technologies that includes extensive treatment of those waste types that have the greatest potential to adversely affect humans or the environment because of their mobility or toxicity if left untreated, or that would remain dangerously radioactive far into the future.

It would provide less extensive treatment of wastes that do not pose great threats to humans or the environment, or that will not remain dangerously radioactive far into the future.

Comprehensive Environmental Response, Compensation, and Liability Act. EPA placed SRS on the NPL effective December 21, 1989. DOE, the South Carolina Department of Health and Environmental Control, and EPA signed a Federal Facility Agreement effective August 16, 1993, to coordinate CERCLA cleanups at SRS, as required by Section 120 of CERCLA. Since the initial listing of the NPL in 1989, SRS has conducted both CERCLA and RCRA cleanup activities under the framework established in the draft Federal Facility Agreement. The comprehensive remediation of SRS will continue as directed by the Federal Facility Agreement currently in place.

Emergency Planning and Community Right-To-Know Act. Each year SRS completes a section 312 annual Tier II inventory report for all hazardous chemicals present at the site in excess of specified quantities and submits it to the South Carolina Department of Health and Environmental Control and to local emergency planning organizations in Aiken, Allendale, and Barnwell Counties, South Carolina. SRS also files an annual toxic release inventory report with EPA based on calculated chemical releases to the environment, which reports aggregate quantities for each regulated chemical that exceeds established threshold amounts. SRS reported eight chemicals to EPA in 1992, with releases totaling 34,820 kilograms (kg) (76,763 pounds [lb]) (WSRC 1994d:19). Changes in facility operating status will lead to changes in chemical inventories and uses of toxic chemicals; the hazardous chemical inventory and toxic release inventory reports will reflect these changes.

Resource Conservation and Recovery Act. The SRS hazardous waste permit was issued in 1987 and modified in 1992. The permit covers storage of wastes at four buildings, treatment at the Consolidated Incineration Facility, and maintenance and groundwater remediation at three closed waste units. Other waste management facilities at SRS are presently operating under interim status. SRS has submitted to the South Carolina Department of Health and Environmental Control a permit application covering the facilities' activities, under which they can continue to operate in conformance with regulatory requirements while applications are reviewed by the regulatory agencies and a final permit decision is issued.

The Federal Facility Compliance Act of 1992. This act is an amendment to RCRA. Westinghouse Savannah River Company submitted a mixed waste inventory report January 13, 1993, and DOE published the complex-wide report, US DOE Interim Mixed Waste Inventory Reports, on April 12, 1993. DOE provided this report, and annual and periodic updates since, to state governors and to regulatory agencies in states that host DOE sites, describing its inventory of mixed wastes and treatment capabilities. To meet requirements established by this act, SRS prepared and submitted a *Proposed Site Treatment Plan* (WSRC-TR-94-0608, May 1995) that sets forth options for treating mixed wastes currently in storage at SRS or that will be generated there over the next 5 years.

Clean Air Act. The air quality control construction permit for the Consolidated Incineration Facility was granted by the South Carolina Department of Health and Environmental Control on November 25, 1992. Emergency power diesel generators are covered under this permit. The M-Area Vendor Treatment facility emergency diesel generator is exempt from permitting requirements because of its limited capacity and expected use. A permitting exemption has been granted for the emergency diesel generator at the replacement HLW evaporator. The SRS NESHAP radionuclide program continues to change to incorporate sampling, monitoring, and dose assessment practices that meet or exceed the requirements of 40 CFR 61, Subpart H. SRS is currently in compliance with CAA requirements.

Clean Water Act. The South Carolina Department of Health and Environmental Control has issued Clean Water Act (CWA) permits for the F- and H-Area Tank Farms, Defense Waste Processing Facility, Z-Area Saltstone Facility, replacement HLW evaporator, F- and H-Area Effluent Treatment facilities, and M-Area Liquid Effluent Treatment Facility. Certain discharges from the outfalls at these facilities have been approved. DOE has submitted an industrial wastewater treatment permit application for the M-Area Vendor Treatment Facility. SRS is currently in compliance with CWA requirements.

Safe Drinking Water Act. SRS continues to work toward upgrading the 13 major treatment/ distribution systems through which SRS provides drinking water to its employees. The State of South Carolina recommended that SRS consolidate 11 of the 13 major site drinking water systems into three systems. Work is in progress to implement this consolidation. Westinghouse Savannah River Company obtained a construction permit for the water line extension that will serve the Consolidated Incineration Facility.

Toxic Substances Control Act. Disposal of PCBs from SRS is conducted at EPA-approved disposal facilities within the regulatory timeframe. SRS has some PCBs which were radioactively contaminated during a spill in 1978. The act calls for annual disposal of PCB waste, but there is insufficient capacity for disposal of radioactive PCB waste offsite. These radioactive PCB materials are stored onsite in a facility that meets storage requirements for up to 1 year. SRS continues to seek disposal technologies and facilities that can handle radioactive PCB waste.

A.1.3 Kansas City Plant

Site Description. KCP is situated on approximately 57 ha (141 acres) of the 121-ha (300-acre) Bannister Federal Complex located within incorporated city limits 19 km (12 mi) south of the downtown center of Kansas City, MO. The plant shares the Bannister Federal Complex site with other Federal agencies: the General Services Administration, the Department of Defense Finance and Accounting Service, the Federal Aviation Administration, the National Archives and Records Center, and the Internal Revenue Service, among others. The locations of the Bannister Federal Complex and its major facilities are shown in figures A.1.3-1 and A.1.3-2.

KCP currently contains approximately 297,000 m^2 (3.2 million ft^2) of floor space with approximately 82 percent located within the large Federal office and industrial building that dominates the site. KCP and the rest of the Bannister Federal Complex are completely developed with limited open space. No residential structures are within the Bannister Federal Complex. Kansas City has zoned the Bannister Federal Complex, including KCP, as heavy industrial.

KCP is a Government-owned, contractor-operated facility that produces and procures nonnuclear electrical, electronic, electromechanical, mechanical, plastic, and nonfissionable metal components for the DOE nuclear weapons program. In 1992, there were 4,473 people employed at KCP. Site employment is expected to decrease to approximately 3,900 by the year 2000 (KCP 1995a:1). KCP's primary missions are shown in table 3.2.4-1.

DP activities comprise the vast majority of operations at KCP. The nuclear weapons-related operations at KCP are production and maintenance of electrical, mechanical, and plastic products. KCP does not process special nuclear materials but does have a health physics program consistent with industrial radiography and electrical manufacturing. The following is a brief description of KCP mission activities.

Squib Valve Assembly. Pyrotechnic devices that provide valving functions for various nuclear weapons systems are manufactured. Their assembly requires handling Class 1.4 explosives in a static-free environment using fixture-assisted assembly techniques.

Hybrid Microcircuit Assembly. Hybrid microcircuit resistor/conductor networks using alumina oxide substrates with thin-film or thick-film technologies for radars, programmers, timers, and fire sets are manufactured. Their assembly includes attaching electrical components to these networks. This product's assembly requires a Class 10,000 clean room with temperature and humidity controls.

Hybrid Microcircuit Assembly for Joint Test Assemblies. Hybrid microcircuits that consist of an insulating substrate, such as alumina, that contains a thin or thick resistor/conductor network interconnected with active (transistors and integrated circuits) and passive (resistors and capacitors) components that are enclosed in a metal or ceramic package are manufactured.

Microminiature Electrical Assembly. Hybrid microcircuits (semi-conductors packaged in ceramic, leadless chip carriers, transistor outline headers, or kovar [alloy of nickel, cobalt, and iron] flatpacks) are constructed. These products perform several electronic functions in weapons systems such as switches, radars, programmers, fire sets, clocks, and telemetry.

Telemetry Assembly. Telemetry assemblies, neutron detectors, and test component firing systems are manufactured. The telemetry assemblies and neutron detectors provide warhead scoring data in flight tests as part of the joint test assembly. The test component firing systems are high energy transfer systems manufactured for use in underground testing at NTS.

Radar Assembly. Radars used in weapons fuzing systems for bombs and warheads are manufactured. Included in this product line are antenna assemblies that can be an integral part of a radar fuze assembly or a separate component used in the fuzing system. Facility requirements include controlled humidity environment, solvent cleaning stations, and electrostatic control.

Timers, Programmers, and Trajectory Sensing Signal Generators. Trajectory sensing signal generators (electronic assemblies that accept environmental data, verify correctness of that data, and produce predetermined and sequenced output functions for the weapon) are manufactured. The trajectory sensing signal generator product is part of the weapon's nuclear safety system. The primary function is to help ensure that accidental detonation caused by abnormal thermal and shock environments does not occur.

Test Equipment Design and Fabrication. Custom designed and fabricated test equipment able to accept products produced internally and by vendors is produced. This function is capable of performing electrical and mechanical design, producing definition drawings, developing computer software, and fabricating the necessary hardware.

Cellular Silicone and Filled Elastomers. Cellular silicone cushions that are used as filler to cushion components and to allow for thermal expansion are produced.

Foam Molding. Structural foam supports using urethane foam materials are produced.

Syntactic Foam Molding and Plastics Machining. Foam molding that is capable of withstanding higher operating temperatures than conventional foam molding is produced. These products are made using high temperature resins and microspheres, which are sintered in a high temperature oven. Facility requirements include an environmentally controlled (temperature and moisture) plastics machining facility, because of the physical requirements of plastic products.

Laminates and Desiccants. Aluminum silicate desiccant powders and resins used to provide a dry environment in sealed nuclear assemblies and fiber-reinforced plastic laminates are produced.

Noncryptographic Coded Switch Assembly. Electronic devices using hybrid microcircuits and magnetic core memory used to permit the controlled use of nuclear weapons upon proper authorization and to prevent unauthorized use are manufactured.

Strong Link Switch Assembly. Complex electromechanical safety devices used in all modern weapons programs are manufactured. Facility requirements include clean rooms for switch assembly and testing.

Fire Set Assembly. High-voltage circuitry firing systems capable of supplying the energy required to initiate a weapon system are manufactured. Energy is derived from low-voltage battery power and is converted by this system to high voltage and stored until an initiating signal is received. Components include capacitors, inductors, hybrid microcircuits, flat cable and flex circuit technologies, and switches.

Composite Structures. Fiber-reinforced molding resins are manufactured.

Stockpile Support. Components and subsystems removed from the stockpile for reuse, systems testing, or component cycle testing are evaluated. No unique processes, materials, or technologies are used for stockpile support.

Category F Permissive Action Link Electronics Assembly. Electronic assemblies that are part of the nuclear surety system are manufactured.

Special Products-Special Electronics Assembly. This is a restricted access area where electronic products with special security requirements are manufactured.

Cryptographic Coded Switch Assembly. A Permissive Action Link Switch Adapter, an electronic device designed to provide an "electrical block" to the arming switch of the weapon, is assembled. The Permissive Action Link Switch Adapter utilizes both thin- and thick-film hybrid microcircuit technology and is packaged in a foam plastic housing.

T-Gear Containing Cryptographic Keying Material. Cryptographic keying material used to code and recode Permissive Action Link Switch Adapter devices in weapons is manufactured. The presence of these codes prevents unauthorized access to weapons.

MK5 Arming, Fuzing, and Firing Set Assembly. Arming, fuzing, and firing assemblies are assembled. This assembly incorporates a radar, a programmer, an accelerometer, a decelerometer, thermal batteries, a fire set, a contact fuze, and a force balance integrating accelerometer.

B83 Weapon Subassembly. Electronic and mechanical structures are assembled and placed in a case structure with environmental protection. Assemblies provide distance, timing, velocity sensing, velocity control, and electrical power for weapon assemblies.

Machining Technology. This activity provides a wide variety of traditional and nontraditional metal-removing processes, including conventional and numerically controlled turning, milling, drilling, boring, and grinding processes.

Other Mechanical Technology. This activity provides support for mechanical product manufacturing including sheet metal hydroforming, fire edge blanking, punch pressing, riveting, laser marking, threaded insert installation, and manual assembly operations.

Plastics Technology. A wide range of polyurethane foam components, epoxy encapsulants, and modified commercial products for the Complex are manufactured.

Electrical/Electronic Fabrication and Assembly Technology. Printed wiring assemblies used in weapon timers, programmers, trajectory sensing devices, and various other electrical and electronic components are fabricated.

Secondary Support Areas. This activity provides support functions that service nearly all product lines, including a broad range of standard industrial processes (e.g., plating, painting, heat treating, and welding), some of which are uniquely tailored to meet special weapon requirements.

Environmental Regulatory Setting. KCP has a monitoring system in place to ensure continuity of operations and protection of the environment. Soil, surface and groundwater, and air media are regularly sampled and analyzed for various potential pollutants as a part of the ongoing environmental monitoring programs. The monitoring system includes over 163 monitoring wells, 5 sampling points at the ultraviolet/ozone system, 3 ambient air monitoring stations, and sampling results from 4 outfalls, 9 surface water sites, and 1 sanitary discharge. The remainder of this section summarizes the status of KCP's compliance with the major environmental regulations.

National Environmental Policy Act. There are no other major Federal actions under consideration that require NEPA studies and that would affect the plant.

Emergency Planning and Community Right-To-Know Act. The plant prepared and submitted to EPA an annual Toxic Chemical Release Inventory Form (EPA Form R) for 1993 as required under Section 313 of this act.

Resource Conservation and Recovery Act. DOE and EPA signed a Corrective Action Administrative Order on Consent under Section 3008(h) of RCRA on June 23, 1989. The intent of the order is to provide an agreed-upon method of effecting environmental remediation involving solid waste management units at the plant. While the consent order is with EPA, the Missouri Department of Natural Resources maintains RCRA authority over the KCP groundwater monitoring program. Groundwater monitoring has revealed chlorinated solvent contamination, particularly trichloroethylene, in at least three onsite plumes. The city of Kansas City, MO, regulates the discharge permit for the groundwater treatment unit, which is treating the groundwater plumes to preclude release of the contaminant into surface waters offsite.

Comprehensive Environmental Response, Compensation, and Liability Act. KCP is not regulated under this act for any required remediation. Remediation is presently regulated by the provisions of the RCRA Corrective Action Administrative Order on Consent.

Clean Air Act. Overall plant operations are regulated by an annual Air Operating Permit issued by Kansas City, MO. Results of radionuclide monitoring indicate that no radionuclides are present in quantities exceeding background levels. The plant is also in compliance with air pollution requirements for nonradiological air emissions. The plant is working proactively with the city to better define the requirements necessary to obtain the city's approval before constructing a new or modifying an existing source of air pollution, as well as to streamline reporting needs with respect to plant air emissions.

Clean Water Act. Sanitary and industrial wastewater discharges from the plant go into the Publicly Owned Treatment Works and are regulated by Discharge Permit #74; city ordinances administered by the Kansas City, MO, Water and Pollution Control Department; and EPA Pretreatment Standards for the Metal-Finishing Category (40 CFR 433.17). KCP stormwater effluents are regulated by NPDES Permit #MO 0004863, issued by the Missouri Department of Natural Resources.

Safe Drinking Water Act. The drinking water system at the plant meets all conditions for exclusion listed in 40 CFR 141.3, which implements this act. Therefore, the plant does not operate a public water system which is covered by this act.

Toxic Substances Control Act. KCP maintains compliance with the requirements of this act.

Federal Insecticide, Fungicide, and Rodenticide Act. The plant maintains compliance with this act and related state statutes concerning use of pesticides.

A.1.4 Pantex Plant

Site Description. Pantex is located in the panhandle of Texas, in Carson County. It is about 27 km (17 mi) northeast of downtown Amarillo and 64 km (40 mi) southwest of Pampa. The plant is located on a portion of the former Pantex Army Ordnance Plant. Pantex was constructed in the first half of the 1940s by the U.S. Army for the production of conventional ordnance. At the end of World War II, the plant was deactivated and the property eventually reverted to the War Assets Administration. In 1949, the entire installation was sold to Texas Technological College (now Texas Technological University, commonly called Texas Tech) for 1 dollar. The land was to be used for experimental farming, but was subject to recall under the National Security Clause. Following an extensive survey of World War II ordnance plants, Pantex was chosen in 1951 by the Atomic Energy Commission for expansion of its nuclear weapons assembly facilities. The Army Ordnance Corps reclaimed the site for the Atomic Energy Commission and contracted a civilian contractor to rehabilitate it.

DOE owns approximately 3,683 ha (9,100 acres) at Pantex. Just over 809 ha (2,000 acres) of the DOE-owned property are used for industrial operations at Pantex excluding the Burning Ground, firing sites, and other outlying areas. The Burning Ground and firing sites occupy approximately 198 ha (489 acres). Remaining DOE-owned land serves DOE safety and security purposes. DOE also owns a detached piece of property called Pantex Lake, approximately 4 km (2.5 mi) northeast of the main plant site. This property, comprising 436 ha (1,077 acres), includes the playa lake wetland itself which occupies approximately 138 ha (340 acres). Currently, no Government industrial operations are conducted at the Pantex Lake property. The location of Pantex is shown in figure A.1.4-1.

As of April 1995, approximately 2,599 ha (6,421 acres) of DOE-owned land were being used by Texas Tech for agricultural purposes through a service agreement. The DOE-owned acreage used for agricultural purposes is variable and subject to periodic changes. Adjacent to the 3,683 ha (9,100 acres) owned by DOE, approximately 2,347 ha (5,800 acres) are leased from Texas Tech. DOE use of these lands is primarily for safety and security buffer areas. DOE also leases a small facility at the Amarillo International Airport for its own transportation use.

Pantex industrial operations are conducted for DOE by a management and operating contractor, the U. S. Army Corps of Engineers, and SNL. Seventy-six km (47 mi) of roads exist within Pantex boundaries. A spur of the Burlington Northern Santa Fe Railroad, formerly Atchison Topeka and Santa Fe Railroad, extends through the leased land into the DOE-owned property on the southwest area of the plant site. There are 27 km (17 mi) of railroad tracks within the site boundaries.

Historically, the Pantex site was divided into functional areas commonly called zones. Some maps may still show where the old functional areas were located. The main functional areas are Zone 12, which is the fabrication, assembly/disassembly (A/D), and technical/administrative support area; Zone 11, which is the high explosives (HE) development area; Zone 10, which is an excess property storage site; and Zone 4, which is the weapon/HE magazines and pit storage area. There are other supporting activities in other zones. The locations of Pantex zones are shown in figure A.1.4-2.

All the land within a 5-km (3-mi) radius of the plant site is used for agricultural purposes, either farming or grazing. Approximately 2,000 people live within 8 km (5 mi) of the outside boundary of Pantex. A significant population concentration occurs southwest of the Pantex facility near the Amarillo International Airport and includes the Texas State Technical Institute and the Highland Park Village. Highland Park Village consists of 500 single- and multi-family housing units (duplexes) with an occupancy rate averaging about 90 percent. Approximately 100 students are housed in a Texas State Technical Institute student dormitory.

Plant operation includes direct and support manufacturing operations, management and administrative services, protective services, and maintenance and utilities. Current missions at Pantex are shown in table 3.2.5-1.

Most operations at Pantex are DP activities. The plant's primary role today is the dismantlement, including removal of the fissile material, of retired U.S. nuclear weapons being returned to DOE from DOD. Other activities include certain maintenance and surveillance activities of the remaining nuclear weapons stockpile, modification and assembly of existing nuclear weapons systems, and production of HE components for nuclear weapons. DOE also conducts quality evaluation of weapons, quality assurance testing of weapons components, and research and development (R&D) activities supporting nuclear weapons at the plant. The principal operations performed at Pantex are the dismantlement of retired nuclear weapons; assembly of nuclear weapons from components received from other DOE facilities; fabrication of chemical HE components for nuclear weapons; operation of chemical HE synthesis, and characterization surveillance testing and disposal of chemical HE; and maintenance, modification, repair, and testing of nuclear weapons components. Weapons dismantlement, assembly, and stockpile surveillance activities involve handling significant quantities of sealed nuclear components, (pits, secondaries, tritium reservoirs), as well as a variety of nonradioactive toxic chemicals. Brief descriptions of the above mission activities follow.

New production is defined as the final assembly of a new nuclear weapon to be added to the stockpile. Pantex receives weapons components and other materials from throughout the Complex. The first step in the new production process is mating the HE main charge subassemblies with the special nuclear materials, which takes place within an assembly cell. Assembly bays house the remainder of the assembly process. This is where the nuclear subassembly produced in the assembly cell is built into a complete weapon. After final assembly, weapons assembled at Pantex are shipped either to other facilities within the Complex or to military facilities. Dismantlement of retired weapons is basically a reversal of the assembly process. All parts must then be properly disposed or stored.

The tasks of modification, maintenance, and repair involve disassembly of a stockpiled nuclear weapon so that one or more components can be repaired, replaced, or modified. After replacing the components, the weapon is reassembled and returned to the stockpile.

HE component production includes manufacturing main charge subassemblies and mock components for use in weapon test assemblies, manufacturing small HE components, producing a variety of explosive materials from chemical reactants and commercially produced explosives, and evaluating explosive materials and components through a variety of analytical, mechanical, and explosive tests.

Pantex performs many quality assurance evaluation activities on both new and stockpiled nuclear weapons. These tests involve disassembly of weapons, laboratory testing of various components, and rebuilding weapons for shipment back to the stockpile. Five evaluations are performed at Pantex: new material laboratory testing, new material flight testing, stockpile laboratory testing, stockpile flight testing, and accelerated environmental aging and materials compatibility testing. These evaluations are outlined below:

- New Material Laboratory Testing--disassembly of a randomly selected, newly produced weapon before it is shipped to the stockpile. Various components are subjected to either destructive or nondestructive tests. After testing, the weapon is rebuilt and shipped to the stockpile.
- New Material Flight Testing--similar to new material laboratory testing. Weapons are selected at random before delivery to the stockpile and assembled into a nonnuclear, explosive joint test assembly for flight testing. These assemblies are tested by DOD aboard aircraft and missiles to verify the functioning of components under in-flight conditions. After the test flight, the joint test assembly is returned to Pantex for further examination when possible.
- Stockpile Laboratory Testing--similar to new material laboratory testing, but stockpile laboratory testing is performed on units randomly selected from the stockpile.
- Stockpile Flight Testing--similar to new material laboratory flight testing, but stockpile flight testing is performed on weapons randomly selected from the stockpile.
- Accelerated Environmental Aging and Materials Compatibility--determines the effects of aging on the integrity of weapons systems over time. These tests involve subjecting newly produced units to an artificial aging process or to environmental stresses to determine whether or not they retain their chemical and physical properties, and to ensure that they will react in a predictable manner after an extended period of time.

Also, some testing is performed at the Gas Analysis Laboratory, which evaluates samples taken from accelerated aging units, material compatibility tests, development activities, material certification tests, and production operations.

In addition to the principal efforts associated with weapons A/D, Pantex provides development support and services to the weapons laboratories and to other government entities.

Pantex contains a number of facilities that stage (temporarily store) weapons components that are destined either for the assembly cells or for shipment to other DOE facilities. Staging procedures may involve the leak testing of staging containers, inventories to verify the number and contents of containers, and unpacking and repacking to physically verify and test contents.

Environmental Regulatory Setting. Pantex conducts operations in compliance with all applicable environmental regulations and statutes and with the requirements of the various permits issued to the plant. The Texas Natural Resources Conservation Commission has state authority for developing and enforcing regulations and standards for air, water, and waste management. EPA has delegated regulatory authority to the State of Texas for air and solid and hazardous waste. As of December 31, 1994, Pantex is in compliance with the major environmental laws and regulations, with no regulatory enforcement actions or lawsuits pending. The remainder of this section summarizes the status of Pantex compliance with the major environmental regulations.

National Environmental Policy Act. DOE finalized the EA for the Interim Storage of Plutonium Components and issued a FONSI in January 1994. This EA analyzed the storage of a larger number of pits for a longer interim period than previously stored. In its FONSI, DOE decided to store no more than 12,000 plutonium pits at Pantex. In May 1994, DOE published a Notice of Intent (NOI) to prepare a new site-wide environmental impact statement (EIS) for *The Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components.* This Site-Wide EIS incorporates several actions that were ongoing at the onset of this EIS. The draft EIS was issued in March 1996.

Comprehensive Environmental Response, Compensation, and Liability Act. On May 31, 1994, EPA placed Pantex on the NPL effective June 30, 1994 (59 FR 27989) as a Superfund site. As a result, Pantex is subject to the provisions of CERCLA enforcement and is required to develop a Federal Facility Agreement. In August 1994, DOE began discussions with EPA and the State of Texas on this agreement to perform response and remediation activities, pursuant to CERCLA and the National Contingency Plan requirements and consistent with corrective actions currently being performed under RCRA. On December 14, 1994, Pantex hosted a meeting of Federal and state trustees who are responsible for assessing damages for injury to, destruction of, and loss of natural resources. Trustees are continuing to participate in the Natural Resource Damage Assessment process under section 107 of CERCLA.

Emergency Planning and Community Right-To-Know Act. No Toxic Chemical Release Inventory Form (EPA Form R) for 1993 was required under Section 313 of this act, because no reportable substances were released at levels above threshold values. However, in accordance with the Agreement in Principle with the State of Texas that was effective July 31, 1990, DOE provides the state with a chemical and radiological contaminant inventory and assessment of the plant.

Resource Conservation and Recovery Act. Pantex is defined as a large-quantity generator and has both permitted and interim-status storage and treatment facilities. Pantex manages some solid wastes under Texas Solid Waste Disposal Act Hazardous Waste Permit Number HW-50284, which includes a corrective action section. Under interim permit status, Pantex also operates thermal treatment units for processing explosives. Hazardous wastes generated at Pantex include, but are not limited to, solvent-contaminated wastewater and spent organic solvents that are contaminated with explosives.

These wastes are either managed onsite by storage and limited treatment or shipped offsite for treatment and disposal at permitted treatment, storage, and disposal facilities.

All of the routinely generated radioactive waste from Pantex operations is low-level radioactive waste. This waste is generated in small quantities from weapons A/D and consists primarily of materials contaminated with depleted uranium or tritium. Low-level radioactive waste is temporarily stored onsite until it is shipped to NTS. Pantex manages mixed waste in accordance with the Pantex Plant*Federal Facility Compliance Act* Compliance Plan, while pursuing commercial treatment capability (see plan below).

The Federal Facility Compliance Act of 1992. This act is an amendment to RCRA. DOE published the Interim Mixed Waste Inventory Report in April 1993, annual updates, and periodic updates since, describing its inventory of mixed wastes and treatment capabilities. Pantex prepared and submitted the Pantex Plant*Federal Facility Compliance Act* Compliance Plan to provide mixed waste treatment capability for all mixed waste streams in accordance with the *Federal Facility Compliance Act*. This plan was approved by the Texas Natural Resources Conservation Commission and adopted through an Agreed Order on September 27, 1995. The Agreed Order, signed by the state on October 2, 1995, requires implementation of this plan.

Clean Water Act. EPA issued Pantex a draft wastewater NPDES permit on December 31, 1994. Actions to finalize the draft permit are progressing. Pantex has a stormwater NPDES permit pending, having resubmitted its permit application on August 24, 1994, and submitted NOI, on September 29, 1994. Pantex also has a wastewater no-discharge permit (Number 02296). On April 1, 1993, the state issued a draft permit based on DOE's May 1992 application to change the permit from a no-discharge to a discharge permit. Such a change requires public hearings and the process is continuing.

Safe Drinking Water Act. The plant water supply meets all required primary and secondary drinking water standards and operational and maintenance regulations. A state inspection on October 4, 1994, confirmed that the system is being operated and maintained in compliance with Texas statutes and regulations.

Clean Air Act. Most Federal requirements are implemented in Texas under the *Texas Clean Air Act.* Pantex Plant has permits and standard exemptions issued by EPA and the Texas Natural Resource Conservation Commission. In 1994, Pantex reviewed activities conducted in all buildings to determine their compliance with 40 CFR 61 Subpart A (General Provisions) and Subpart H (Emissions of Radionuclides Other than Radon from DOE Facilities). All buildings were in compliance. At the Burning Ground explosive weapons components, explosive contaminated materials, and explosive waste are thermally treated. The Burning Ground operates under a written Grant of Authority from the State of Texas for its air emissions and under RCRA interim status for its waste management activities. In 1990, Pantex applied to the state to modify its Permit for Industrial Solid Waste Management Site, to include the Burning Ground. The hearing process on the permit modification is continuing.

Toxic Substances Control Act. Pantex is managing PCBs, asbestos, and chemicals in compliance with applicable regulations. For example, waste materials contaminated with PCBs are shipped offsite to permitted facilities for treatment and disposal. As of December 3, 1994, all equipment and parts used at Pantex that contain PCBs have concentrations of less than 50 parts per million (ppm).

Federal Insecticide, Fungicide, and Rodenticide Act. Compliance with this act and several related state statutes, such as the *Texas Pesticide Control Act* , allows agricultural production on the arable land surrounding the plant. Pesticides are applied by state-licensed personnel who ensure the health and safety of workers and protect the integrity of the environment from potential adverse impacts of agricultural chemicals applications.

A.1.5 Los Alamos National Laboratory

Site Description. LANL is located in north-central New Mexico adjacent to the town of Los Alamos (see figure A.1.5-1). It is about 96 km (60 mi) north-northeast of Albuquerque and 40 km (25 mi) northwest of Santa Fe. The area is dominated by the Jemez Mountains to the west and the Sangre de Cristo Mountains to the east. These two ranges flank the Rio Grande Valley, which roughly bisects the state from north to south. LANL is located on the Pajarito Plateau, a volcanic shelf on the eastern slope of the Jemez Mountains, at an approximate elevation of 1,900 to 2,400 m (6,230 to 7,870 ft). Erosion has cut the Pajarito Plateau into a number of steeply sloped, deeply eroded drainage canyons and isolated finger-like mesas that fan out from the west to the east. The laboratory occupies approximately 11,300 ha (28,000 acres); 1,400 ha (3,500 acres) lie in Santa Fe County with the remainder in Los Alamos County.

LANL is divided into 74 Technical Areas (TAs) of which 30 are currently active (see figure A.1.5-2). TA-3 is located on South Mesa and is the main or core area where approximately half of the personnel are located. This area serves as the central technical, administrative, and physical support facility for LANL. It also provides space for experimental, theoretical, and computational sciences. From the core area, four roads connect to the other lab areas. The northern-most road crosses the Los Alamos Canyon and connects with the town of Los Alamos, the airport, medical center, and the Tritium System Test Assembly Facility. The road also provides access down the canyon to a nonoperating research reactor and to the facilities for engineering design of weapons components. The East Jemez Road runs east to the Los Alamos Meson physics facility, a general construction support area, a trailer park, a county landfill, and guard facilities, including a firing range.

From TA-3, Pajarito Road runs southeast to White Rock, the only other housing area near LANL. The TAs in this corridor are used predominantly for nuclear materials R&D, fusion and laser R&D, waste management, and other multiuse experimental sciences. The special nuclear materials, radiochemistry, plutonium processing, and waste management facilities are located in this corridor.

From the core area, West Jemez Road runs south along the western boundary of LANL. This West Jemez Corridor sits atop five mesas. TA-16, one of the larger areas, is dedicated to HE research and research, development, and testing (RD&T). Functions at this site include engineering design, prototype manufacturing, processing, and environmental testing of nuclear warhead systems. Ten other TAs located in this corridor are used extensively by the Dynamic Testing Division. The Aboveground Experiments Division and Design Engineering Divisions also have facilities at TAs within this corridor.

Developed land accounts for approximately 5 percent of the LANL area, 580 of 11,300 ha (1,440 of 28,000 acres). Within this developed area lie 2,318 buildings totaling 756,000 m^2 (8.14 million ft^2). The breakout of this space is as follows: 18 percent for offices, 12 percent for laboratories, 8 percent for heavy experimental facilities, 14 percent for storage, 33 percent for various service facilities, and the remainder for all other uses. Approximately 93 percent of the personnel and square footage are located within 38 of the TAs. About 415 buildings have floor space that exceeds 190 m^2 (2,000 ft^2) and they account for 89 percent of the lab's total floor space. Of these buildings, 152 exceed 930 m^2 (10,000 ft^2) and comprise 75 percent of the total space. The average size of the remaining (approximately 1,903) buildings is 60 m^2 (650 ft^2); half of these buildings are either temporary or transitional. Forty-one percent of all the buildings at LANL are permanent. Of the major buildings (larger than 190 m^2), 73 percent of the total square footage was built prior to 1980.

Current missions at LANL are shown in table 3.2.6-1. A complete description of current facility operations can be found in the Los Alamos National Laboratory Institutional Plan. The major DP facilities located at LANL are shown in table A.1.5-1. In addition to the facilities included in this table, DOE operates various smaller facilities related to the ongoing Stockpile Stewardship and Management Program. Many of these have been subject to recent NEPA reviews, but are not included here because they would be considered minor facilities in relation to the entire Stockpile Stewardship and Management Program.

Environmental Regulatory Setting. It is the policy of LANL that operations be performed in a manner that protects the environment and addresses compliance with applicable Federal and state environmental protection regulations. The New Mexico Environment Department has state authority for developing regulations and standards for air, water, and hazardous and mixed waste management.

The remainder of this section summarizes the status of LANL compliance with the major environmental regulations.

National Environmental Policy Act. The current LANL Site-Wide EIS was published in 1979. Since the new LANL Site-Wide EIS is under preparation, any EA that proceeds ahead of the Site-Wide EIS was either identified in the NOI (60 FR 25697) of May 12, 1996, or must qualify as an interim action. The Site-Wide Draft EIS is expected to be released to the public in early February 1997 with the Site-Wide Final EIS to be issued in late August 1997.

Comprehensive Environmental Response, Compensation, and Liability Act. LANL is not on EPA's NPL; therefore, cleanup from past operations is covered not by CERCLA, but by other regulations, principally RCRA.

Resource Conservation and Recovery Act. The state was granted authorization by EPA to regulate control of hazardous waste under RCRA on January 25, 1985, and mixed waste on July 25, 1990.

LANL is a large-quantity generator under RCRA and operates under both interim status provisions and a New Mexico Environment Department permit. Applications for mixed waste storage and treatment at LANL were submitted to the state prior to 1992 and are under interim status provisions.

Table A.1.5-1.-- Major Defense Program Facilities Located at Los Alamos National Laboratory

Facility	Function
Chemistry and Metallurgy Research (CMR) Building (TA-3)	Nuclear materials analytical chemistry, R&D, and storage, control and accountability
Main Shops Complex (TA-3)	Nonnuclear and uranium component manufacturing
Sigma Complex (TA-3)	Nonnuclear beryllium and pit support component fabrication, uranium process development and component production, and materials R&D
Nondestructive Testing Facilities Anchor Sites (TA-8)	Radiography, acoustics, and holography
High Explosives Operations, Anchor East (TA-9)	HE storage, characterization, safety and R&D, and pilot scale HE synthesis and formulation
Environmental Testing Facilities, K-Site (TA-11)	Vibration, impact, dynamic testing, and thermal testing
High Explosives Operations, Q-Site (TA-14)	HE testing and disposal
Hydrodynamic Testing Facilities, Pulsed High Energy Radiation Machine Emitting X-Rays (PHERMEX), Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, Firing Site R-306, and other facilities (TA-15)	Hydrodynamic testing, dynamic experiments, and HE testing
Weapons Engineering Tritium Facility (WETF), S-Site (TA-16)	Tritium processing and recovery, tritium R&D, tritium reservoir loading and surveillance, and fusion and neutron tube target loading
Explosives Facilities, S-Site (TA-16)	Large scale HE formulation, synthesis, casting, pressing, machining, assembly, inspection, packaging, treatment, storage, transportation, and disposal
Los Alamos Critical Experiment Facility (LACEF) (TA-18)	Nuclear criticality studies in design, construction, research, development, and application; nuclear material storage control and accountability
Tritium Operations (TA-21)	Neutron tube target loading and tritium R&D
Detonator Facility (TA-22)	Detonation R&D and high power detonator production

Target Fabrication Facility (TA-35)	Inertial confinement fusion target fabrication, physical and chemical vapor deposition component production and process development, material science R&D, and calorimetry
Trident Laser Facility and other facilities (TA-35)	Inertial confinement fusion experiments and high energy density weapons physics
Pegasus-II Facility and other facilities (TA-35)	Pulsed power capacitor bank, high energy density weapons physics experiments, hydrodynamic experiments, and dynamic material properties research, and pulsed power research
Kappa Site (TA-36)	HE and nonnuclear ordnance testing
Ancho Canyon (TA-39)	Explosively driven pulsed power experiments and development, dynamic experiments, and HE testing
DF Site (TA-40)	Detonation science and HE testing, and detonator development and surveillance
Radiochemistry (TA-48)	Radiochemistry, radiochemistry R&D, isotope production, waste management technology development, and isotope separation
Los Alamos Neutron Science Center (LANSCE) Complex (TA-53)	Neutron spallation sources; neutron research for materials science, stockpile stewardship research and development; nuclear and accelerator research and development; tritium production research and development; research on sub-atomic particles and particle physics, atomic physics, neutrinos, and the chemistry of sub-atomic interactions; isotope production; and radio frequency power sources, high-power microwaves, and free electron lasers studies
Plutonium Facilities (TA-55)	Nuclear material processing and recovery, plutonium R&D, plutonium component fabrication and surveillance, processing of plutonium-238 to produce heat sources, fabrication of ceramic-based and other reactor fuels, nuclear material R&D, and nuclear material storage, control, and accountability

Note: HE - high explosives; R&D - research and development; TA - technical area.

Source: LANL 1995t.

The state conducts annual RCRA audits of generator locations and treatment, storage, and disposal facilities throughout the LANL facilities. On January 28, 1993, the state issued two Compliance Orders listing a total of 24 alleged violations, including violations involving the management of mixed waste, deficiencies related to general waste management requirements, and deficiencies that could adversely affect human health and the environment if not addressed in a timely manner. Negotiations between DOE and the state resulted in a civil penalty of $700,000. All of the deficiencies relating to the general waste management requirements were corrected within 30 days.

The Environmental Restoration Project Office at LANL provides oversight for the closure of several solid waste management units which are subject to the corrective action requirements and closure provisions of the Hazardous and Solid Waste Amendments under RCRA. The state has regulatory authority for closure of these sites. During 1992, LANL and the state were in the process of developing a permit application to initiate the construction of a mixed waste storage and disposal facility for the disposal of mixed waste generated by the site remediation processes. LANL halted all construction efforts for the mixed waste storage and disposal facility in 1995.

LANL operates a controlled air incinerator that was permitted in November 1989 for the treatment of hazardous waste. The facility was placed on standby in 1992 for upgrades. The controlled air incinerator will be closed under RCRA and TSCA by the end of 1996.

The Federal Facility Compliance Act of 1992. This Act is an amendment to RCRA. DOE published the Interim Mixed Waste Inventory Report in April 1993 and has published annual updates and periodic updates since, describing its inventory of mixed wastes and treatment capabilities. The New Mexico Environment Department issued a Compliance Order in October 1995 directing DOE to implement the LANL Site Treatment Plan for Mixed Waste. This order terminates the Federal Facilities Compliance Agreement between DOE and EPA concerning land disposal restricted wastes.

Clean Water Act. The NPDES permit for LANL regulates discharges from 9 wastewater treatment facilities and 130 industrial outfalls. During 1992, compliance for sanitary and industrial discharges was 99.6 percent and 99.0 percent, respectively. Two NOIs for stormwater discharges were submitted on October 1, 1992, for the Lagoon Elimination Project and the Los Alamos Integrated Communication System. An additional NOI was submitted on September 29, 1992, for stormwater discharges associated with industrial activities.

Safe Drinking Water Act. LANL maintains compliance with Safe Drinking Water Act (SDWA) standards for its public water systems.

Clean Air Act. The New Mexico State Implementation Plan incorporates requirements of the act including the 1990 CAA Amendments, NESHAP, National Ambient Air Quality Standards, and New Source Performance Standards. The state administers these Federal and state requirements through a series of Air Quality Control Regulations. During 1991, two open burn permits were issued to LANL for the burning of scrap wood from experiments and the burning of jet fuel for ordnance testing.

LANL operated 36 continuous emissions monitoring stations in 1992 to sample air discharges for radioactive releases. While no radionuclide concentrations were detected which would pose an environmental or health problem, EPA issued a Notice of Noncompliance on November 23, 1992, following an audit of LANL's NESHAP program in August 1992. The notice stated that LANL emissions exceeded the 10 mrem/yr effective dose equivalent standard during the 1990 reporting period. As a result of two Notices of Noncompliance issued to DOE by EPA Region 6 on November 27, 1991, and November 23, 1992, DOE and EPA entered into negotiations to achieve compliance with NESHAPs. The negotiations resulted in a Federal Facilities Compliance Agreement being signed on June 13, 1996, which requires that compliance with Subpart H be achieved by August 15, 1996.

Toxic Substances Control Act. This act regulates PCB use and storage at LANL. In compliance with TSCA regulations, equipment and materials containing PCBs greater than, or equal to, 50 ppm are removed and shipped offsite to permitted treatment and disposal facilities or disposed of at TA-54, Area G (only applied to solids containing 50 to 499 ppm of PCBs). No deficiencies were noted following an EPA inspection during the summer of 1993.

Federal Insecticide, Fungicide, and Rodenticide Act. In addition to this act, LANL is regulated by the New Mexico Pest Control Act which regulates pesticide use, storage, and certifications. Annual inspections to assess compliance with this act are conducted by the state.

A.1.6 Lawrence Livermore National Laboratory

Site Description. LLNL is located in southern Alameda County, CA, approximately 64 km (40 mi) east of San Francisco. The LLNL complex consists of a main site east of the city of Livermore (Livermore Site), several leased properties near the Livermore Site, and a more remote site (Site 300) in the Altamont Hills, 27 km (17 mi) southeast of the Livermore Site (see figures A.1.6-1 and A.1.6-2).

The Livermore Site occupies a 332-ha (821-acre) area in the southeast portion of the Livermore Valley. The valley is about 26-km (16-mi) long (east-west) and 11- to 16-km (7- to 10-mi) wide (north-south). Hills ranging in elevation from 300 to 600 m (1,000 to 2,000 ft) surround the Livermore Valley. These hills are predominantly open space devoted to agriculture and recreation uses.

Onsite land use includes offices, laboratory buildings, support facilities (e.g., cafeterias, storage areas, maintenance yards, facilities for waste treatment and groundwater treatment, security, and a fire station), roadways, parking areas, and landscaping. A 150 m (500 ft) wide security buffer zone lies along the northern and western borders of the site.

The Livermore Site has approximately 550,000 m^2 (5.9 million ft^2) of facilities that include existing space and areas under construction. This space is distributed among approximately 600 buildings, over 300 are temporary structures. Temporary facilities (trailers, modular buildings, and World War II buildings) constitute 30 percent of the occupied space and house approximately 51 percent of the total laboratory office population. Approximately 53 percent of the permanent facilities are more than 20 years old; 40 percent are more than 30 years old.

East of the laboratory is agricultural property with a few scattered rural residents. A branch of the California Aqueduct, the South Bay Aqueduct, traverses land east of the lab in a north-south direction. To the north lies a light industrial park, a line of the Union Pacific Railroad, and Interstate 580. Residential areas of low to medium density and the city of Livermore extend to the west. Immediately south of the Livermore site is the SNL site at Livermore. Farther south, and southwest, the land is cultivated for vineyards.

Site 300 is an HE test site occupying 2,800 ha (7,000 acres) of largely undeveloped steep ridges and canyons about 29 km (18 mi) southeast of Livermore in the sparsely populated Altamont Hills of the Diablo Range. Elevations vary from a low of 150 m (500 ft) along Corral Hollow Creek on the southern boundary to 520 m (1,700 ft) above mean sea level in the northwest portions of the site. Slopes range from 8 to greater than 45 degrees.

Site 300 consists of two remote firing areas supported by a chemistry processing area and an administrative support area at the site entrance. The site also includes a number of storage magazines. Major buildings include the firing complex, the advanced test accelerator, the dynamic test complex, disassembly complex, and drop tower test areas. Other facilities include police and fire department, badge office, HE storage, warehouse, medical, cafeteria, and other service facilities. There are approximately 31,700 m*2* (341,000 ft*2*) of facilities, including four trailers.

While the majority of the land surrounding Site 300 is agricultural (primarily for grazing cattle and sheep), two other defense-related research and testing facilities are in the area. A facility adjacent to Site 300 on the east and a similar facility approximately 1 km (0.6 mi) to the south both conduct HE tests.

South of the western portion of Site 300 is the Carnegie State Vehicular Recreation Area which is for the exclusive use of off-highway vehicles. The nearest urban area is the city of Tracy, approximately 13 km (8 mi) northeast of Site 300. Several rural residences, however, are much closer to the site. Power-generating wind turbines occupy the land northwest of the site.

Current missions at LLNL are shown in table 3.2.7-1. A complete description of current facility operations can be found in the Lawrence Livermore National Laboratory Site Institutional Plan. The major DP facilities located at LLNL are shown in .

Environmental Regulatory Setting. It is the policy of LLNL to protect the environment and ensure that operations are conducted in accordance with applicable laws and regulations that have been enacted to protect the environment. With some minor exceptions, the State of California has regulatory authority for air, water, solid waste, hazardous waste, and mixed waste as administered through a variety of state and local agencies. The remainder of this appendix section summarizes the status of LLNL compliance with the major environmental regulations.

National Environmental Policy Act. During 1994, two EAs for proposed projects were initiated by LLNL. The Draft Environmental Assessment for the Mixed Waste Management Facility addressed the potential impacts from construction and operations of a facility that will demonstrate potential technologies for treating DOE mixed waste on a pilot scale. Based on the results of this research, certain technologies may be adopted later by DOE for treatment of mixed wastes throughout DOE's facilities. DOE is currently reviewing this Draft EA.

Table A.1.6-1.--Major Defense Program Facilities at Lawrence Livermore National Laboratory

Facility	Functions
Microfabrication Laboratory, Bldg. 153	Microelectronics fabrication
High Explosives Application Facility (HEAF), Bldg. 191	High explosives research with modern diagnostic and testing equipment
High Pressure - High Temperature Laboratory, Bldg. 232	High pressure - high temperature thermodynamic and materials properties experiments
Hydrogen Research Facility, Bldg. 331	Inertial confinement, fusion-directed, experimental work with isotopes of hydrogen gas, metal hydrides in contained beds, and small amounts of experimental metal hydrides and tritium-labeled compounds
Plutonium Facility, Bldg. 332	Testing plutonium-bearing engineering assemblies, developing and demonstrating improved plutonium fabrication techniques, and fundamental and applied research in plutonium metallurgy
High Pressure Laboratory, Bldg. 343	Tests and experiments with high pressure systems
Inertial Confinement Fusion Laser Facility, Bldg. 391	Nova laser, high-energy-density physics
Hydrodynamic Test Facilities with Flash X-Ray Facility at Site 300	Hydrodynamic and explosives testing with gamma-ray implosion imagery and other diagnostics

Source: LLNL 1995o.

The Draft EA for the Site 300 Explosives Waste Treatment Facility addressed the potential impacts of constructing and operating up-to-date replacement facilities for treating explosives wastes and explosives-contaminated wastes at Site 300. DOE is currently reviewing this Draft EA.

The California Environmental Quality Act (California Public Resources Code Sections 21000 et seq.) establishes state policy for protecting environmental quality. The goals of the California

Environmental Quality Act are achieved by requiring local and state agencies to assess the potential environmental impacts of proposed actions for which they may have a decisionmaking role. This is done through the preparation of an initial study, which leads to issuance of a negative declaration or a requirement to prepare an Environmental Impact Report. An Environmental Impact Report may also be prepared directly for projects that may have significant environmental impacts. No Initial Study or Environmental Impact Report documents were prepared by the University of California in 1994 on proposed projects for which the university was the decisionmaking or lead agency.

Comprehensive Environmental Response, Compensation, and Liability Act. Both the Livermore Site and Site 300 are listed on the EPA's NPL. The Livermore site was placed on the NPL in 1987, and LLNL's groundwater project complies with provisions specified in a 1988 Federal Facility Compliance Agreement entered into by EPA, DOE, the California Department of Toxic Substances Control, and the San Francisco Bay Regional Water Quality Control Board. The ROD was issued by EPA in 1992. Remedial investigations and treatment operations are ongoing.

Groundwater investigations began at Site 300 in 1981. The site was placed on the NPL in 1990. In June 1992, DOE negotiated a Federal Facility Agreement with EPA and the state that describes the groundwater and soil investigations to be conducted and specifies the reporting dates. Since June 1992, Site 300 investigations and remedial actions have been conducted under the joint oversight of EPA, Central Valley Regional Water Quality Control Board, and the Department of Toxic Substances Control under the authority of a Federal Facility Agreement.

Emergency Planning and Community Right-To-Know Act. In compliance with this act, LLNL implemented a computerized chemical tracking system called ChemTrack. The system allows for improved emergency response planning and complete inventory information, as well as improved overall chemical management.

Resource Conservation and Recovery Act. RCRA- regulated operations at LLNL's Livermore Site are managed under Interim Status Standards as administered by the California Department of Toxic Substances Control. A Part B Permit application has been submitted and describes storage and treatment operations at five facilities located in and near Buildings 233, 419, 514, 612, and 693. An additional new storage and treatment facility known as the Decontamination and Waste Treatment Facility would include construction of five new buildings for waste management operations to be located in the vicinity of Building 693. The Decontamination and Waste Treatment Facility would replace the majority of existing waste management facilities located in Areas 612 and 514.

At Site 300, LLNL operates a Part B-permitted container storage unit (Building 883) for management of hazardous waste. This facility permit is currently undergoing renewal. Explosives wastes are burned at an open burn facility near Building 829 under terms of a compliance order until a new thermal treatment unit can be designed, permitted, and constructed at which time the Building 829 facility will close. Part B Permit applications have all been submitted to the California Department of Toxic Substances Control for a new explosives storage facility and a new open burn/open detonation facility.

The Department of Toxic Substance Control conducted its annual audit of generator locations throughout the Livermore Site from June 22 to 25, 1993, and on July 14, 1993. Seventeen alleged violations were reported August 6, 1993. Site 300 was inspected February 16 and 17, 1993, and November 15 and 16, 1993. In each case, three violations were noted. Appropriate actions were taken at both sites to correct the violations.

The Building 829 Open Burn Facility thermally treats HE waste. The facility operates in accordance with interim status standard and the terms of a September 1993 compliance order. Design and permitting activities are currently in progress to build a new waste treatment facility at Building 845 to eliminate the need for the Building 829 Open Burn Facility. Another new facility has been proposed for Site 300, and a Part B Permit application has been submitted. The facility is an explosives waste storage facility that augments the storage capability at Building 883 by providing a separate dedicated facility to store explosives waste.

Federal Facility Compliance Act of 1992. Mixed wastes are generated and managed by LLNL operations in accordance with requirements of the *Federal Facility Compliance Act.* Existing and proposed management practices have been identified in the proposed site treatment plan submitted in April 1995. DOE is negotiating terms of a compliance agreement with the California Department of Toxic Substances Control.

Clean Water Act. This act is administered by the California Resources Board and regional and local agencies. Routine discharges to ground and surface waters resulting from the groundwater investigation and remediation activities at the Livermore Site are subject to permits issued by the San Francisco Bay Regional Water Quality Control Board. Stormwater associated with industrial activities is discharged under a Wastewater Discharge Permit issued by the Livermore Water Reclamation Plant. Site 300 holds water discharge requirements and NPDES permits issued by the Central Valley Regional Water Quality Control Board. These pertain to discharges associated with cooling towers and groundwater remediation work. Site 300 permits are also in effect for closed landfills and operation of an explosives rinsewater surface impoundment system.

Safe Drinking Water Act. LLNL maintains compliance with *SDWA* standards for its public water systems.

Clean Air Act. This act is enforced by the California Air Resources Board and local districts. The Livermore Site complies with the Bay Area Air Quality Management District rules and regulations. Site 300 is subject to rules enforced by the San Joaquin Valley Unified Air Pollution Control District. LLNL holds over 200 permits for air pollution sources and control equipment that are renewed on an annual basis.

Radionuclide emissions are regulated under NESHAPs, which is administered by EPA. In April 1994, EPA notified DOE and LLNL that all requirements of the August 1993 Federal Facilities Compliance Agreement had been met and that LLNL had satisfactorily demonstrated compliance.

Toxic Substances Control Act. LLNL regulates PCBs and asbestos in compliance with TSCA regulations. LLNL submits annual PCB reports to EPA. Asbestos wastes are reported in the hazardous waste report.

A.1.7 Sandia National Laboratories

Site Description. SNL is headquartered in Bernalillo County at the foot of the Manzano Mountains adjacent to Albuquerque, NM. At their nearest points, SNL facilities are 4.0 km (2.5 mi) south of Interstate 40 and 10.5 km (6.5 mi) east of downtown Albuquerque. The facilities are surrounded by Kirtland Air Force Base, with co-use agreements on some U.S. Air Force property. An area of the Manzano Mountains east of Kirtland Air Force Base has been withdrawn from the U.S. Forest Service for the exclusive use of the Air Force and DOE. The location of SNL and its principal facilities are shown in figures A.1.7-1 and A.1.7-2.

The laboratory is situated on the 30,562-ha (75,520-acre) Kirtland Air Force Base military reservation. Kirtland Air Force Base is located on two broad mesas bisected by the Tijeras Arroyo, an east/west canyon. These mesas are bounded by the Manzano Mountains (Cibola National Forest) to the east and the Rio Grande to the west. Elevations range from 1,500 m (4,921 ft) at the Rio Grande to 3,255 m (10,680 ft) at Sandia Crest, which is in the Sandia Mountains adjacent to Albuquerque.

Albuquerque, the largest population center in Bernalillo County, and also the closest population center to Kirtland Air Force Base, is located slightly north of the base. The 1990 census figures show an Albuquerque population of 384,736. The Isleta Indian Pueblo, which borders Kirtland Air Force Base on the south, is the next nearest population center with a 1990 census of 2,953. An estimated total population of 578,313 people live within an 80-km (50-mi) radius of Kirtland Air Force Base. This includes permanent residents of Kirtland Air Force Base living in the base housing areas. Current missions at SNL are shown in table 3.2.8-1. A description of facility operations can be found in the Sandia National Laboratories Site Institutional Plan. The major DP facilities located at SNL are shown in table A.1.7-1.

The majority of activities at SNL are DP activities. SNL facilities are located in five technical areas and several additional test areas. There are approximately 560 major buildings totaling over 370,000 m^2 (4 million ft^2) located in these areas. Each area has its own distinctive operations and is described in the following paragraphs.

Table A.1.7-1.-- Major Defense Program Facilities Located at Sandia National Laboratories

Facility	Function
Lurance Canyon Burn Site and Explosive, Electro-Explosive, and Aerial Cable Test Facilities (Coyote Test Field)	Weapons component testing in simulated accident scenarios and constrained rocket testing

Neutron Generator Facility, Wind Turbine, Environmental Test Laboratories, and Chemical, Ion, and Laser Physics Laboratories, Integrated Materials Research Laboratory, Micro Electronics Laboratory, Robotics, Manufacturing Science and Engineering Laboratory, Advanced Manufacturing Processes Laboratory, Primary Standards Laboratory, Lightning Test Laboratory, A/D Laboratory (Technical Area I)	Design, test, and manufacture of neutron generator components and weapon systems supporting R&D and production; structural analysis in high fatigue environments and material properties research
Explosives Component Facility, Device Development and Testing Facilities, and Environmental Testing Laboratories (Technical Area II)	Design, test, and manufacture of low power detonators, initiators, and timers for weapons subsystems
Dynamic Shock, Airgun Test and Reentry Burn-Up Test Facilities, Drop Tower, and Molten Core Laboratory (Technical Area III)	Extreme environmental testing, product acceptance qualification testing, material properties determination, and melting and casting process research
Particle Beam Fusion Accelerator (PBFA) High-Energy Radiation Megavolt Electron Source (HERMES) III Accelerator, Saturn Accelerator (Technical Area IV)	High energy gamma ray testing of electronic components for survivability; pulse power and weapon physics R&D; short pulse gamma and x-ray test facility for weapons component radiation testing
Hot Cell Facility, Annular Core Research Reactor, Sandia Pulse Reactor III, Gamma Irradiation Facility (Technical Area V)	Research and surveillance test facility for highly radioactive materials and products; high power pulse or steady state neutron and gamma ray radiation simulation environment for weapons component testing; steady state gamma ray testing of electronic systems and subsystems

SNL 1995i.

Technical Area I has the largest employee population (approximately 5,000) and is dedicated primarily to three activities: the design, research, and development of weapons systems; limited production of weapons system components; and energy programs. Technical Area I includes the main library, offices, laboratories, and shops used by administrative and technical staff; two small accelerators; a foundry; a steam plant; and an emergency diesel generator plant.

Technical Area II is a small area used for explosives testing. Techniques for measuring fractures in geologic strata are developed at this facility. Also located in Technical Area II are an inactive low-level radioactive waste disposal site, a small radioactive material decontamination and storage facility (Building 906), and a storage facility designed to temporarily hold PCB-contaminated materials to be transported to an EPA-licensed disposal facility. The inactive low-level waste (LLW) disposal site has not been used for over 20 years. Most Technical Area II activities have been transferred to the

Explosive Components Facility, a new facility intended to replace Technical Area II. This facility will integrate many of the existing Technical Area II activities, as well as some remote testing activities currently performed in other test areas.

Technical Area III is located adjacent to and south of Technical Area V, 8 km (5 mi) south of Technical Area I. It comprises 20 test facilities that include extensive environmental test facilities (such as sled tracks, centrifuges, and a radiant heat facility). Other facilities in Technical Area III include a paper incinerator, an inactive LLW and mixed waste disposal site, and a melting and solidification laboratory. The inactive radioactive waste disposal site in Technical Area III consists of two adjoining fenced areas that occupy 0.6 ha (1.5 acres). One area was used for LLW disposal in seven shallow trenches. The second area was used for disposal of classified LLW in 37 pits. LLW consisted primarily of tritium-contaminated materials. Three additional pits located in the classified waste disposal area were used exclusively for natural and depleted uranium waste disposal. The site is currently used as an interim storage facility for radioactive and mixed wastes.

An inactive hazardous-waste disposal and storage site is also located near the southern boundary of Technical Area III. This facility has not been used for disposal of hazardous wastes since November 7, 1985. It was used as an interim hazardous waste storage area from 1985 to 1988. A closure plan and post-closure permit application were prepared in May 1988. The newer hazardous waste repackaging and storage building, located south of Technical Area I, has been in use since 1988.

Technical Area IV consists of several inertial-confinement fusion research and pulsed-power research facilities. One large accelerator, the Particle-Beam Fusion Accelerator-II, was completed in 1985. A large accelerator facility, the Simulation Technology Laboratory, houses seven pulsed-power accelerators. Several of these accelerators have been transferred from Technical Area V.

Technical Area V houses two research reactors in two reactor facilities, an intense gamma irradiation facility (using cobalt-60 and cesium-137), and a hot cell facility. The two research reactor facilities in Technical Area V are small and quite dissimilar: the Sandia Pulsed Reactor is an unreflected, unmoderated assembly of enriched uranium, and the Annular Core Research Reactor consists of an annular core of 226 fuel elements in an open water tank.

There are also test areas outside the five Technical Areas. These areas are located south of Technical Area III and in canyons on the west side of the Manzano Mountains. Coyote Canyon and Thunder Range are two examples of such areas.

Depleted uranium was used in the past for explosive testing in these remote areas. The test areas were surveyed following each test and contaminated materials were collected and disposed of in accordance with DOE requirements. Environmental monitoring is done as necessary. Operations in these areas are administratively controlled to avoid uranium contamination to public areas beyond the confines of Kirtland Air Force Base.

Electricity is supplied to SNL and much of southeast Albuquerque through the Public Service Company of New Mexico's switching station on Eubank Boulevard. Voltage is stepped down through transformers to 46 kilovolt (kV) for distribution through four feeders. Feeder 1 serves Technical Areas II through V and outlying areas, Feeder 2 serves the Radiant Heat Facility in Technical Area III, and Feeders 3 and 4 supply Technical Area I.

Kirtland Air Force Base is responsible for the overall natural gas system. The distribution system in technical areas I, II, and IV is owned by DOE and operated by SNL. Natural gas is purchased from Kirtland Air Force Base, which buys it commercially. Fuel is stored in Technical Area I for refueling remote-site tanks and for emergency supply to the steam plant. The steam plant in Technical Area I supplies steam both to that area and to Kirtland Air Force Base for space heating, hot water converters, absorption chillers, and processes.

Responsibility for water storage and transmission rests with Kirtland Air Force Base, with SNL handling distribution only to its own facilities. Remote test areas in Coyote Canyon have water trucked to them.

SNL is responsible for the sewage collection system in its technical areas and in Coyote Test Field, while Kirtland Air Force Base is responsible for the base-wide system. SNL contains over 24 km (15 mi) of sewer lines interconnected with Kirtland Air Force Base. Technical Areas I and IV are tied into the Kirtland Air Force Base system, while Technical Areas II, III, and V and Coyote Test Field have septic tanks and sewage lagoons independent of the main system.

Environmental Regulatory Setting. SNL strives to comply with environmental and other requirements established by Federal, state, and local statutes and regulations, executive orders, and DOE orders. The New Mexico Environment Department has state authority for developing regulations and standards for water, and hazardous and mixed waste management. The Albuquerque/ Bernalillo County Air Quality Control Board has authority for developing regulations and standards for air. The remainder of this section summarizes the status of SNL compliance with the major environmental regulations.

National Environmental Policy Act. During 1994, SNL NEPA compliance activities focused on developing the SNL NEPA program and baseline information and fulfilling commitments made in the *Final Action Plan to Tiger Team.* SNL initiated the preparation of 15 EAs during 1994. FONSIs were issued for the neutron generator/switch tube prototyping relocation on April 8, 1994; general-purpose heat source safety verification testing on February 15, 1995; and the construction and occupancy of the Robotic Manufacturing Science and Engineering Laboratory on April 13, 1994.

Comprehensive Environmental Response, Compensation, and Liability Act. Based on the Preliminary Assessment/Site Inspection conducted in 1988, EPA concluded that none of SNL's inactive waste sites qualified for the EPA's list of high-priority cleanups. Therefore, this act does not govern waste site cleanup, but RCRA does. During 1994, SNL had two reportable quantity chemical releases. Lead was released during a scheduled rocket motor firing and transformer oil leaked from an oil storage system and escaped from the system's secondary containment.

Resource Conservation and Recovery Act. The New Mexico Environment Department was granted authorization to regulate control of hazardous waste under RCRA by EPA on January 25, 1985, and mixed waste on July 25, 1990. SNL, which operates an onsite permitted treatment facility, is defined by RCRA as a large-quantity generator. During 1994, 86,369 kg (190,400 lb) of RCRA-regulated hazardous waste was managed by SNL. On May 12, 1994, DOE transmitted a Class I permit modification of the RCRA storage permit to the New Mexico Environment Department, allowing SNL to receive offsite generated wastes. SNL also operates a Thermal Treatment Facility that was permitted in November 1994 for the treatment of residual explosives.

The New Mexico Environment Department conducts annual RCRA audits of the SNL Hazardous Waste Management Facility and generator locations throughout SNL facilities. On October 7, 1994, the New Mexico Environment Department issued a Compliance Order listing 17 alleged violations, including open containers of hazardous waste, labeling errors, and incomplete training. Five of the violations were dropped following negotiations between SNL and the New Mexico Environment Department, and a civil penalty of $9,240,000 was proposed in January 1995. All of the remaining issues have been corrected.

As identified by the Environmental Restoration Project, potential release sites are being evaluated and corrected. At SNL's inactive Chemical Waste Landfill, concentrations of trichloroethylene slightly above the EPA's drinking water standards were discovered in groundwater 150 m (500 ft) beneath the site. A corrective action plan, entitled *The Chemical Waste Landfill Final Closure Plan and Postclosure Permit Application,* was approved by the New Mexico Environment Department in May 1993. Sites at which assessment efforts continued during 1994 include the Mixed Waste Landfill, Technical Area II, the Liquid Waste Disposal System, Tijeras Arroyo, and also at the Kauai Test Facility in Hawaii.

The Federal Facility Compliance Act of 1992. In accordance with the *Federal Facility Compliance Act* enacted in October 1992, SNL submitted a complete inventory of its mixed waste in November 1993 for the Final Mixed Waste Inventory Report. Additionally, SNL submitted the Conceptual Site Treatment Plan (Phase I) for SNL mixed waste issued in October 1993 and the Draft Site Treatment Plan (Phase II) issued in August 1994 to the New Mexico Environment Department. In December 1994, the Proposed Site Treatment Plan (Phase III), including a revised mixed waste inventory through September 1994 and preferred treatment options in accordance with the DOE/AL Mixed Waste Treatment Plan (April 1994), were submitted to the New Mexico Environment Department.

Clean Water Act. SNL submitted an NPDES permit application on October 1, 1992, for its industrial discharge. Two NOIs to discharge for construction of stormwater discharges were submitted on January 24, 1994, for construction of the Technology Support Center, and on September 19, 1994, for construction of the Robotic Manufacturing Science and Engineering Laboratory. SNL has six wastewater discharge permits from the city of Albuquerque.

Safe Drinking Water Act. SNL maintains compliance with *SDWA* standards for its public water systems.

Clean Air Act. SNL is regulated by the 1990 CAA amendments and by local regulations, including air quality control regulations, which are administered by the Albuquerque/Bernalillo County Air Quality Control Board. In 1994, 15 open burn permits were issued to SNL by the city of Albuquerque. Permits were issued for operations at the Luance Canyon Burn Site, the Thermal Treatment Facility, the Coyote Test Field, and the Fire Extinguisher Training Site. All other existing permits were issued by either the city of Albuquerque or EPA. In early 1995, SNL conducted an inventory of hazardous chemical usage. The inventory included radionuclides, ozone-depleting substances, and chemicals listed in *Superfund Amendments and Reauthorization Act*, Section 313, Toxic Chemical List.

In January 1994, SNL began an ambient air surveillance program which included one criteria pollutant monitoring station, seven particulate matter monitoring stations, and four VOC monitoring locations. No exceedances or violations were detected in 1994.

Toxic Substances Control Act. SNL regulates PCBs and asbestos in compliance with TSCA regulations. Electrical distribution equipment containing greater than, or equal to, 50 ppm are being removed and shipped offsite to permitted treatment and disposal facilities. A total of 49 items, having PCB concentrations over 50 ppm, remained in service as of December 31, 1994. SNL operates two programs for the management of asbestos. The Facilities Asbestos Program manages the abatement of floor tiles and insulation. The Non-Facilities Asbestos Program handles nonfacilities items that may contain asbestos such as gloves, fume hoods, and ovens.

Federal Insecticide, Fungicide, and Rodenticide Act. EPA-registered pesticides are applied by EPA-certified applicators. Records including pesticide types and quantities and Material Safety Data Sheets are retained by SNL.

A.1.8 Nevada Test Site

Site Description. NTS is located in Nye County, NV, and encompasses approximately 351,000 ha (867,000 acres). It varies in width from 45 to 56 km (28 to 35 mi) east to west and in length from 64 to 88 km (40 to 55 mi) north to south. To the north, east, and west, the rugged, mountainous, and undeveloped Federal-owned land masses of the Nellis Air Force Range provide a buffer zone, varying from 24- to 104-km (15- to 65-mi) wide, between the test areas and public lands. The Bureau of Land Management manages the land that borders the southern and southwestern boundaries. U.S. Highway 95 and the town of Amargosa Valley are also to the south. The southeast corner of NTS is about 104 km (65 mi) northwest of Las Vegas. Locations of NTS and its principal facilities and testing areas are shown in figures A.1.8-1 and A.1.8-2.

NTS is unique in that it is a large open area with tightly controlled access and with adequate infrastructure to handle and run tests with hazardous or radioactive materials. Approximately 25 percent of NTS is undeveloped or provides buffer zones for ongoing programs and projects. Facility expansions are possible within all areas and encroachment from land development is not a concern.

NTS is divided into numbered test areas to simplify the distribution, use, and control of resources. The main entrance and the Desert Rock Airstrip are at the southeast corner of the site (Area 22).

Mercury Base Camp is adjacent in Area 23 and provides administrative operations and general support. Offices for DOE, DOD, the Defense Nuclear Agency, LLNL, LANL, SNL, and all of the supporting contractors of these organizations are located in this area. Dormitory, cafeteria, recreation, and transportation facilities are located here.

North of Mercury is Frenchman Flat (Area 5), a historic area because of the atmospheric nuclear tests conducted there. Just north of Frenchman Flat is Area 6. The Control Point One Complex, which provides control over and execution of nuclear detonations at NTS, is located here, as is a new work-camp for construction and craft support. A shallow, usually dry-lake bed, Yucca Lake, is also in this area. Farther north is the broad valley of Yucca Flat, site of many of the more recent nuclear tests (Areas 1, 2, 3, 4, 7, 9, and 10). At the northern edge of this flat at the base of Rainier Mesa is the center of DOD/Defense Nuclear Agency activities (Area 12). The Area 12 Camp, which is closed, provided logistic, service, and administration facilities that, in busier times, supported the northern part of NTS. The Area 12 Camp provided ready access to the Defense Nuclear Agency tunnels mined into the face of Rainier Mesa. In the northwest section of NTS is Pahute Mesa. Pahute Mesa's geology allows its use for testing nuclear devices with larger yields (Areas 19 and 20).

Due to its large size, the perimeter of NTS is not completely fenced; however, roving security guards patrol the test site. Security and hazardous areas are fenced and some areas are protected with armed guards and electronic security measures. Capital assets at NTS include about 1,200 buildings with 8,000 units of installed equipment, approximately 640 km (400 mi) of primary and secondary surfaced roads, and 480 km (300 mi) of unsurfaced roads.

The NTS water system consists of many wells, pumps, booster pumps, and many sumps, reservoirs, chlorinator water softeners, and 160 km (100 mi) of supply and distribution lines. This water system has an average weekly production of 40 million liters (L) (10.5 million gallons [gal]). Total well capacity is 21,670 liters per minute [lpm] (5,752 gallons per minute [gpm]). Twelve wells supply water for domestic use on NTS.

Electrical power to NTS is supplied by Nevada Power Company and Valley Electric Association transmission lines. Both transmission lines are rated at 138 kV. The Nevada Power Company line is approximately 96 km (60 mi) long and ties into the NTS transmission system near Mercury. The Valley Electric Association line is more than 160 km (100 mi) long. It runs from the Amargosa Valley substation and ties into the NTS transmission system at Jackass Flats substation. This system (the Nevada Power Company/Valley Electric Association transmission lines) is capable of providing 45 megawatt electric (MWe) based on a single contingency failure. NTS has over 1,120 km (700 mi) of overhead and underground transmission and distribution power lines. NTS also uses a small amount of liquid fuel. Table 4.9.2.2-1 shows the annual usage of resources. Current missions at NTS are shown in table 3.2.9-1. The major DP facilities located at NTS are shown in table A.1.8-1.

Table A.1.8-1.--Major Defense Program Facilities at Nevada Test Site

Facility	Functions
Device Assembly Facility (DAF)	Assembly of nuclear test devices
Lyner Facility	Underground subcritical testing, dynamic experiments with special nuclear materials
Area 27, Critical Assembly Facilities	Assembly bays, storage magazines, and radiography buildings maintained for use as an alternative to the Device Assembly Facility
Able Site	Maintained for resumption of testing pending Device Assembly Facility operations, and for operations involving HE and special nuclear materials
Baker Site	HE operations and staging
Big Explosive Experimental Facility (BEEF)	Conventional HE testing

Source: NT DOE 1996c; NTS 1996a:1.

In December 1950, President Truman established the Nevada Proving Grounds (forerunner to NTS) as the Nation's on-continent nuclear weapons testing area. The first nuclear test at NTS occurred on January 27, 1951. At that time, the nuclear weapons program was administered by the Atomic Energy Commission (AEC), Albuquerque Operations Office. AEC employees were sent to the Nevada Proving Grounds for the duration of a test series and then returned to Albuquerque. As tests became more frequent during the 1960s, the AEC created the Las Vegas-based Nevada Operations Office, which officially opened on March 6, 1962, and has since administered NTS operations. Approximately 40 percent of the total Nevada Operations Office budget for fiscal year 1992 was for DP activities.

Desert Rock Air Strip is located southwest of Mercury. The airstrip has, in busier times, provided scheduled air service by DOE aircraft between NTS and LLNL, LANL, and SNL, for access by researchers and testing personnel. Currently, it is used only for high priority shipments.

Construction of the only major new facility, the Device Assembly Facility, is essentially complete; however, existing facilities are modified on an as-needed basis. Drilled holes for groundwater monitoring are always in the process of being selected, designed, and developed. A waste management facility is being considered for handling transuranic (TRU) waste from DOE facilities; this and the Solar Power Production Facility are the only major non-DP facilities anticipated for NTS.

Defense Program Activities. Historically, most of the work carried out onsite has been related to DP activities. Since it was established in December 1950, NTS has been the principal testing location for the Nation's nuclear weapons program. As of September 30, 1992, the United States had conducted 1,054 nuclear tests, 928 of which were on NTS and 828 of which were underground. Underground testing was controlled at the Area 6 Control Point One. This facility contains the technical, managerial, and safety infrastructure to control the site.

As has previously been noted, since the *U.S. Nuclear Testing Moratorium Act* went into effect in early October 1992, no nuclear tests have been conducted by the United States. On the day immediately following China's October 4, 1993 nuclear test, President Clinton issued a directive to DOE to continue to maintain indefinitely a state of readiness for possible resumption of U.S. testing. Other aspects of stockpile stewardship activities at NTS include treaty-compliant and permitted HE tests, subcritical dynamic experiments, and hydrodynamic tests.

The Device Assembly Facility is the only new major facility for DP activities at NTS. This 9,290 m^2 (100,000 ft^2) facility was authorized in 1984. It is physically located just south of Control Point One. It will combine and centralize most functions and facilities of the existing device assembly area. The Device Assembly Facility will enable LLNL and LANL to conduct multiple operations with HE and nuclear devices simultaneously. All aspects of the operation will be handled in this one facility because its multiple processing areas include assembly cells, assembly bays, high bays, radiographic facilities, special nuclear materials laboratories, HE staging, special nuclear materials staging, shipping and receiving areas, and associated administrative and support areas. In addition, the facility will provide for increased overall security and permit easier entrance and exit for the workers during hazardous operations. Special nuclear materials will not be manufactured or machined at this facility; only the device A/D and material storage/staging functions would be handled here.

The Nevada Operations Office has been delegated the lead Federal role in maintaining the capability to respond to certain kinds of national emergencies. It will provide the leadership when a Federal Radiological Monitoring and Assessment Center is established. Additionally, a team of highly trained DOE and contractor radiological specialists known as the Nuclear Emergency Search Team trains, tests equipment for search and detection, and stores equipment for rapid deployment under the auspices of the Nevada Operations Office. It can be mobilized in case of accidents involving radioactive materials or a terrorist threat involving nuclear weapons.

Other Department of Energy Activities . Although the principal activity at NTS is testing nuclear devices, DOE is also involved in a number of other activities. These activities include liquefied gaseous fuels spill testing, solar technology demonstration, radioactive and mixed waste disposal, and the Yucca Mountain characterization programs. NTS has also been designated a DOE National Environmental Research Park.

The Spill Test Facility in Area 5 was completed in 1986. It is operated on a fee basis for commercial users as a basic research tool for studying the dynamics of accidental releases of hazardous materials and to evaluate the effectiveness of various foams and fire retardants in accidents involving chemicals and hazardous materials. Test facility personnel discharge a measured volume of hazardous test fluid at a controlled rate onto a surface specially prepared to meet the test requirements and record close-in and downwind meteorological data and gaseous concentration levels.

NTS is a proposed site for a program sponsored by DOE for a Solar Enterprise Zone. As part of this program, a 100 MWe solar power plant is proposed to be built at NTS. The power from this plant would support Government needs in the area, and the remainder would be sold to the commercial grid. This size plant can be supported with the existing transmission lines at NTS. There is also potential to expand the solar power capability at NTS to approximately 500 MWe in the future; however, this expansion would require substantial infrastructure upgrades including new transmission lines. The first 100 MWe plant is expected to be in place and generating by the 2005 No Action timeframe.

NTS also operates radioactive waste disposal facilities. The Radioactive Waste Management Site, located in Area 5, accepts LLW materials that were generated in the Nation's DP activities. This 37-ha (92-acre) facility consists of trenches and pits for burying LLW and aboveground storage for TRU waste awaiting transfer to the Waste Isolation Pilot Plant (WIPP). Also located at the Area 5 Radioactive Waste Management Site are Greater Confinement Disposal Units, which consist of 3 m (10 ft) in diameter partially cased shafts that are 37 m (120 ft) deep. These units were used for disposing of waste not suited for shallow land burial because of high exposure and potential for migration into biopathways. Management in charge of Greater Confinement Disposal is considering using different disposal configurations (other than boreholes). Nonradioactive hazardous wastes are also accumulated at the Area 5 Radioactive Waste Management Site awaiting shipment to offsite treatment and disposal facilities. In Area 3, the Radioactive Waste Management Site uses surface subsidence craters (that were formed by underground nuclear tests) for the emplacing and burying of LLW in bulk form (such as debris collected from atmospheric nuclear test locations).

The Yucca Mountain Site is located along the western boundary of NTS. It is being considered by DOE for the disposal of spent power-reactor fuel and vitrified HLW, the latter resulting principally from DP activities. The Yucca Mountain Site Characterization Project staff reports directly to DOE's Office of Civilian Radioactive Waste Management; however, because it has elements based on NTS, the Nevada Operations Office provides some administrative and operational support services to the project.

Recently, NTS has been designated as a DOE National Environmental Research Park with a purpose of consolidating previous ecological reports, filling in a significant gap in the existing DOE research park network, and providing a unique opportunity for research in the arid desert environment. This not only enables NTS scientists to link into the existing ParkNet computerized data system, but also makes the extensive accumulation of environmental research collected over the history of NTS available to students and scientists throughout the world. NTS's location in the transition zone between the Southern and Northern Basin and Range Ecological Regions, and its inclusion of vast undisturbed areas of mountain ridges, closed basins, and diverse ecological communities makes it particularly valuable.

Non-Department of Energy Activities. The most significant NTS activity involving non-DOE organizations has been the Defense Nuclear Agency's Nuclear Testing Facility. Congressional legislation (the *Hatfield Amendment*), however, limited nuclear testing to those tests that support the safety and reliability of the U.S. nuclear stockpile. This may preclude further Defense Nuclear Agency nuclear tests, which are done to support research into nuclear weapons effects.

Defense Nuclear Agency nuclear tests occurred in horizontal tunnels mined beneath Rainier Mesa. The nuclear devices for these tests were designed, built, funded, controlled, and executed by the

Office of Defense Programs. The Defense Nuclear Agency's nuclear testing provided the database and design information for both nuclear effects and survivability. Nuclear weapons-effects were studied for all U.S. tactical and strategic weapons systems that were required to operate in a nuclear warfare environment. These tests played a major role in maintaining high confidence in the nuclear stockpile and nuclear-capable weapons systems. The weapons-effects tests were conducted to study a number of nuclear effects including x-ray, gamma-ray, neutron, stress (thermal, electrical, and mechanical), electromagnetic pulse, airblast, ground and water shock propagation, and temperature effects. These tests assessed both weapons effects and the survivability of military systems in a nuclear environment.

Area 25 has been used for a variety of purposes, including U.S. Army ballistic research using depleted uranium and transporter testing for the proposed mobile MX missile. Various military exercises and training activities are also conducted in and around Area 25.

The Desert Research Institute, EPA, the University of Utah, and the Nevada Operations Office operate the Community Radiation Monitoring Program. This program provides the community surrounding NTS with an increased understanding of its activities and the natural radiation environment.

Other activities have been and will likely continue to be carried out for other Federal departments and agencies. Representatives from EPA, the U.S. Geological Survey, and the National Oceanic and Atmospheric Administration are onsite to assist and monitor conditions.

Environmental Regulatory Setting. The State of Nevada has regulatory authority for air, water, solid waste, and hazardous waste. A Memorandum of Understanding between DOE and the state covers required notifications whenever there might be radiological releases from NTS. DOE and the state also signed an Agreement in Principle in October 1990 to provide DOE funding to Nevada for oversight of environmental activities at NTS, including environmental restoration activities. The Agreement in Principle provides the understanding between and commitment of both parties regarding DOE's provision of technical and financial support to the state in return for environmental oversight and monitoring.

The remainder of this section summarizes the status of NTS compliance with the major environmental regulations.

National Environmental Policy Act. The site-wide EIS for NTS and offsite locations in the state of Nevada examines existing and potential impacts to the environment that have resulted, or could result, from current and future DOE operations in southern Nevada. The EIS analyzes the impacts from DOE programs at the following sites: NTS, the Tonopah Test Range, portions of the Nellis Air Force Range Complex, the Central Nevada Test Area, and the Project Shoal Area. These programs include ongoing activities for the stewardship of the national nuclear weapons stockpile, management of radioactive waste, and environmental restoration. Also examined in the EIS are newer programs, such as the proposed Solar Enterprise Zone sites at NTS, Dry Lake Valley, Eldorado Valley, and Coyote Spring Valley.

Comprehensive Environmental Response, Compensation, and Liability Act. NTS has soils contaminated by plutonium and other radioactive materials as a result of past testing operations. EPA is in the process of ranking NTS according to the Hazard Ranking System based on the preliminary assessment/site investigation reports prepared in 1988. Concurrently, the state is negotiating a Federal Facility Agreement with DOE for environmental restoration, including restoration mixed waste. Nevada has taken this action pursuant to the state's corrective actions regulations to negotiate a formal cleanup agreement with DOE rather than waiting for EPA to list NTS on the NPL under provisions of CERCLA. If an agreement between the state and DOE is signed, it is unlikely that EPA will further pursue ranking NTS.

Emergency Planning and Community Right-To-Know Act. The State of Nevada combines the reporting requirements of Section 312, Tier II Report with the information requirements for the Nevada State Fire Marshall Division Uniform Fire Code Materials Report. NTS reports to the State of Nevada information on 28 chemicals in 36 areas which were above the reporting threshold. In addition, the State of Nevada *Chemical Catastrophe Prevention Act* of 1992 requires the registration of highly hazardous substances above predetermined thresholds.

Resource Conservation and Recovery Act. DOE received a permit for the Explosive Ordnance Disposal Unit and the Hazardous Waste Storage Unit in May 1995. RCRA Corrective Action is included in the permit for these two facilities. The Environmental Restoration Program under Corrective Action activities will be the major contributor to the generation of mixed waste.

As provided in the June 23, 1992, Settlement Agreement for Mixed TRU waste, NTS is allowed to continue to operate the Area 5 Radioactive Waste Management Site TRU Waste Storage Pad in accordance with 40 CFR, Part 265, Subpart I. The agreement also requires that DOE submit a report documenting why the current inventory of mixed TRU cannot be removed until WIPP becomes operational and on the progress DOE is making to certify the stored TRU waste to WIPP Waste Acceptance Criteria. In January 1994, a Mutual Consent agreement was established between DOE and the state allowing DOE to use the available storage capacity on the TRU Waste Storage Pad for the storage of onsite generated low-level mixed waste that cannot be disposed because the waste does not meet the RCRA standards of treatment for land disposal. The Mutual Consent Agreement was amended in June 1995 to allow for all mixed waste generated by DOE within the State of Nevada to be stored at the TRU waste storage pad.

NTS is registered as a hazardous waste generator (ID no. NV3890090001) and is routinely inspected by the Nevada Division of Environmental Protection. There were no Findings of Alleged Violation identified from the RCRA Annual Compliance Evaluation conducted at NTS near the end of 1993 because NTS is conducting RCRA operations in compliance and had corrected previous RCRA findings; unresolved findings have been incorporated as part of the enforceable agreements between DOE and the state.

The Federal Facility Compliance Act of 1992. This act is an amendment to RCRA. DOE published the Interim Mixed Waste Inventory Report in April 1993, annual updates, and periodic updates since, describing its inventory of mixed wastes and treatment capabilities. A Site Treatment Plan was issued in October 1995 and its provisions will be incorporated into the Consent Order being negotiated between the state and DOE.

Clean Air Act. There are no criteria pollutant or prevention of significant deterioration monitoring requirements for NTS operations. However, NTS does comply with other requirements established by the CAA, State of Nevada air quality controls, radionuclide monitoring, and air permit compliance. As of December 31, 1993, NTS operations are in full compliance with standards of 40 CFR 61, Subpart H (National Emissions Standards for Emissions of Radionuclides Other than Radon from DOE Facilities). NTS air quality permits limit particulate emissions to 20 percent opacity. Seven permitted equipment/processes, such as weapons event stemming operations, have been identified as routinely exceeding the 20 percent opacity requirement. NTS requested an independent study of fugitive dust emissions from permitted equipment and from surface disturbance operations to identify means of improving NTS air quality emissions. Recommendations were either instituted or equivalent changes were made to improve overall NTS air quality emissions. Chlorofluorocarbon recycling equipment is in place at all NTS service and maintenance centers. Freon is recovered and reused, eliminating ozone-depleting substance emissions into the atmosphere almost completely.

Clean Water Act. Wastewater discharges at NTS facilities are not regulated under NPDES permits because all such discharges are to onsite sewage lagoons. Discharges to these lagoons are permitted under the *Nevada Water Pollution Control Act.* Monitoring and reporting requirements are typically included under local permit requirements. Wastewater monitoring at NTS is required for sampling wastewater influents to sewage lagoons and containment ponds. The sewage lagoons are in compliance and are routinely inspected by State of Nevada personnel. DOE has requested a formal determination by the state concerning the regulatory situation of NTS reference stormwater requirements based on both Standard Industrial Code usage and whether waters of the United States exist on NTS. The Nevada Division of Environmental Protection must determine if requirements under Federal stormwater discharge regulations are relevant to NTS. This determination is still pending.

Safe Drinking Water Act. Compliance with this act primarily addresses the quality of potable water supplies at NTS as determined through the sampling and monitoring requirements for drinking water systems. The State of Nevada has enacted and enforces SDWA regulations and also regulates daily system operations. DOE developed an operations and maintenance plan to address standard operating procedures for water system operations at NTS. The State of Nevada classifies NTS water system as requiring a Grade II Water System Operator Certification. NTS provides such a certified operator. To meet requirements under the state health regulations, potable water distribution systems at NTS are monitored for residual chlorine content, coliform bacteria, VOCs, inorganic compounds, and other water quality standards. Drinking water systems are in compliance with standards.

Toxic Substances Control Act. State of Nevada regulations that implement this act require submission of an annual report which describes the quantity and status of PCBs and PCB-contaminated equipments as well as shipments of PCBs and PCB-contaminated items from NTS to an EPA-approved disposal facility. NTS is managing PCBs, asbestos, and chemicals in compliance with applicable regulations.

Federal Insecticide, Fungicide, and Rodenticide Act. Pesticide usage includes insecticides, herbicides, and rodenticides. Records are maintained on all pesticides used for at least 3 years. All applicators are provided the opportunity to receive state-sponsored training materials.

North Las Vegas Facility. This is a 32-ha (80-acre) site within the Las Vegas urban area. The site is positioned along Losee Road which runs parallel to and is a short distance west of Interstate 15. It is a quarter mi (0.4 km) north of Carey Avenue and 1 mi (1.6 km) south of Cheyenne Avenue in the city of North Las Vegas. It is bordered on the north, south, and east by general industrial zoning. The western border is adjacent to Commerce Street, which separates the site from fully developed single-family residential zoned property. Electrical power is supplied to the site by the Nevada Power Company, and natural gas is supplied by Southwest Gas Corporation. The city of North Las Vegas supplies the water and sanitary sewer services. The site consists of office and warehouse buildings with one large high bay and a tower as well as a large paved area for trailers. Mechanical and technical support functions associated with the underground test program were performed at this site. LLNL, LANL, and SNL used the North Las Vegas Facility (NLVF) to prepare, assemble, and test the instrumentation rack and canister assembly prior to deployment to NTS for testing operations.

NLVF, although considered an adjunct to NTS, must independently comply with many of the basic environmental requirements just as NTS does. DOE operations at NLVF have environmental requirements similar to the requirements of other 32-ha (80-acre) sites in the city of North Las Vegas.

A.2 Stockpile Stewardship Project Descriptions

The stockpile stewardship projects considered in this PEIS are the proposed NIF, the proposed CFF, and the proposed Atlas Facility. Detailed project-specific analyses of these alternatives are contained in Appendix I, Appendix J, and Appendix K, respectively.

A.3 Stockpile Management Project Descriptions

A.3.1 Weapons Assembly/Disassembly

Weapons A/D is a key element of the DOE stockpile management responsibility. This function provides the capability to: dismantle retired weapons; assemble HE, nuclear components, and nonnuclear components into nuclear weapons; repair and modify weapons; perform weapons surveillance; and store strategic reserves of nuclear components (pits and secondaries).

Weapons A/D consists of five main functions:

- Weapon assembly
- Weapon disassembly
- Joint test assembly and post-mortem
- Test bed A/D
- Storage of plutonium and HEU strategic reserves

The functions, as described in the following subsections, would vary between weapon programs. The plant must have the capability to vary production operations and quality assurance tests to meet the special needs of each program.

Weapons contain special nuclear material. Operations involving special nuclear material must be conducted within a critical assembly area. Weapons, joint test assemblies, and test beds contain HE and explosive detonators; therefore, operations involving these must be conducted in facilities designed for explosives operations.

Weapon Assembly. Weapon assembly is performed to produce a new weapon, to rebuild a weapon that has been disassembled for surveillance, or for modification or replacement of components. The assembly steps for a rebuild are the same as for a new build, except that the starting point varies, depending on the extent of disassembly.

Weapon assembly requires approximately 2,000 steps to combine hundreds of parts and subassemblies to form a weapon. The process is labor-intensive and includes many verification and quality control steps. Prior to the start of the assembly process, several bays would be configured with special tooling required for the specific weapons operations. As the assembly progresses, partially assembled weapons may be moved in series from bay to bay. At several points during assembly, the weapon would be moved from assembly bays to special purpose bays. These special purpose bays would be permanently configured with nonprogram specific equipment for performing verification or inspection operations, such as radiography inspection, leak testing, and mass properties determination.

Complete weapon assembly would be accomplished in three stages: physics package (also known as nuclear explosive package) assembly, mechanical weapon assembly, and ultimate user package assembly. The weapon assembly function is shown in figure A.3.1-1, and each stage is described below. Weapon parts would be unpackaged, cleaned, verified and, in some cases, tested prior to assembly.

Physics package assembly entails bonding or mating the main charge subassemblies to a nuclear pit and then enclosing this subassembly in a case along with other components. Prior to assembly, gamma spectrometry would be used to verify the authenticity of the nuclear components. The pit would also be leak-tested and weighed. After the physics package is cased, tests would be performed to ensure electrical continuity, and a radiographic inspection would be conducted to ensure that the internal subassemblies are correctly aligned.

When the main charge is made from conventional HE, the physics package assembly must be conducted in a specialized structure called an assembly cell. An assembly cell is designed to minimize the release of radioactive material in the event that the conventional HE detonates. After the physics package is cased, the potential for detonation is greatly reduced, and the physics package may be moved to an assembly bay. The physics package for a weapon using an insensitive HE main charge can be assembled in a bay. The completed physics package then continues to mechanical weapon assembly.

Mechanical weapon assembly entails placing the physics package in a warhead case and installing components for the arming, fuzing, and firing systems; the neutron generator; and the gas transfer system. At prescribed points during the assembly process, electrical testing and gas transfer system pressure testing would be conducted to verify proper installation. The completed mechanical package would be leak-tested, backfilled with a specified gas atmosphere, inspected with radiography, and subjected to mass properties testing. Leak-testing would ensure that the weapon case is properly sealed. Radiographic inspection would be used for verification of the weapon system. Mass properties testing measures the center of gravity and moments and products of inertia to ensure proper flying characteristics. The final stage of the mechanical weapon assembly is the user package assembly.

Ultimate user package assembly involves installing some additional components and packaging the weapon for shipment. This operation varies, depending on whether the mechanical assembly is used in a bomb or a warhead. For bombs, components such as the tail, nose, and/or preflight sections would be added. Tail and preflight sections would be preassembled prior to installation. The completed bomb would be loaded onto a trailer (roadable) for shipment. Warheads may have a separation subassembly installed and the completed warheads would be loaded into containers for shipment. The ultimate user assembly would be moved to the weapon staging area for shipment to DOD via safe secure trailer.

Weapon Disassembly. Weapon disassembly is performed to dismantle, modify, or evaluate a weapon. The operations conducted for each type of disassembly are similar, but the extent of the disassembly and procedures vary.

Dismantlement Disassembly . The weapon would be disassembled down to subassemblies and components that are suitable to be shipped to the originators, that facilitate recertification of usable parts, or that facilitate sanitization and demilitarization of unusable parts.

Modification (Retrofit) Disassembly. A weapon requiring modification would be disassembled to the extent necessary to gain access to the components requiring replacement. The disassembly procedures are intended to maximize reuse of parts.

Stockpile Evaluation Disassembly . The evaluations and tests required would be defined by the design laboratories. The extent of disassembly depends on which components require testing. Procedures include additional testing, and typically call for removing components in connected groups to facilitate further testing in test beds or joint test assemblies.

The weapon disassembly process is similar to the reverse of the assembly process and would be accomplished in three stages: ultimate user package disassembly, mechanical weapon disassembly, and physics package disassembly. Many of the facilities used for various disassembly and testing operations are the same facilities used for weapon assembly. The weapon disassembly function is shown in figure A.3.1-2, and each stage is described below.

Ultimate user package disassembly begins by performing a series of verification steps to ensure that the weapon is in a safe condition and that internal components are intact. The steps include tritium monitoring, electrical safing system test, gamma spectrometry safeguards verification, and a radiographic safing system verification. Bombs would be removed from trailers, and mechanical assemblies would be separated from the tail and nose sections. Warheads would be removed from ultimate user containers and then mechanical assemblies would be separated, as required, from separation subassemblies.

Mechanical weapon disassembly also begins with a series of tests. These tests include an internal atmosphere test check, a radiographic inspection, and a tritium pressure leak test. Evaluation of disassemblies may also require vacuum chamber leak test and mass property testing. The mechanical weapon disassembly entails removing the components for arming, fuzing, and firing systems; neutron generators; the gas transfer system; and the outer weapon case. The remaining physics package is further disassembled. The physics package may require a radiographic inspection for an evaluation disassembly.

Physics package disassembly would be accomplished by opening the case, removing the HE/pit subassembly and other components, and then separating the HE main charge from the nuclear pit. As described for weapon assembly, the physics package disassembly must be performed in a cell if the main charge is conventional HE.

The balance of the weapon disassembly function involves processing various weapons parts. These parts may be disassembled further on site or left intact. Parts may be recertified and staged for reassembly, shipped to the originating site for evaluation or disposition, or processed as residual material in the waste management process. Selected components may be assembled in a test bed or the bulk of the components may be used in a joint test assembly.

Joint Test Assembly and Post Mortem. As part of the ongoing stockpile evaluation program, weapons are randomly selected from the stockpile or new production inventory for conversion to joint test assemblies. A joint test assembly is a nuclear explosive-like assembly (mock weapon) that will be test flown by DOD. A joint test assembly generally contains most of the original weapon parts, except for the nuclear components and main charge subassemblies. A joint test assembly also contains telemetry components to monitor joint test assembly performance during flight, mock materials to simulate the size and weight of missing components, and witness plates to verify that energetic actuators performed as expected.

A process flow diagram of the joint test assembly support function is shown in figure A.3.1-3. Assembly of a joint test assembly is similar to weapon assembly, but some components are different. The physics package equivalent for a joint test assembly is called joint test subassembly. A high degree of quality control is required due to the high cost of the complex test.

After the flight test, joint test assemblies for bomb programs are generally recovered and returned for post-mortem disassembly and evaluation. Joint test assemblies for warhead programs are recovered if possible and returned for evaluation. The parts obtained from disassembly are processed for disposal. The procedures for joint test assembly are similar to those for a weapon disassembly, except that additional measures are taken to contain residues produced by the energetic actuators. The parts obtained from disassembly may be recertified and staged for reassembly, shipped to the originating site for evaluation or disposition, or processed in the waste management facility.

Joint test A/D operations, as well as the special evaluations such as radiography gamma spectrometry and leak-testing required for joint test assemblies, are performed in the same bays and special purpose bays used to conduct weapon assembly and disassembly operations.

Test Bed for Assembly and Disassembly. A test bed is an apparatus used for bench testing weapon systems, subsystems, and components. It is composed of parts removed from a weapon in evaluation disassembly and an explosive box. The explosive box contains the blast and fragments from the small explosive charges which detonate as the weapons systems are tested. The weapon parts are generally from the arming, fuzing, and firing systems and include antennas, radio frequency lines, radar, programmers, fire sets, detonator cables, and permissive action links. Prior to testing, some test beds are exposed to temperature extremes in environmental conditioning ovens. The testing is conducted at fully instrumentated test stations that can simulate deployment temperatures.

The test bed support function is shown in figure A.3.1-4 and is described below. Test bed assembly entails constructing the explosive box and parent part assembly and mounting these items on the test fixture. The explosive box is manufactured by enclosing explosive or electro-explosive components in an explosive barricade containing a fill material to damp the detonations. The explosive box may also contain a fiber optic sensing system to monitor the actuation timing. The parent parts assembly is composed of the removed weapon parts. The explosive box may also contain parent parts.

Optional Storage of Plutonium and Highly Enriched Uranium Strategic Reserves. Storage of the plutonium strategic reserve could occur at the weapons A/D Facility (as shown in figure A.3.1-5). If Y-12 is selected as the site for the secondary fabrication mission, HEU strategic reserve storage would remain at ORR. If Y-12 is not selected, then the HEU strategic reserve could also be stored at the weapons A/D Facility. The strategic storage of plutonium and HEU provides cased pits and canned subassemblies for replacement in the enduring stockpile and for use as feedstock for nuclear fabrication. The quantities associated with the storage are identified in classified documents. If the responsibility for strategic storage is transferred to the Office of Materials Disposition, then consolidated storage could be at one of five sites being considered in the Storage and Disposition PEIS.

The weapons A/D process constructs a weapon from approximately 200 parts and subassemblies. Assembly feeds include main charge subassemblies from the HE fabrication plant, special nuclear material components, weapon parts and subassemblies, electrical components, and hardware. A joint test assembly has approximately the same number of parts as a weapon. Feeds include most of the weapon parts removed from an evaluation weapon disassembly, telemetry components, mock HE and special nuclear material components, and witness plates. Test bed feeds include selected weapon parts removed from an evaluation disassembly, small explosive parts, the explosive box, the test fixture, electrical components, and hardware. The feeds for disassembly operations include nuclear weapons, joint test assemblies, and test beds.

A.3.1.1 Downsize at Pantex Plant

Pantex is the existing A/D site for the U.S. nuclear weapons stockpile. To efficiently meet the workload established by DOE for fiscal year 2004 and beyond, operations would be consolidated into the facilities that exist at Pantex. No new facility construction is required to accomplish the consolidation of the A/D mission. Changes would only be required to allow the relocation and modification of some functions into the newer facilities and the upgrade of some infrastructure systems.

The five main functions for A/D operations discussed in section A.3.1 would be downsized and consolidated at Pantex. The site plans for the consolidated A/D operations at Pantex are shown in figures A.3.1.1-1 and A.3.1.1-2. The drawings depict the arrangement of plant buildings and site support areas for Pantex. Four types of security access areas exist at Pantex: material access area, protected area, limited area, and property protection area. Operations involving special nuclear material must be performed within a material access area. The material access area and some facilities supporting material access area operations are located in the protected area. The protected area is secured with a double fence and intruder detection systems. The protected area and operations involving classified materials and information are contained within a limited area. The property protection area surrounds the limited area and includes a buffer zone. Weapons A/D operations are performed within the material access area within Zone 12.

The downsizing and consolidation of A/D operations would enable Pantex to utilize existing structures. Consideration has been given to optimizing operations, as well as maximizing the use of facilities, in the downsizing analysis. No new construction would be required at Pantex to accomplish the reduced weapons A/D mission. Pantex has 59 A/D bays, of which only 31 bays are required to meet the A/D workload. Therefore, functions that reside in older facilities (not economically or technically feasible to upgrade) would be relocated to modern, heavy-type construction facilities.

All facilities at Pantex were built in compliance with design codes and standards in effect at the time of design and construction. At the time of any major modification, facilities were upgraded commensurate with codes and standards at the time of the modification. Where applicable, facilities were built to specific regional design criteria.

Structures containing explosives are generally constructed with steel-reinforced concrete and are designed to mitigate the effects of an accidental explosion. The resulting facility design typically consists of a number of separate operating bays that could vent to an unoccupied area should a detonation occur. Structures that do not require concrete construction due to the presence of special nuclear materials or HE are generally constructed of steel, although portions of these buildings may be concrete. Most facilities include support areas for offices; break rooms; rest rooms; electrical heating, ventilation, and air conditioning equipment; maintenance; and in-process staging of materials, components, tooling, and supplies. Many production and laboratory facilities also include vacuum systems.

Key facilities required to meet the mission of the A/D downsized and consolidated operations are listed in table A.3.1.1-1. A brief description of key facilities follows.

Assembly Bays. Assembly bays are used to manually assemble or disassemble nuclear weapons. Weapon assembly requires approximately 2,000 steps to combine hundreds of parts and subassemblies to form a weapon. The process is labor-intensive and includes many verification and quality control steps. Prior to assembly, several bays are configured with special tooling required for assembly of a specific weapon. As assembly progresses, partially assembled weapons move in series from bay to bay. The physics package for a weapons program using a conventional HE main charge must be assembled in an assembly cell. The weapon disassembly process is conceptually the reverse of the assembly process, although tooling used and testing required will vary. High fidelity joint test assemblies (those containing explosives and/or special nuclear material) are also assembled and disassembled in bays.

Pantex has several A/D bay facilities; however, only 31 bays in Buildings 12-084, 12-099, and 12-104 are required. Each bay includes an area to perform assembly operations, staging areas for tooling and weapon parts, and a mechanical room for heating, ventilation, and air conditioning equipment and controls.

Assembly Cells. Assembly cells are designed to support the manual assembly or disassembly of a physics package for weapon programs using a conventional HE main charge. Physics package assembly involves mating explosive and nuclear components and sealing these components in a metal case. Assembly cells are designed to mitigate the release of radioactive material in the event that conventional HE detonates. After the physics package is cased, the potential for a detonation is greatly reduced and the physics package may be moved to an assembly bay. Assembly in a cell is not required for a physics package using an insensitive HE main charge.

Each cell includes an area to perform assembly operations; staging areas for special nuclear material, tooling, and weapon parts; and a mechanical room for heating, ventilation, and air conditioning equipment and controls. Prior to the start of the assembly process, an assembly cell is configured with special tooling to facilitate the assembly or disassembly of a specific weapon program. Pantex has 13 assembly cells; however, only 4 of the assembly cells (three in Building 12-098 and the 12-96 cell) are required.

Special Purpose Bays. Special purpose bays are similar to assembly bays, but special purpose bays are permanently configured with special equipment to perform general testing or assembly operations. As with assembly bays, special purpose bays are grouped and share some common support areas. The functions performed in these bays are described in the following sections.

Test Bed Assembly/Disassembly. Test beds and training units are assembled and disassembled in part of Building 12-086. Training units are nuclear-explosive-like assemblies that are used for training Pantex and DOE personnel to build, repair, maintain, and handle nuclear weapons. The facility contains a number of universal assembly bays which are configured with program-specific tooling. No modifications are required in this facility to support test bed functions.

Nondestructive Evaluation. Linear accelerator, computed tomography, and x-ray radiography are performed in part of Building 12-104A. These functions are used to inspect components, assemblies, and complete weapons to confirm proper configuration. Ultrasonic testing detects voids in the material used to bond close fitting parts. Acoustic emissions testing detects flaws in material. Radiometric inspection identifies the types of encased radioactive materials. No modifications are required in this facility to support the downsizing of Pantex.

Table A.3.1.1-1.-- Pantex Plant Downsized and Consolidated Weapons Assembly/ Disassembly Facility Data

Building Number	Description	Type of Construction	Gross Area (m ^{2})	Footprint Area (m ^{2})	Security Access Area	Number of Levels	Special Material
12-008	Commercially procured weapon material	Steel	56	56	Limited area	1	None

12-042	Tester and tooling storage	Steel	4,404	4,404	Material access area	1	None
12-042 A/B/C/ D/F	Weapons evaluation testing	Steel/concrete	2,044	2,044	Material access area	1	HE
12-053/E	Metrology lab	Concrete	474	474	Material access area	1	None
12-058	HE component staging	Concrete	242	242	Material access area	1	HE
12-059/E	Commercially procured weapon material/ chemical lab	Steel	771	771	Limited area	1	None
12-061	Component warehouse	Steel	2,230	2,230	Material access area	1	None
12-079	Component warehouse	Steel	2,666	2,666	Material access area		None
12-082	Special nuclear material container refurbishment/ component tech acceptance	Concrete	632	632	Material access area	1	None

12-084	17 assembly/ disassembly bays, 1 pit laser bay, 1 nondestructive evaluation environmental bay, metallurgical evaluation	Concrete	10,675	10,675	Material access area	1	HE/ special nuclear material
12-086	Test bed assembly, electronic testing, gas lab, metrology lab	Concrete	4,479	3,627	Material access area	2	HE
12-092	Component packaging	Steel	88	88	Material access area	1	HE
12-095	Explosives Class C staging	Concrete	244	244	Material access area	1	HE
12-096	1 assembly/ disassembly cell	Concrete	731	731	Material access area	1	HE/ special nuclear material
12-098/E	3 assembly/ disassembly bays, passive action link code activated process	Concrete	3,192	3,192	Material access area	1	HE/ special nuclear material
12-099	3 assembly/ disassembly bays, weapon staging	Concrete	5,639	5,639	Material access area	1	HE/ special nuclear material
12-104	11 assembly/ disassembly bays	Concrete	7,917	7,917	Material access area	1	HE/ special nuclear material

12-104A	Paint, mass properties, separations testing, accelerated aging, 2 staging bays, 1 vacuum chamber and purge backfill bay, 1 x-ray bay, 1 computed tomography, 1 linear accelerator bay	Concrete	6,503	6,503	Material access area	1	HE/ special nuclear material
12-104P	Generator buildings	Steel	NA	NA	Material access area	1	None
12-116	Special nuclear material component staging, AT-400A processing	Concrete	4,274	4,274	Material access area	1	Special nuclear material
12-117	Special nuclear material loading dock	Steel	576	576	Material access area	1	None
Total			63,233				

Note: NA - not applicable.

Source: PX MH 1995a.

Environmental/Physical Properties Testing. A portion of Building 12-084 is used to perform nondestructive testing of weapon components. Weapon components are subjected to mechanical and thermal shock to simulate deployment conditions. Mechanical conditioning tests include vibration, hostile shock, mini-air gun shock, and steady-state acceleration shock. Environmental chambers are used to simulate temperature extremes and thermal shock conditions. Equipment would be relocated from other areas of the plant into Building 12-084 to support this function.

Leak Detection and Backfill.

Leak rate tests are performed in one bay of Building 12-104A with vacuum chambers (or fixtures) on all outgoing nuclear weapons and on units returned from the field to ensure that the weapon case is properly sealed and correct internal atmosphere is maintained. Backfill involves filling the inside of the weapon case with a specific gas. This operation is performed following completion of a leak rate test and an evacuation step. No modifications are required in this facility to support the downsizing of Pantex.

Mass Properties Determination. Mass properties are critical for ensuring proper flight characteristics of a weapon. Products of inertia and lateral center of gravity are determined with remotely operated dynamic balancing machines. Center of gravity and moments of inertia are determined with a special machine. Modifications are required in one bay of Building 12-104A to allow existing equipment to be relocated to support this function.

Painting and Body Work. Weapons and weapon components, joint test assemblies, containers, and trailers are painted, repainted, or touched-up in a portion of Building 12-104A. Old paint is removed with sandblasting or chemical stripping. Minor dents in nonweapon components are straightened. No modifications are required to support this function.

Accelerated Aging. Accelerated environmental aging is conducted to simulate the aging process on newly produced weapons and weapon components in a portion of Building 12-104A. For these tests, weapons or materials are placed in an environmental chamber and subjected to thermal cycling above and below ambient temperatures for an extended period, typically from 1 to 2 years. Gas samples are taken from the weapon and analyzed in the gas laboratory. The accelerated aging chamber consumes a significant amount of electrical power. After aging, weapons are disassembled and evaluated. No facility modifications are required to support this function.

Separations Systems Testing. Selected reentry body separation subassemblies are tested in a portion of Building 12-104A to provide data for evaluating release assembly hardware and associated installation procedures and for measuring service-related deterioration of the release assembly system. Facility modifications are required to allow the existing equipment to be relocated and operate in this area.

Special Nuclear Material Container Refurbishment. Containers used to ship radioactive components are reverified annually in a portion of Building 12-082. The structural integrity of containers is verified through leak tests, visual inspection, and maintenance. No modifications are required in Building 12-082 to support this function.

Pit Laser Sampling . A gas sample is taken for selected weapon system pits to determine the internal atmosphere type, percentage, and pressure. Pit laser sampling occurs in a bay in Building 12-084. No modifications are required in this facility.

AT-400A Processing. Pits are robotically packaged into the AT-400A, a hermetically sealed container. The AT-400A container meets requirements for long-term storage and shipping of pit items. This activity would occur in a portion of Building 12-116. The AT-400A robotics processing equipment and required modifications to Building 12-116 to accept this activity are included in the Pantex No Action alternative.

Component Packaging . Packaging of selected reaccepted weapon components occurs in Building 12-092, a special access area. No modifications are required in this facility.

Component Technical Acceptance . Components are reaccepted for assembly using a variety of inspection/verification techniques. This activity will occur in Building 12-082. No modifications are required to support this function.

Weapons Evaluation Testing Laboratory. Weapon system, subsystem, and component tests are conducted in Building 12-042 A/B/C/D/F by SNL personnel. Numerous fully instrumentated test stations are provided for heating, cooling, and test firing the tests beds. A cryogenic carbon dioxide system is used for cooling these units during testing. Environmental conditioning ovens and centrifuges are also provided for testing components under deployment conditions. No modifications are required in this facility.

Metrology Laboratory. Buildings 12-086 and 12-053 are used for metrology functions within the material access area. Instruments and testers for weapon assembly operations are calibrated here. Some areas within these facilities require tight heating, ventilation, and air conditioning temperature control to + 0.3 *o* C (+ 0.5 *o* F). Modifications are required in Building 12-086 to allow existing equipment to be relocated.

Gas Laboratory. Gas analyses are performed in Building 12-086 and are used to evaluate samples from accelerated aging tests and production operations. Information from these analyses provides data related to the internal atmosphere of weapons and effects of weapon material aging by measuring outgassing products. The three basic techniques used are gas fractionation, gas chromatography, and mass spectrometry. Facility modifications are required for this function which would relocate existing equipment into Building 12-086.

Weapon Material Testing Laboratory. A laboratory for testing and accepting commercially procured weapon material is located in Buildings 12-008 and 12-059. No modifications are required for these facilities.

Tooling/Tester Storage. Precision tools, instruments, testers, and special equipment for A/D operations are stored in Building 12-042. Generic assembly bays and cells are configured with program-specific tooling at the beginning of a production run. Tooling storage would contain tools for assembly, disassembly, and evaluation operations for all the weapon programs in the enduring stockpile. This function would be relocated from another facility into Building 12-042.

Weapon Staging. A portion of Building 12-099 is used for staging nuclear weapons awaiting transportation to and from DOD facilities. No facility modifications are required to accommodate weapons staging.

Special Nuclear Material Component Staging. The special nuclear material staging facilities, Buildings 12-116 and a loading area 12-117, are designed to ship, receive, and stage special nuclear material. The facilities include segregated staging bays and inspection equipment.

Inert Component/Container Warehouses . Buildings 12-058, 12-061, 12-079, and 12-095 are used for storing, repackaging, and distributing inert weapon components, materials, and containers for Pantex. HE components to support A/D are staged in Building 12-058. Weapons and special nuclear material are staged in other buildings. These facilities include storage racks, a loading dock, and areas designed for packaging and unpackaging and shipping and receiving. No modifications are required in these facilities.

Strategic Reserves Storage . The plutonium and HEU strategic reserves would be stored in Area 12.

Requirements for Construction and Operation. Downsizing and consolidating A/D operations at Pantex would require approximately 0.2 ha (0.4 acres) of land for construction material laydown. There would be no associated disturbed land area involved with downsizing of operations at Pantex. Materials and resources consumed during the 3-year construction period are listed in table A.3.1.1-2. The principal source of air emissions during construction would be fugitive dust from site preparation and construction activities and exhaust from construction equipment and vehicles. Annual emissions during a peak construction year are presented in table A.3.1.1-3.

The number of workers required during each construction year is presented in table A.3.1.1-4.

The weapon A/D process requires the following utilities: electricity, plant air for operating pneumatic tools and hoists, instrument air for radiation monitors, steam for heating test beds in environmental conditioning ovens, cryogenic carbon dioxide for cooling test bed test stations, and water for operating vacuum pumps. Utilities consumed during surge operation can be found in table A.3.1.1-5.

Table A.3.1.1-2.--Pantex Plant Downsizing and Consolidating Weapons Assembly/ Disassembly Construction Materials/Resources

Material/Resource	Total Consumption	Peak Demand [1]
Electricity	609 MWh	4 MWe

Water (L)	1,400,000	
Concrete (m^3)	840	
Steel (t)	15	
Liquid fuel and lube oil (L)	28,800	
Industrial gases (m^3) [2]	600	

Table A.3.1.1-3.-- Pantex Plant Downsizing and Consolidating Weapons Assembly/ Disassembly Construction Emissions

Pollutant	**Quantity (t)**
Sulfur dioxide	0.04
Nitrogen oxides	0.46
Volatile organic compounds	0.23
Carbon monoxide	1.26
Particulate matter	0.19
Total suspended particulates	0.46
PX MH 1995a.	

Chemicals consumed during operation primarily include water treatment chemicals, materials for facility equipment and vehicle maintenance, and bottled gases. Annual estimated chemical use during surge operations is listed in table A.3.1.1-6.

Emissions. Emissions result from plant boiler operation and cleaning operations that use solvents. Releases would be limited to what is possible, using best available control technology. Emissions for the downsizing and consolidating alternative A/D surge operations are shown in table A.3.1.1-7.

Radiological release for A/D operations are limited to uranium isotopes and tritium. These releases are the result of assembly and disassembly operations, as well as waste operations. Extremely small releases of plutonium (near background) are possible.

Table A.3.1.1-4.-- Pantex Plant Downsizing and Consolidating Weapons Assembly/ Disassembly Construction Workers

Employees	Year 1	Year 2	Year 3	Total
Craftworkers				
Carpenter	1	7	2	10
Concrete mason	1	5	1	7
Electrician	0	6	5	11
Iron worker	1	8	1	10
Laborer	2	6	2	10

Millwright	0	2	1	3
Operator	0	3	1	4
Sheet metal worker	0	7	2	9
Pipe fitter	0	5	3	8
Sprinkler fitter	0	5	1	6
Teamster	1	3	1	5
Other craftworkers	0	4	3	7
Total Craftworkers	6	61	23	90
Construction management and support staff	1	6	2	9
Total Employment	7	67	25	99
PX MH 1995a.				

Table A.3.1.1-5.-- Pantex Plant Downsizing and Consolidating Weapons Assembly/ Disassembly Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand
Electricity	43,000 MWh	10 MWe
Liquid fuel (L)	740,000	
Natural gas (m^3)	7,150,000	
Water (L)	196,000,000	
PX MH 1995a.		

Table A.3.1.1-6.-- Pantex Plant Downsizing and Consolidating Weapons Assembly/ Disassembly Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)
Acetone	227
Argon	8,165

Carbon dioxide	49,896
Circlene FG 20	635
Clepox 143	635
Degreaser	680
Desiccants	454
Dispersant	290
Dry air	771
Eco-Star	2,858
Ethyl acetate	544
Ethyl alcohol	227

Fixer and replenisher	1,497
Glass beads	408
Glass cleaner	1,452
Helium	1,769
Heptane	318
Hydraulic/lubricating oil	29,030
Inorganic proprietary	2,722
Joint compound	1,179
Micro liquid lab cleaner	363
Mild steel metal	5,897

Molecular sieve	1,043
Neutrasorb acid neutralizer	272
Nitrogen	3,629
Paint	16,330
Planisol-M concentrate	363
Polyalkylene and ethylene glycol	240
Potassium hydroxide	408
Siliconized ammonium phosphate base	590
Sodium chloride	34,020
Solksorb solvent absorbent	1,769

Specialty gas mixtures	1,542
Stainless steel metal	2,268
Sulfuric acid	363
TISAB with CDTA	862
Water treatment chemicals 3	11,340

Table A.3.1.1-7.-- Pantex Plant Downsizing and Consolidating Weapons Assembly/ Disassembly Surge Operation Annual Emissions

Pollutant	Quantity (t)
Ammonia	<0.001
Carbon monoxide	5.4
1,2-Dichloroethane	<0.001

Nitrogen oxides	21.3
Particulate matter	0.8
Sulfur dioxide	<0.001
1,1,1-Trichloroethane	0.44
2,2,4-Trimethyl-1,3-Pentane diolbutyrate	<0.001
Volatile organic compounds	11.3
PX MH 1995a; PX 1996e:1.	

Weapons Assembly Transportation. As illustrated in figure A.3.1.1-3, the two major types of radiological hazardous materials that would be transported to Pantex include special nuclear material components and HE components. Special nuclear material would be shipped in safe secure trailers. Upon arrival at the site, a safe secure trailer would proceed directly to the weapon staging facility. Movement of explosive components would be performed by trucks and battery-powered vehicles specifically designed for this purpose. The quantity of HE (conventional and insensitive) transported onsite by these trucks would be strictly limited.

All major weapon assembly work would be performed in assembly bays and cells. Special nuclear material would be transferred from staging areas by battery-powered vehicles travelling on ramps. After final assembly and inspection, weapons would be transferred to the weapon staging facility on ramps. Weapons would then be shipped offsite by safe secure trailer.

Small quantities of low-level, mixed, and hazardous wastes generated during assembly of nuclear weapons would be collected, packaged, and transported by electric car to local accumulation sites and then by truck to a low-level staging area near the waste management facility. The wastes would be transferred by truck for offsite disposal.

Weapons Disassembly Transportation. As illustrated in figure A.3.1.1-4, returning weapons would be delivered in safe secure trailers. After a security inspection, weapons would be unloaded and temporarily stored in the same weapons staging area used for outgoing assembled weapons. Individual weapons would be transported to an assembly bay or cell by a battery-powered vehicle travelling on a ramp. After disassembly, the various special nuclear material components would be transported by battery-powered vehicles to staging areas for subsequent shipment offsite. HE components would be transported by electric vehicle to the HE staging area for subsequent transportation to the HE fabrication plant. Waste would be collected, transported, and disposed of in a manner similar to that described for weapons assembly.

Waste Management. Pantex waste management is described in detail in appendix section H.2.4. The liquid and solid nonhazardous wastes generated over a 3-year period would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Wastewater would be used for soil compaction and dust control or processed through the Pantex sanitary wastewater system. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in Department of Transportation (DOT)-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

Table A.3.1.1-8.-- Pantex Plant Weapons Assembly/Disassembly Waste Volumes

Category	Annual Average Volume Generated from Construction (m 3)	Annual Volume Generated from Surge Operations (m 3)	Annual Volume Effluent from Surge Operations (m 3)
Low-Level			
Liquid	None	0.06	None

Solid	None	21 4	10 5
Mixed Low-Level			
Liquid	None	0.06	0.06
Solid	None	Minimal	Minimal
Hazardous			
Liquid	None	2	2
Solid	0.25	0.05	0.05
Nonhazardous (Sanitary)			
Liquid	315	141,000	141,000
Solid	5 6	340	170 7
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary

The project design incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous or mixed waste. Production processes would be configured, with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.1.1-8 presents the estimated annual waste volumes from the A/D and pit recertification, requalification, and reuse facility during construction and surge operations. Solid and liquid waste streams are routed to the waste management system. Figure A.3.1.1-5 depicts the waste management system. Solid wastes would be characterized and segregated into LLW, hazardous, and mixed wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous and toxic elements before discharge or transport. All fire-sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Low-Level Waste. LLW generated from the recertification, requalification, and reuse operations would consist of tubes removed from the pits, personnel protective equipment, glove box gloves, filters, cleaning materials, and disposal supplies. Small amounts of LLW would be generated by A/D operations and would consist primarily of sanitized and demilitarized weapon parts, test residue, compacted wipes, rubber gloves, and vacuum filters. Compactible LLW would be processed at the solid waste compaction facility. Compactible and noncompactible waste would then be shipped to NTS or a commercial vendor for disposal. Liquid LLW, consisting of solvents used in cleaning operations, would be solidified prior to packaging.

Mixed Low-Level Waste. Pit recertification, requalification, and reuse operations would not generate any mixed LLW. Small amounts of mixed LLW would be generated from operation of the A/D facility and would consist primarily of sanitized and demilitarized weapons parts, test residue, compacted wipes, rubber gloves, and vacuum filters. Mixed waste would be stored onsite in RCRA-permitted facilities and shipped to an offsite commercial facility for processing. Liquid mixed waste would be managed in accordance with the Pantex Site Treatment Plan.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations, as well as sanitized and demilitarized parts. The cleaning solvents selected would be from a list of nonhalogenated solvents. Hazardous liquids would be sent to one of three onsite wastewater treatment facilities. The treated nonhazardous effluent would be discharged in accordance with NPDES permits. Hazardous effluents would be packaged and shipped offsite to a RCRA-permitted treatment, storage, and disposal facility.

Solid hazardous wastes would be generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. All HE and HE-contaminated substances would be returned to the HE fabrication site. All hazardous solid waste would be shipped to a RCRA-permitted facility for disposal.

Nonhazardous (Sanitary) Waste. Sewage wastewater and process wastewater would be treated in the sanitary wastewater treatment facility. Most of the treated effluent would be recycled for use in the cooling tower and other processes. Excess effluent would flow into a lagoon which then either evaporates or leaches into the ground. The sludge and other nonrecyclable, nonhazardous solid sanitary and industrial wastes would be compacted and shipped to the city of Amarillo landfill for disposal.

Nonhazardous (Other) Waste. Small amounts of classified nonhazardous waste would be generated from operation of the A/D facility. This waste would be demilitarized and sanitized before disposal in a permitted landfill.

A.3.1.2 Relocate to Nevada Test Site

All functions described in section A.3.1 would be relocated to NTS in this alternative. Figure A.3.1.2-1 shows the location of NTS facilities. The proposed A/D plant site plan is shown in figures A.3.1.2-2 and A.3.1.2-3. The size, number, and arrangement of the plant building and support areas are conceptual and may change significantly as design progresses. The site plans are included to convey general layout information only.

The existing Device Assembly Facility would form the cornerstone of the A/D plant. All plant facilities located within the material access area either occupy existing buildings inside the Device Assembly Facility or are located in hardened new construction connected to the Device Assembly Facility. All plant facilities located within the limited area at the plant site (adjacent to the Device Assembly Facility) would be new construction.

Key facilities required to meet the mission of the A/D operations at NTS are listed in table A.3.1.2-1. The following sections describe the key facilities in more detail.

Table A.3.1.2-1.-- Nevada Test Site Weapons Assembly/Disassembly Facility Data

Building Number	Function	New or Existing	Location	Gross Area (m^2)	Construction Type	Number of Floors
Assembly/ Disassembly						

DAF 301-304	Physics package cells	Existing	Material access area	1,732	Hardened concrete	1
DAF 341, 343, 345	Mechanical bays	Existing	Material access area	624	Hardened concrete	2
M01-M24	Mechanical bays	New	Material access area	6,044	Hardened concrete	2
L01	Test bed	New	Limited area	186	Steel	1
Laboratories						
23-700	Gas analysis lab	Existing	Area 23	828	Steel	1
L02	Weapons evaluation testing lab	New	Limited area	2,415	Steel	1
23-725	Metrology lab	Existing	Area 23	1,353	Steel	1
M51	Metrology lab	New	Material access area	557	Hardened concrete	1
23-190	Commercially procured material testing/staging	Existing	Area 23	701	Concrete	1

Warehousing/ Staging						
L03	HE components	New	Limited area	279	Hardened concrete	1
23-160	Inert components/ containers	New	Area 23	4,682	Steel	1
L04	Tooling/testers	New	Limited area	2,323	Steel	1
M26-M31	Weapons staging	New	Material access area	836	Hardened concrete	1
Special Purpose						
M32	Pit laser sampling	New	Material access area	46	Hardened concrete	1
M33	Accelerated aging	New	Material access area	372	Hardened concrete	1
L05	Special nuclear material container refurbishment/ verification	New	Limited area	139	Steel	1
DAF 351, 353	AT-400 processing	Existing	Material access area	426	Hardened concrete	1

DAF 494	Mass properties	Existing	Material access area	118	Hardened concrete	1
DAF 492	Separations testing	Existing	Material access area	118	Hardened concrete	1
DAF 310	Vacuum chambers	Existing	Material access area	215	Hardened concrete	1
L06	Paint	New	Limited area	111	Steel	1
DAF 491	Permissive action link capability	Existing	Material access area	213	Hardened concrete	1
M34	Purge/backfill	New	Material access area	46	Hardened concrete	1
DAF 493	Component packaging	Existing	Material access area	118	Hardened concrete	1
Special Purpose (Continued)						
DAF 495	Component technical acceptance	Existing	Material access area	118	Hardened concrete	1
DAF 331, 332	Nondestructive evaluation	Existing	Material access area	744	Hardened concrete	1

M35	Nondestructive evaluation	New	Material access area	325	Hardened concrete	1
M52	Electronic testing	New	Material access area	325	Hardened concrete	1
NT DOE 1995b.						

Assembly Cells. Four existing assembly cells in the Device Assembly Facility would support the manual A/D of a physics package. A fifth available cell would be held in reserve for test devices or expanded use if necessary. Each cell (standard Pantex design) includes an area to perform assembly operations, staging areas for special nuclear materials and weapon parts, and a mechanical room for heating, ventilation, and air conditioning equipment controls.

Assembly Bays. A new assembly bay facility would be constructed adjacent and connected to the Device Assembly Facility. This facility would contain 24 assembly bays; 20 of standard Pantex design and four with extended operational areas. Three additional bays of standard Pantex design are provided in the existing Device Assembly Facility. All assembly bays would be separated by a minimum of 4.1 m (13.6 ft) of earth fill for explosive blast shock mitigation. Each bay would include an area or areas to perform assembly operations, staging areas for tooling and weapon parts, and a second floor mechanical room for heating, ventilation, and air conditioning equipment and controls. Two additional assembly bays are held in reserve within the existing Device Assembly Facility for device assembly operations or expanded use, if required.

Test Bed . A new nonhardened facility would be constructed within the limited area, adjacent to the Device Assembly Facility for test bed fabrication. This facility would contain universal assembly bays configured with program-specific tooling.

Laboratories

Gas Analysis . Gas analysis would be performed in an existing nonhardened building in Area 23. This building would be configured with laboratory facilities equipped to provide analysis by gas fractionation, gas chromatography, and mass spectrometry.

Weapons Evaluation Testing. A new nonhardened facility would be constructed within the limited area, adjacent to the Device Assembly Facility for weapons evaluation testing. This facility would contain a number of fully instrumented test stations to provide for heating, cooling, and test firing the test beds. A cryogenic system would be used for the cooling of these units during testing. Environmental conditioning ovens and centrifuges would be provided for the testing of components under deployment conditions.

Metrology. Metrology laboratory facilities would be located in an existing nonhardened building in Area 23 and in a new hardened building within the material access area, connected to the existing Device Assembly Facility. These facilities would be equipped to calibrate instruments and testers used in weapon assembly operations. A class 1000 clean room with heating, ventilation, and air conditioning temperature control to + 2.8 *o* C (+ 5 *o* F) would be added to these buildings.

Commercially Procured Material Testing/Staging . An existing building located in Area 23 would be used to test and stage commercially procured materials used in the assembly process. This building would have both receiving and staging areas and a room equipped for performing standard material tests.

Special Purpose Bays

Pit Laser Sampling . A new hardened building would be constructed within the material access area, connected to the Device Assembly Facility, to perform laser sampling of pits.

Accelerated Aging. A new hardened building would be constructed within the material access area, connected to the Device Assembly Facility, to simulate accelerated environmental aging of newly produced weapons and weapon components. This building would contain five environmental chambers to provide thermal cycling above and below ambient temperatures for an extended period of time.

Special Nuclear Materials Container Refurbishment/Verification . A new building would be constructed within the limited area, adjacent to the Device Assembly Facility, to refurbish and verify processing of special nuclear material containers.

AT-400A Processing. Two existing hardened bays within the Device Assembly Facility would be used for AT-400A processing.

Mass Properties . Mass properties determination would be performed in an existing hardened bay within the Device Assembly Facility. This building would be equipped with remotely operated dynamic balancing machines to determine products of inertia and lateral center of gravity and a center of gravity and moments of inertia machine.

Separations Testing. An existing hardened bay in the Device Assembly Facility would be used for separations testing. This bay would be equipped to test selected reentry body subassemblies, measurements of service-related deterioration of the release assembly system, and for acquisition of data associated with the evaluation of release assembly hardware.

Vacuum Chambers. Two vacuum chambers would be installed in an existing hardened building in the Device Assembly Facility to perform leak rates on all outgoing weapons or on weapons returned from the field.

Paint . A new nonhardened building would be constructed within the limited area, adjacent to the Device Assembly Facility, to paint, repaint, or touch-up weapons, weapon components, and containers.

Purge/Backfill. A new hardened building would be constructed within the material access area, connected to the Device Assembly Facility, to conduct purge and backfill operations. This building would be equipped to either purge or fill the inside of the weapon case with a specific gas.

Component Packaging/Technical Acceptance. Component packaging and technical acceptance operations would be conducted in two existing hardened Device Assembly Facilities.

Nondestructive Evaluation. Explosive components would be inspected by linear accelerator, medium x ray, and computed tomography within the existing two radiography buildings in the Device Assembly Facility. Other weapon and component testing would be conducted in a new hardened building located within the material access area, connected to the Device Assembly Facility. This building would contain equipment to support mechanical conditioning tests including vibration, hostile shock, mini air-gun shock, and steady-state acceleration shock.

Electronic Testing. Electronic testing of weapon components would be conducted in a new hardened building located within the material access area, connected to the Device Assembly Facility.

Warehousing/Staging

High Explosives Components. Three new hardened bunkers would be constructed within the limited area, adjacent to the Device Assembly Facility, for the storage of HE components. These bunkers would be bermed and would provide a safe separation distance to all other occupied facilities at the plant site.

Special Nuclear Materials Components. A new hardened building would be constructed within the material access area, connected to the Device Assembly Facility, to stage and store special nuclear material components. This building would contain segregated staging bays and inspection equipment and would utilize the existing safe secure trailer loading dock within the Device Assembly Facility for secure receiving of special nuclear material components.

Inert Components/Containers Shipping and Receiving. An existing building located in Area 23 would be used to ship, receive, and store inert weapon components. This facility would include storage racks, a loading dock, and areas designed for packaging and unpackaging.

Tooling/Testers . A new nonhardened building would be constructed within the limited area, adjacent to the existing Device Assembly Facility, to control the storage of precision tools, instruments, testers, and special equipment used in A/D operations. Segregated storage areas would be provided for all specific tooling requirements supporting weapons programs in the enduring stockpile.

Weapons. Six new hardened bays would be constructed within the material access area, connected to the Device Assembly Facility, for the interim staging of a maximum of 100 weapon units. This facility would have a dedicated safe secure trailer dock for shipping and receiving weapons.

Strategic Plutonium/Canned Subassembly Storage . The strategic Plutonium/Canned Subassembly Storage Facility would consist of new hardened construction within the material access area connected to the existing Device Assembly Facility.

Weapons A/D facilities construction would take 6 years to complete. Materials and resources consumed during the entire construction period are listed in table A.3.1.2-2.

The principal sources of air emissions during A/D facility construction would be fugitive dust from land clearing, site preparation, excavation, and other construction activities, and exhaust from construction equipment and vehicles. The annual emissions generated during a 1-year period with peak construction activity are shown in table A.3.1.2-3.

Table A.3.1.2-2.-Nevada Test Site Weapons Assembly/Disassembly Construction Materials/Resources Requirements

Material/Resource	Total Consumption	Peak Demand [8]
Electricity	38,000 MWh	5 MWe
Water	98,400,000 L	94,600 L/day
Concrete (m^3)	75,000	
Steel (t)	16,300	

Liquid fuel and lube oil (L)	3,030,000	
Industrial gases (m^3) [9]	65,100	

Table A.3.1.2-3.-- Nevada Test Site Weapons Assembly/Disassembly Construction Emissions

Pollutant	**Quantity** **(t)**
Sulfur dioxide	1.8
Nitrogen dioxide	24
Volatile organic compounds	7.3
Carbon monoxide	36
Particulate matter	13.6
Total suspended particulates	31

NT DOE 1995b.

The number of craftworkers, as well as construction management and support staff, required during each year of construction, are presented in table A.3.1.2-4.

The utilities consumed during operation include electric power, liquid fuels, and water. Annual utility consumption rates and peak electric power rates for surge operation are shown in table A.3.1.2-5.

The chemicals and materials consumed during operation primarily include water treating chemicals, reactants and solvents for explosives formulation and synthesis, explosive powders, materials for facility equipment and vehicle maintenance, metals for manufacturing tooling, and bottled gases. Annual surge operation material consumption is listed in table A.3.1.2-6.

Emissions. Gaseous environmental releases result from operation of the thermal treatment unit for nonradioactive HE contaminated waste and mixed HE contaminated waste. Emissions will also result from plant boiler operation, cleaning operations using solvents, and small scale synthesis operations. The thermal treatment units would be designed and operated to attain and maintain temperatures that result in the destruction of hazardous constituents and hazardous particulates that will be trapped in filters. The releases will be limited to what is possible using the best available control technology. The annual emissions for the A/D facility surge operations are shown in table A.3.1.2-7.

Waste Management. NTS waste management is described in detail in appendix section H.2.8. The liquid and solid nonhazardous wastes generated during the 6-year construction period would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

Table A.3.1.2-4.-- Nevada Test Site Weapons Assembly/Disassembly Construction Workers

Employees	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total

Craftworkers							
Carpenter	61	117	115	63	41	36	433
Concrete mason	8	15	10	2	2	4	41
Electrician	24	27	53	90	96	55	345
Iron worker	30	75	67	23	16	16	227
Laborer	38	62	52	20	17	20	209
Millwright	3	7	10	20	19	7	66
Operator	10	23	29	22	18	9	111
Sheet metal worker	5	14	29	29	14	5	96
Pipe fitter	15	32	75	82	78	32	314
Sprinkler fitter	3	8	16	16	7	3	53

Teamster	3	6	7	7	6	3	32
Other craftworkers	4	8	15	24	20	6	77
Total Craftworkers	204	394	478	398	334	196	2,004
Construction staff [10]	29	59	73	61	51	30	302
Management and support staff [11]	44	91	111	92	78	46	462
Total Employment	277	544	662	550	463	272	2,768

Table A.3.1.2-5.-Nevada Test Site Weapons Assembly/Disassembly Facility Surge Operation Annual Utility Requirements

Utility	**Consumption**	**Peak Demand [12]**
Electricity	45,000 MWh	7 MWe
Liquid fuel (L)	432,000	
Natural gas (m^3)	3,680,000	

Water (L)	98,400,000	

Table A.3.1.2-6.-- Nevada Test Site Weapons Assembly/Disassembly Facility Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)
Acetone	64
Acetonitrile	64
Aluminum metal	499
Argon	8,165
Brass metal	50
Carbon dioxide	49,896
Circlene FG 20	227

Clepox 143	227
Copper/copper oxide wire	295
Copper metal	136
Degreaser	227
Dispersant	68
Dry air	771
Eco-Star	726
Electrode/probe solutions	59
Ethyl alcohol	59
Fixer/replenisher	454

Glass cleaner	454
Glass beads	136
Helium	1,769
Heptane	113
Hydraulic/lubricating oil	8,165
Hydrochloric acid	68
Joint compound	363
Kimwipes	1,134
Lead metal	136
Micro liquid lab cleaner	113

Mild steel metal	1,814
Molecular sieve	295
Neutrasorb acid neutralizer	68
Nitrogen	3,629
Paint	4,536
Planisol-M concentrate	113
Polyalkylene and ethylene glycol	68
Potassium hydroxide	113
Siliconized ammonium phosphate base	181
Sodium hydroxide	113

Solksorb solvent absorbent	499
Specialty gas mixtures	1,542
Stainless steel metal	612
Sulfuric acid	113
Tetrahydrofuran	4,990
TISAB and CDTA	250
Toluene	68
Water treating chemicals	2,268
NT DOE 1995b; NTS 1995a:3.	

Table A.3.1.2-7.-- Nevada Test Site Weapons Assembly/Disassembly Facility Surge Operation Annual Emissions

Pollutant	Quantity (t)
Carbon monoxide	0.007
Nitrogen dioxide	0.907
Particulate matter	0.00227
Sulfur dioxide	0.907
NT DOE 1995b; NTS 1995a:3.	

The project design incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.1.2-8 presents the estimated annual waste volumes from the A/D and pit reuse facility during construction and surge operations. Liquid and solid waste streams are routed to the waste management system. Solid wastes would be characterized and segregated into LLW, hazardous and mixed wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous and toxic and radioactive elements before discharge or transport. All fire-sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Low-Level Waste. LLW generated from reuse operations would consist of tubes removed from the pits, personnel protective equipment, glove boxes, filters, cleaning materials, and disposal supplies. Small amounts of LLW would be generated by A/D operations and would consist primarily of sanitized and demilitarized weapon parts, test residue, compacted wipes, rubber gloves, and vacuum filters. Bulk waste would be disposed of in Area 3, and packaged waste would be disposed of in Area 5, employing standard shallow land burial techniques.

Mixed Low-Level Waste. Pit reuse operations would not generate any mixed LLW. Small amounts of mixed LLW would be generated from operation of the A/D facility and would consist primarily of sanitized and demilitarized weapon parts, test residue, compacted wipes, rubber gloves, and vacuum filters. Mixed LLW would be stored in an onsite RCRA-permitted storage facility until treatment in accordance with the site treatment plan that was developed to comply with the Federal Facility Compliance Act of 1992.

Table A.3.1.2-8.-- Nevada Test Site Weapons Assembly/Disassembly Facility Waste Volumes

Category	**Annual Average Volume Generated from Construction (m ^{3})**	**Annual Volume Generated from Surge Operations (m ^{3})**	**Annual Volume Effluent from Surge Operations (m ^{3})**
Low-Level			
Liquid	None	0.06	None
Solid	None	30 [13]	15 [14]
Mixed Low-Level			
Liquid	None	None	None

Solid	None	2	2
Hazardous			
Liquid	None	6	6
Solid	5	0.05	0.05
Nonhazardous (Sanitary)			
Liquid	6,670	53,000	53,000
Solid	260 [15]	100	50 [16]
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations. The cleaning solvents selected would be from a list of nonhalogenated solvents. Solid hazardous wastes would be generated from nonradioactive materials, such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. Hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste storage area. The hazardous waste storage area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Sewage wastewater and process wastewater would be treated using a series of facultative lagoons and evaporation ponds and disposed of in septic tanks, sumps, or ponds. Solid wastes are disposed of in landfills at various locations on the site.

Nonhazardous (Other) Waste. Small amounts of classified nonhazardous waste would be generated from operation of the A/D facility. These wastes would be sanitized and disposed of per site practice.

1

Peak demand for electricity is the maximum rate. Peak demand for water is the average daily consumption during a 1-year period with construction activity.

2

Cubic meters measured at standard temperature and pressure.

PX MH 1995a.

3

Chlorine, sodium sulfite, sodium sulfate, sulfuric acid, poly electroly, and phosphoric acid.

PX MH 1995a.

4

Includes 9.2 m *3* generated from A/D operations and 11.3 m *3* generated from pit reuse operations.

5

Assumes 2/3 of solid LLW is compactible by a factor of 4:1 and the liquid LLW is solidified by a factor of 2:1.

6

Includes 4.6 m3 of concrete and 0.6 t (0.7 tons) of steel. Volume estimate made by using 0.127 m3/t for density of steel.

7

Assumes 2/3 of solid is compactible by a factor of 4:1.

PX 1995a:6; PX DOE 1995k; PX MH 1995a.

8

Peak demand for electricity is the maximum rate. Peak demand for water is the average daily consumption during a 1-year period with peak construction activity.

9

Cubic meters measured at standard temperature and pressure.

NT DOE 1995b.

10

Construction staff includes temporary construction facilities, construction services, and field staff.

11

Management and support staff include all construction personnel and an allowance for DOE site personnel, field and vendor inspection services, construction management, and engineering support during construction.

***NT DOE 1995b* .**

12

Peak demand is the maximum rate expected during any time.

NT DOE 1995b; NTS 1995a:2.

13

Includes 18.3 m^3 generated from A/D operations and 11.3 m^3 generated from pit reuse operations.

14

Assumes 2/3 of solid LLW is compactible by a factor of 4:1 and the liquid LLW is solidified by a factor of 2:1.

15

Includes 255 m *3* of concrete and 39 t (43 tons) of steel. Volume estimate made by using 0.127 m *3* /t for density of steel.

16

Assumes 2/3 of solid is compactible by a factor of 4:1.

NT DOE 1995b; NT DOE 1995f; NTS 1995a:2; NTS 1995a:3; PX DOE 1995k.

A.3.3 Pit Fabrication and Intrusive Modification Pit Reuse

A nuclear weapon has a primary assembly that contains a pit subassembly surrounded by HE. The nuclear material in a pit, typically plutonium, is encased in a shell of nonnuclear metal such as stainless steel. Fabricating and processing the plutonium, and assembling the pit components, is the task that LANL or SRS would perform under this option. For both pit fabrication and intrusive modification, plutonium would be supplied from existing pits that have been retrieved and disassembled.

In order to fabricate replacement pits, the plutonium from disassembled pits first would be processed (dissolution, purification, reduction to metal). Processing also provides means to convert manufacturing scrap and residue (oxides) to metal usable in fabrication operations. Plutonium fabrication involves foundry and mechanical operations, including casting, shaping, machining, bonding, assembly, inspection, and packaging. Intrusive modification would disassemble an existing pit, keeping the plutonium component intact. Modification would be made external to the plutonium and a new outer shell applied. These operations are similar to the assembly and inspection functions for replacement pit fabrication.

Waste management and analytical chemistry activities would also be required for all of the plutonium operations. The block flow diagram of pit fabrication is shown in figure A.3.3-1. In addition to the actual operational aspects of plutonium fabrication, several other important processing functions are required. For example, the plutonium metal is under strict accountability for security and safeguard reasons. These security and safeguard requirements influence some of the facility and personnel needs at LANL or SRS to accomplish this task. Also, the nuclear weapons design/production process includes pit certification and qualification, which influences the facility and personnel needs.

Process Descriptions

Pit Fabrication. Pit fabrication involves preparation of plutonium components (casting, machining, inspecting, and cleaning), assembly of the pits (assembling the plutonium and nonnuclear components then hermetically sealing the pit with a weld), and post-assembly processing of the pits to the stockpile configuration.

Plutonium Processing. Plutonium processing consists of disassembly and metal preparation (obtaining stockpile pits, extracting the plutonium, and purifying the plutonium metal to a reusable form) and chloride and nitrate processing (recovering plutonium from residues generated by the manufacturing processes by using either the chloride or nitrate plutonium recovery processes).

Waste Management. Waste management includes taking waste generated by the manufacturing processes and placing it in a form suitable for final disposal. Wastes to be managed would consist of liquid or solid, TRU or LLW, and may include hazardous or mixed waste.

Analytical Chemistry. Analytical chemistry consists of all analytical measurements required to support pit manufacturing. These chemical evaluations include metal samples from the metal preparation area, plutonium components, samples from the plutonium processing unit processes, all samples that support the disposition of waste, and samples required to maintain physical and administrative control of special nuclear material. Samples supporting waste disposition must meet standards set by the RCRA and EPA.

Storage. Storage would include interim storage of retired stockpile pits awaiting disassembly and new pits awaiting shipment to the nuclear weapons assembly facility, as well as long-term storage of plutonium and oxide.

A.3.3.1 Reestablish at Los Alamos National Laboratory

Currently, LANL processes plutonium for RD&T and stockpile support purposes on site. Reconfiguring and upgrading these existing plutonium laboratory facilities in TA-55 is the proposed approach to provide a Pit Fabrication and Intrusive Modification Pit Reuse Facility. Other nuclear facilities to be used for this effort are located in TAs -3, -8, -35, -50, and -54 (as shown in figure A.3.3.1-1). Within TA-55 is the Plutonium Facility (PF-4), which includes a Pit Fabrication Facility in the 300 Area and facilities for plutonium and waste processing in the 400 Area (as shown in figure A.3.3.1-2). TA-3 is a key area; it contains the Sigma Complex, Chemistry and Metallurgy Research building, and main machine shop. Another key area, TA-35, has the physical vapor deposition coating building. Nondestructive evaluation is carried out in a facility in TA-8. Radioactive waste is treated in TA-50 (liquid) and TA-54 (solid). The facilities that are currently used by stockpile surveillance activities would be shared with the pit fabrication group until dedicated facilities become available. The current stockpile Pit Rebuild Program at LANL would be absorbed within the pit fabrication effort as the activity is the same; only the number of pits produced would change. The number of pits fabricated annually is projected to be from 20 to 50 (depending on equipment availability), but could be about 80 if surge mode (multiple shifts, personnel overtime, and use of equipment to full capacity) were exercised. The key building descriptions for the Pit Fabrication and Intrusive Modification Pit Reuse Facility at LANL are shown in table A.3.3.1-1.

Table A.3.3.1-1.-- Los Alamos National Laboratory Pit Fabrication Facility Data

Building	Footprint (m2)	Number of Levels	Special Nuclear Material Permitted	Construction
TA-55, PF-4 Plutonium Facility	14,000	2	Yes	Concrete post and beam with concrete masonry unit in-fill walls
TA-55, PF-4 Nuclear Material Storage Facility			Yes	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-29 Chemistry and Metallurgy Research Building	51,100	3	Yes	Concrete post and beam with concrete masonry unit in-fill walls

TA-3, SM-141 Nonnuclear Component Fabrication	1,860	1	No	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-66 Sigma Building	15,800	1	No	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-39 Nonnuclear Shops Building	7,660	1	No	Concrete post and beam with concrete masonry unit in-fill walls
LANL 1995g.				

The pit fabrication process flow at LANL would begin with old pits from the weapons retirement process being routed to a disassembly area. The plutonium metal from disassembled pits would be purified before transfer to the fabrication area. Residues generated in the disassembly/metal purification areas are primarily chloride salts, crucibles, and chloride-contaminated scrap. The bulk of the residual plutonium would be purified and converted to plutonium metal in the chloride recovery area. Recovered plutonium metal would also be sent to the fabrication area. During fabrication, plutonium metal would be cast into the desired near-net-shape and machined to the final shape with desired tolerances. The finished components would then be assembled with other nonplutonium materials into the new weapon pit component.These new pits would then be sent to the weapon assembly facility. During the casting and machining operations, a number of residues would be generated that require processing and would subsequently undergo nitrate recovery operations. In nitrate recovery, the residues are purified and converted to oxide for return to the reduction operations. Solid and liquid wastes from processing areas would be routed to waste management facilities for processing into a disposable waste form. Analytical laboratories provide chemical analyses of plutonium metal, oxides, solutions, and wastes.

Tables A.3.3.1-2 and A.3.3.1-3 summarize resource requirements for facility modification and operation of the Pit Fabrication Facility. Table A.3.3.1-4 summarizes the bulk quantities of chemicals that would be used in the pit fabrication processes. These quantities assume the surge mode of 80 new pits per year.

Table A.3.3.1-2.-- Los Alamos National Laboratory Pit Fabrication Construction Requirements

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	Minimal
Peak electrical demand (MWe)	Minimal
Concrete (m *3*)	Minimal
Steel (t)	Minimal
Gasoline, diesel, and lube oil (L)	Minimal
Industrial gases [1] (m *3*)	Minimal
Water (L)	Minimal
Land (ha)	None
Employment	
Total employment (worker years)	216
Peak employment (workers)	138
Construction period (years)	3

Table A.3.3.1-3.-- Los Alamos National Laboratory Pit Fabrication Surge Operation Annual Requirements

Requirement	Consumption
Resource	
Electrical energy (MWh)	5,480
Peak electrical demand (MWe)	0.7
Liquid fuel [2] (L)	None

Natural gas [3] (m^3)	30,900
Water (L)	30,200,000
Plant Footprint (ha)	NA [4]
Employment [5] (Workers)	628

Table A.3.3.1-4.-- Los Alamos National Laboratory Pit Fabrication Surge Operation Annual Chemical Requirements

Chemical	**Quantity (kg)**
Solid Chemicals	
Aluminum nitrate	2,041
Aluminum sulfate	2,041
Bentonite	1,021
Calcium fluoride	62
Calcium carbonate	1,021
Calcium chloride	227
Diatomaceous earth	45,360
Ferrous ammonium sulfate	5
Hydroxylamine hydrochloride	23
Iron, magnesium, calcium	11
Magnesium hydroxide	340
Oxalic acid	748
Portland cement	45,360
Resins	23
Sodium carbonate	57
Sodium hydroxide	28
Sodium nitrite	96
Sodium sulfite	794
Urea	20
Liquid Chemicals	
Carbon dioxide	17
Film developer, fixer, toner	1,043
Hydrochloric acid	1,497
Hydrofluoric acid	340
Hydrogen peroxide	1,996
Hydroxylamine nitrate	658
Nitric acid [6]	3,420
Nitrogen	57
Potassium hydroxide	17,010
Sodium hydroxide	2,268
Gaseous Chemicals	
Argon	170,100
Chlorine	340
Helium	23
Hydrogen chloride	11
Nitrogen	1,360,800

Oxygen	1,814

Waste Management. The liquid and solid hazardous and nonhazardous wastes generated during building modification would include concrete and steel construction waste materials. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. Small amounts of radioactive waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and to provide for cost-effective disposal for recycling. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.3.1-5 presents the estimated annual waste volumes from the Pit Fabrication and Reuse Facility during modification activities and Solid and liquid waste streams are routed to the waste management system. Figures A.3.3.1-3 through A.3.3.1-5 depict the waste management system. Solid wastes would be characterized and segregated into TRU, LLW, hazardous, and mixed wastes, then treated to a form suitable for disposal or storage within the facility. [figure A.3.3.1-4] Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire-sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Spent Nuclear Fuel. The Pit Fabrication and Reuse Facility would not generate any spent nuclear fuel.

Transuranic Waste. TRU waste would be generated from operation of the Pit Fabrication and Reuse Facility and would consist of glass, leaded gloves, plastics, equipment, metals, and heater elements. These wastes would be shipped to WIPP for disposal.

Low-Level Waste. LLW would be generated from operation of the Pit Fabrication and Reuse Facility and would consist primarily of plastics, metal, cement sludge, and vacuum filters. Liquid LLW would be sent either by truck or industrial drain to TA-50 for processing. The liquid LLW treatment facilities include a chemical treatment and ion-exchange plant at the radioactive liquid waste treatment facility and a chemical treatment plant. The waste would be processed, with radioactive constituents removed, in accordance with the NPDES permit. Low-level solids would be disposed of in 0.1-m *3* (2-ft *3*) boxes at TA-54, Area

Mixed Low-Level Waste. No mixed LLW is expected to be generated. If any were to be generated, it would be managed in accordance with LANL Site Treatment Plan.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations. The cleaning solvents selected would be from a list of nonhalogenated solvents. Hazardous chemical wastes would be treated at commercial offsite RCRA-permitted facilities until completion of the Hazardous Waste Treatment Facility. The remaining liquid waste would be treated by gravity settling and discharged through an NPDES-permitted outfall. No solid hazardous wastes are expected to be generated.

Table A.3.3.1-5.-- Los Alamos National Laboratory Pit Fabrication Waste Volumes (80 Pits Per Year)

Waste Category	**Annual Volume Generated from Construction (m3)**	**Annual Volume Generated from Surge Operations (m3)**	**Annual Volume Effluent from Surge Operations (m3)**
Transuranic			
Liquid	None	5	None
Solid	6 7	43	60
Mixed Transuranic			
Liquid	None	None	None
Solid	None	2	2
Low-Level			
Liquid	None	15	None
Solid	12 8	386	393
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None

Hazardous			
Liquid	0.06	2	2
Solid	51	None	None
Nonhazardous (Sanitary)			
Liquid	None	12,300[9]	12,300
Solid	None	552[10]	552
Nonhazardous (Other)			
Liquid	None	Included in sanitary	Included in sanitary
Solid	26[11]	Included in sanitary	Included in sanitary

Nonhazardous (Sanitary) Waste. Sewage wastewater and process wastewater would be sent by drain to the sanitary wastewater treatment plant (TA-46). Treated effluents would be disposed of by either sanitary drains or through permitted NPDES outfalls. Cooling tower blowdown and overflow would be discharged through outfalls permitted by the State of New Mexico. Sludge and other solid sanitary waste would be disposed onsite at the Sandia Canyon site (TA-61).

Nonhazardous (Other) Waste. Nonhazardous (other) wastes would be disposed of in a permitted landfill or discharged through permitted NPDES outfalls.

A.3.3.2 Reestablish at Savannah River Site

The Pit Fabrication and Intrusive Modification Pit Reuse Facility at SRS would use existing hardened facilities but with all new equipment. The facilities available for this mission include the Separations Areas, F-Area, and H-Area (figure A.3.3.2-1). All aspects of pit component fabrication would be included: pit fabrication, plutonium processing, and waste management. Pit fabrication could be located in the 232-H Building or the F-Canyon. Plutonium processing would be in the F-Canyon facilities. The intrasite transfers of plutonium between areas would be in the form of metal ingots, buttons, and scrap as well as small quantities of oxide. Any liquid transfers would be performed through vessels and piping with secondary and tertiary containment systems. The nonnuclear portions of the pit component would be fabricated and manufactured elsewhere, then shipped to SRS as finished parts. Potentially tritium contaminated pits would not be handled at SRS; rather, they would be sent to LANL. The total number of pits fabricated annually is projected to be in the range of 20 (normal operations), 50 (design capacity, normal operations), or 120 in the surge mode (multiple shifts, personnel overtime, and use of equipment to full capacity).

Currently, Building 232-H is being used for tritium processing and handling operations. These missions are being moved to the Replacement Tritium Facility. The building would be refurbished, leaving adequate space for pit fabrication. The space would be in a hardened facility and essentially free of tritium contamination. Those areas with high levels of tritium contamination would be isolated from the pit fabrication areas. Adjacent nonhardened areas would be used for receiving and handling nonnuclear components or direct service support to the pit fabrication process. Figure A.3.3.2-2 shows the H-Area proposed pit fabrication facilities.

The F-Canyon facilities have adequate noncontaminated hardened areas that can house the plutonium processing functions. The canyon includes the new, never operated, plutonium storage facility, the new special recovery facility, and a vacant production space that was previously decontaminated. Only minor modifications would be required to the glove boxes and equipment in the two new facilities. The plutonium processing operations would also handle the receiving, handling, and disposition of surplus plutonium. The existing waste management systems and laboratory facilities can be used to support the process.

The infrastructure at SRS includes liquid and solid waste management; analytical laboratories; security systems; ES&H systems; training facilities; and research, development, and demonstration facilities. The waste management operations are collocated with the plutonium processing facilities. This allows for the expedient transfer of byproducts from the plutonium purification process to the liquid waste stream, which is subsequently vitrified with high-level waste in the existing Defense Waste Processing Facility.

SRS has the existing support infrastructure to handle plutonium processing. Feedstock for the pit fabrication process would be plutonium metal. Plutonium would be received from offsite via safe secure trailer, unloaded into a staging area, then moved to the plutonium storage facility until needed. Once the retired pit is determined not to be contaminated, it would enter the disassembly process where the nonnuclear and other nuclear components would be removed from the plutonium. The plutonium would be collected and purified while the nonnuclear parts would be declassified and sent to solid waste treatment, and the other nuclear parts would be cleaned and sent to staging to await offsite transport. The purified plutonium would be converted back to metal and would enter the pit fabrication process. The listing of the major support facilities for the Pit Fabrication and Intrusive Modification Pit Reuse Facility is shown in table A.3.3.2-1.

The plutonium fabrication process is an abbreviated version used by the Rocky Flats Environmental Technology Site. Though there are several pit types, the process is basically the same. The process consists of casting parts to the near net-shape, machining the surfaces of the casting to achieve the final shape, and performing tests on the completed parts to assure suitability. After this inspection, the plutonium components are cleaned and assembled with the nonnuclear components to form a pit that is then welded together. Once the plutonium is encapsulated, it may then be safely removed from the glove box, certified, and stored or shipped offsite as needed.

Nonnuclear components used in the new pits would be received from offsite. After inspection these parts would be stored in Building 704-55H until needed for either newly fabricated or reused pits. Some nonnuclear parts require a vapor deposition coating of material be applied. Generally all of these coatings would be produced in a vacuum environment using either a thermal evaporation or plasma sputtering process. Tables A.3.3.2-2 and A.3.3.2-3 show resource requirements for facility modification and surge operation of the Pit Fabrication Facility. Table A.3.3.2-4 shows annual chemical usage for surge operation.

Table A.3.3.2-1.-- Savannah River Site Pit Fabrication Facility Data

Building	Facility Type	Footprint (m2)	Number of Levels	Construction
211-F	Supply tanks	NA	NA	Outside/metal frame
221-F	Feed preparation	4,060	6	Concrete/metal frame
292-F	Canyon exhaust fan house	1,160	1	Concrete
294-F	Sand filters	2,230	NA	Concrete
294-1F	Sand filters	3,340	NA	Concrete
703-F	Administration building	1,860	1	Metal frame
704-F	Administration building	1,130	1	Metal frame
707-F	Administration building	1,490	1	Metal frame
707-7F	Administration building	1,490	1	Metal frame
717-F	Mock-up/maintenance shops	1,170	2	Metal frame
723-F	Laundry	1,060	1	Metal frame
772-F	Laboratory	3,850	2	Concrete/metal frame
772-1F	Laboratory	280	1	Concrete/metal frame
232-H	Manufacturing	4,840	3	Concrete
232-1H	Shop and storage	1,210	1	Metal frame
235-H	Tritium facility office	780	1	Metal frame
703-H	Administration building	1,860	1	Metal frame
704-H	Administration building	1,390	1	Metal frame
704-2H	Administration building	4,670	1	Metal frame
704-55H	Administration building	1,230	1	Metal frame
707-H	Administration building	1,770	1	Metal frame
766-H	Training facility	7,620	2	Metal frame

NA - not applicable.

WSRC 1995c.

Table A.3.3.2-2.-- Savannah River Site Pit Fabrication Construction Requirements

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	15
Peak electrical demand (MWe)	0.37
Concrete (m^3)	1,600
Steel (t)	249
Gasoline, diesel, and lube oil (L)	175,000
Industrial gases (m^3) 12	3,780
Water (L)	30,000,000
Land (ha)	2
Employment	
Total employment (worker years)	801
Peak employment (workers)	288
Construction period (years)	5

Table A.3.3.2-3.-- Savannah River Site Pit Fabrication Surge Operation Annual Requirements

Requirement	Consumption
Resource	
Electrical energy (MWh)	9,700
Peak electrical demand (MWe)	1.6
Liquid fuel (L)	28,400
Natural gas (m^3) 13	None

Water (L)	46,200,000
Coal (t)	1,090
Plant Footprint (ha)	NA 14
Employment (Workers)	813

Table A.3.3.2-4.-- Savannah River Site Pit Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)
Solid Chemicals	
Calcium carbonate	642
Calcium metal	227
Hydroxylamine nitrate	633
Magnesium oxide	383
Sodium hydroxide	4,983
Sodium nitrite	206
Water treatment chemicals	64
Liquid Chemicals	
Betz 25k series corrosion inhibitor	200
Betz Slimcide (CE-77 PE)	34
Cleaning/developing fluids	340
Hydrofluoric acid	10
Nitric acid 15	3,420
Liquid nitrogen	4,000
Polyphosphate	191
Sodium hypochlorite	96

Gaseous Chemicals	
Argon	3,924
Carbon dioxide	45,360
Hydrogen	6
Hydrogen fluoride	442
Nitrogen	2,790

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. Liquid waste which is primarily sanitary water would be treated as sanitary plant waste. Solid nonhazardous waste would consist primarily of office trash and sludge from sanitary wastewater treatment. Nonrecyclable portions of this waste would be sent to a permitted landfill after volume reduction practices such as compacting and shredding had been performed. No liquid hazardous waste would be generated other than the lubrication oils and coolants needed to maintain the construction equipment. Solid hazardous waste would consist primarily of solvent rags and empty containers of hazardous materials. Hazardous waste would be packaged in DOT approved containers and shipped offsite to commercial RCRA-permitted treatment,storage, and disposal facilities. No radioactive waste would be generated during construction.

The Pit Fabrication Facility considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.3.2-5 presents the estimated annual waste volumes from the Pit Fabrication Facility during modification activities and operation for the base case surge. Solid and liquid waste streams would be routed to the waste management system.

Figure A.3.3.2-3 depicts the overall waste management system at SRS. Additional figures by waste category are available in appendix section H.2.2. Solid wastes would be characterized and segregated into TRU, low-level, mixed, hazardous, and nonhazardous, then treated to a form suitable for disposal or storage. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

Spent Nuclear Fuel. The Pit Fabrication Facility would not generate any spent nuclear fuel.

High-Level Waste. The Pit Fabrication Facility would not generate any operational HLW. However, as a result of the plutonium recovery and purification processes, plutonium processing would generate a liquid TRU waste that would be managed as a high specific activity waste at SRS. As shown in figure A.3.3.2-3, one of the final waste products from the treatment of this waste is a glass log composed of comingled TRU waste from pit fabrication and legacy HLW.

Transuranic Waste. As noted above, plutonium processing would generate a liquid TRU waste as a result of the plutonium recovery and purification processes. This waste would have a high specific activity and would be managed in accordance with the SRS High-Level Waste Management Plan as outlined in appendix H.2.2. Solutions from both processes would be transferred to F-Canyon, evaporated, and the resulting evaporator bottoms neutralized with sodium hydroxide and transferred to the F-Area Tank Farm. Excess oxalic acid in the precipitation filtrates would be destroyed during filtrate evaporation. The residual sludge consisting primarily of americium and plutonium would be fed to the Defense Waste Processing Facility for conversion to a HLW form using borosilicate glass. The waste would then be immobilized by melting and poured into stainless steel cylinders which would be stored until a repository is available.

Table A.3.3.2-5.-- Savannah River Site Pit Fabrication Waste Volumes (120 Pits Per Year)

Category	**Annual Average Volume Generated from Construction (m3)**	**Annual Volume Generated from Surge Operations (m3)**	**Annual Volume Effluent from Surge Operations (m3)**
Transuranic			
Liquid	None	28 [16]	None
Solid	None	129 [17]	129 [17]

Mixed Transuranic			
Liquid	None	None	None
Solid	None	11	11
Low-Level			
Liquid	None	80 [18]	None
Solid	None	88 [19]	34
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	<0.01	<1	None
Solid	8 [20]	None	<0.01 [21]
Nonhazardous (Sanitary)			
Liquid	3,020	46,160	46,140 [22]
Solid	23	1,450	1,580
Nonhazardous (Other)			
Liquid	None	None	None
Solid	500 [23]	1,450 [24]	None

The solid TRU waste would consist primarily of graphite molds, crucibles, failed equipment, leaded gloves, filters, and combustible materials such as plastics and rags used during glove box operations. Approximately one-half of the volume of waste reported as TRU is considered as intermediate-level waste at SRS and would be disposed of in the intermediate-level waste vaults in E-Area. Intermediate-level waste is managed as TRU waste at SRS because it contains beta or gamma emitters that produce a dose equal to or greater than 200 mrem/hr at 5 centimeters (cm) (2 inches [in]) from an unshielded container. TRU waste destined for disposal in a Federal repository would be certified to meet the WIPP waste acceptance criteria and packaged in drums at the Pit Fabrication Facility then placed in interim storage. Disposal is planned for WIPP, once it has been determined to be a suitable repository for TRU wastes, pursuant to the requirements of 40 CFR 191 and 40 CFR 268. Noncertifiable drums would be repackaged and certified for shipment to WIPP in the future TRU waste facility.

Mixed TRU waste consisting of leaded gloves and TRU waste contaminated with organics such as solvents would be managed in accordance with the SRS site treatment plan. Current plans call for disposal at WIPP.

Low-Level Waste. Solid LLW would consist primarily of failed equipment and combustible plastics and cellulose-based products used in maintaining and cleaning the facilities. Combustible LLW may be incinerated using the consolidated incineration facility. Solid LLW would be packaged in B-25 (90 ft *3*) metal boxes and transported to the LLW disposal facility for disposal in concrete vaults. Evaporator overheads from the evaporation of the high-specific liquid waste described above and other liquid LLW would be sent to the F/H-Area Effluent Treatment Facility where radionuclide contaminants are removed using filtration, ion exchange, and reverse osmosis. The decontaminated effluent would be discharged through a permitted NPDES outfall. Concentrate from the F/H-Area Effluent Treatment Facility is transferred through the H-Area Tank Farm to Z-Area for solidification and final disposal in onsite vaults in Z-Area as a cement-based waste form called saltstone.

Mixed Low-Level Waste. The Pit Fabrication Facility is not expected to generate any mixed LLW. In the event any mixed LLW is generated, it would be managed in accordance with the SRS site treatment plan.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations. The cleaning solvents selected would be from a list of nonhalogenated solvents. Hazardous wastes would be collected in DOT-approved containers and sent to onsite hazardous waste accumulation areas (B-, M-and N-Areas). The hazardous waste accumulation area would provide a 90-day staging capacity. Incinerable waste would be shipped to an offsite vendor for treatment and disposal. Waste that cannot be incinerated would be placed in storage until the hazardous/mixed waste disposal facility and consolidated incineration facility are operational.

Nonhazardous (Sanitary) Waste. Sewage wastewater would be treated in the new central sanitary wastewater treatment facility prior to discharge through permitted NPDES outfalls. The sludge would be disposed of in a permitted landfill. Other nonrecyclable, nonhazardous, solid sanitary, and industrial wastes would be compacted and disposed of in a permitted landfill.

A.3.4 Nonintrusive Modification Pit Reuse

Unlike the pit fabrication and intrusive modification pit reuse function, the nonintrusive modification pit reuse function does not disassemble the pit. The entire pit is received through the weapons retirement/disassembly process. The pit is then cleaned and inspected, and, if necessary, the exterior of the pit is modified. No plutonium would be exposed in the nonintrusive modification pit reuse function. Since the intrusive modification pit reuse mission described in section A.3.3.1 for LANL and section A.3.3.2 for SRS inherently includes the nonintrusive modification pit reuse capability, a full discussion of the facilities and processes for conducting nonintrusive modification pit reuse activities at LANL and SRS is not included in this section. The nonintrusive modification pit reuse mission at Pantex and NTS are described in sections A.3.4.3 and A.3.4.4.

A.3.4.1 Los Alamos National Laboratory

The facilities necessary to accomplish these functions at LANL are a subset of those used in the intrusive modification pit reuse function and are discussed in section A.3.3.1.

A.3.4.2 Savannah River Site

The facilities necessary to accomplish these functions at SRS are a subset of those used in the intrusive modification pit reuse function and are discussed in section A.3.3.2.

A.3.4.3 Pantex Plant

Pits that are to be reused would be obtained from the weapons A/D Facility that is currently located at Pantex. Pits would be transferred from one facility to another on the same site, and all infrastructure would be shared. Since the plutonium is encapsulated and any modification is made to the outside of the pit, the entire nonintrusive modification pit reuse process can be conducted in an area that will remain free of radioactive contamination. Three classes of nonintrusive modification pit reuse are proposed at Pantex: recertification (minimum requirement for those pits still within their original design life), requalification (more extensive requirement for those pits that have exceeded their original design life), and nonintrusive modification reuse (modifications imposed upon the pit due to design changes). Pantex would have the capability to recertify 120 pits per year with an annual surge, multi-shift capacity of 200 pits. The combined capability for requalified and modified reused pits would be 150 annually, with a surge annual capacity of 250 pits; of these numbers, approximately 20 pits would be modified. Normal operation is considered to be four 10-hour work days per week, 52 weeks per year.

The facilities that would be used to support the pit recertification, requalification, and nonintrusive modification reuse mission include the weapons assembly bays in Buildings 12-64, 12-84, 12-104, and 12-104A and the current support areas in Zone 12 North along with the special nuclear material facility, Building 12-116. Four existing A/D bays in Building 12-104 would be modified to meet the nonreactor nuclear facility requirements. These four bays, along with an area for control, decontamination, and access control portals, would become the Nonintrusive Modification Pit Reuse Facility. The Nonintrusive Modification Pit Reuse Facility and special nuclear materials facility would be used to consolidate the interim storage, staging, and operations that would be necessary to support recertification, requalification, and nonintrusive modification pit reuse activities.

The Nonintrusive Modification Pit Reuse Facility would make extensive use of robotics. The first area would be used for unpacking and receiving to prepare the pit for the reuse process. As the process starts, the pit would enter the qualification bay and an automated processing line. This line would clean, inspect, and verify tolerances and performance to the specified requirements. The pit would then enter the assembly and welding bay, which includes a glove box line for any needed pit modification. After inspection, the pit would go to the purge and backfill bay to be leak tested and cleaned.

The recertification, requalification, and nonintrusive modification reuse processes would generate LLW, hazardous, industrial, and potentially mixed wastes. The operating areas would have accumulation sites and would perform the onsite characterization. The Waste Operations Group would be responsible for establishing the waste streams, scheduling the waste movement from the accumulation sites to the waste packaging areas, and disposing of the wastes. These processes are not intended to generate radioactive contamination and would not generate TRU or mixed waste under normal operations.

A.3.4.4 Nevada Test Site

NTS is an alternative site for the proposed Nonintrusive Modification Pit Reuse Facility. This facility would require a new building, but it would be adjacent and connected to the Device Assembly Facility. It would be within the secure area of the Device Assembly Facility and would be considered a nonreactor nuclear facility handling special nuclear materials. Though new construction would be required, the existing NTS infrastructure would be sufficient to support the facility. The pits to be reused in this facility would come from the weapons A/D Facility. Locating the Nonintrusive Modification Pit Reuse Facility at NTS assumes that the new weapons A/D Facility would also be at NTS. The A/D Facility mission would be performed within the Device Assembly Facility (originally designed to support assembly of test devices) and the pits would be transferred through corridors between these facilities. Since the plutonium would be encapsulated and any modification would be made to the outside of the pit, the entire process can be conducted in an area which will remain free of radioactive contamination. Three classes of pit reuse are proposed at NTS: recertification (minimum requirement for those pits still within their original design life), requalification (more extensive requirement for those pits that have exceeded their original design life), and nonintrusive modification reuse (modifications imposed upon the pit due to design changes). The total nonintrusive modification pit reuse capability at NTS for these three classes is 50 pits per year, which is based upon one full shift per day (maintenance and training included in the same shift).

The new Nonintrusive Modification Pit Reuse Facility would use the same processes as proposed for use at Pantex. The basic services required would include radiography, interim storage, gas analysis, gas preparation, and security. Radiography would be accomplished by a linear accelerator that is a shared resource with the A/D Facility. An interim storage area for 50 pits would be planned for within the 2,230 m2 (24,000 ft2) new Nonintrusive Modification Pit Reuse Facility. Both the gas analysis and preparation services would be incorporated within the facility. Gas analyses would be used to evaluate samples from accelerated aging tests, material compatibility tests, development activities, material certification tests, and production operations. Security in and around the Device Assembly Facility is sufficient (though it would be expanded) for the new facility, and the shipping and receiving functions would be handled through the Device Assembly Facility. The waste streams and utility requirements would be considered a part of the A/D process and are included with that estimate (see section A.3.1.2). The processes would include a waste management facility, waste storage facility, mixed waste storage and LLW disposal facility, sanitary wastewater treatment unit, sanitary and industrial landfill, and stormwater ponds.

1

Cubic meters at standard temperature and pressure.

LANL 1995g.

2

Used only for utility backup.

3

Cubic meters at standard temperature and pressure.

4

Within existing facilities.

5

Total full time equivalent employment. Increment from
current employment would be 260.

NA - not applicable.

LANL 1995b:4; LANL 1995g.

6

Annual makeup requirement with recycling. Total first year requirement is 32,886 kgs.

LANL 1995b:4.

7

Over a 3-year construction period a total of 27 t (30 tons) of associated piping and ventilation ductwork from glove boxes would be generated. For volume conversion, 1,500 kg/m3 was assumed.

8

Over a 3-year construction period a total of 41 t (45 tons) of glove boxes and 14 t (15 tons) of associated piping and ventilation ductwork would be generated. For volume conversion, 1,500 kg/m3 was assumed.

9

Assumes 50 gal/day/person/shift, with parameters of 250 days/yr, and 260 total additional employees for three shifts.

10

Assumes 0.3 ft *3* /day/person/shift, with parameters of 250 days/yr, 3 shifts/day, and 260 total additional employees for three shifts.

11

Includes 0.15 t (0.175 tons) of steel assuming a density of 0.127 t/m3.

LANL 1995g; LANL 1996e:1.

12

Cubic meters at standard temperature and pressure.

***WSRC 1995c* .**

13

Cubic meters at standard temperature and pressure.

14

Contained within existing facilities.

NA - not applicable.

WSRC 1995c.

15

Annual makeup requirement with recycling.

WSRC 1995c.

16

At SRS, this would be managed as high specific activity liquid waste which would be combined with HLW at the Tank Farm and then processed in accordance with the High-Level Waste Management Plan as depicted in appendix section H.2.2. The resultant waste forms include 0.61 glass logs composed of comingled TRU waste from pit fabrication and legacy HLW, and LLW saltstone. Based on aqueous alternative process for Complex 21; denitrated water=49.3 L/kg Pu metal processed and discarded filtrates=6.9 L/kg plutonium metal. Neutralized with 0.2 L of 50 percent caustic per kg of waste.

17

One-half of this volume is considered intermediate-level waste at SRS and would be disposed of in the intermediate-level waste vaults in E-Area. It is managed as TRU waste because it contains beta or gamma emitters that produce a dose equal to or greater than 200 millirem/hr at 5 cm (2 in) from an unshielded container.

18

Based on aqueous alternative process for Complex 21; 166 L of recycle water per kg of Pu metal processed. Assume "recycle" water sent to Effluent Treatment Facility; recovered acid is recycled.

19

Incinerable=58 m3, nonincinerable=30 m3.

20

Includes 7.6 m^3 (9.9 yd^3) of D&D wastes such as wall material contaminated with asbestos.

21

Treatment of liquid hazardous wastes results in solid hazardous ash. Volume reduction is 200:1.

22

Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary waste.

23

Includes 1.5 m^3 (2 yd^3) of concrete and 0.8 t (0.2 tons) of steel. Includes 498 m^3 (651 yd^3) of D&D wastes such as ductwork, concrete, electrical wiring, and equipment.

24

Recyclable wastes.

SRS 1996a:2; WSRC 1995c.

A.3.2 Secondary and Case Fabrication

This alternative involves those activities required to support the production and maintenance of the secondaries and case components of the nuclear weapons physics package as follows:

- Providing secondary materials
- Processing materials
- Fabricating parts and components
- Assembling and disassembling secondary components
- Performing quality evaluations of secondary assemblies
- Providing safe secure storage of secondary material and products

Functional capabilities required to perform these activities include operations to physically and chemically process, machine, inspect, assemble, certify, disassemble, and store secondary materials. Management of wastes generated from these operations is also required. The fabrication of secondaries and cases can be subdivided into the following major material production processes: uranium, lithium, and nonnuclear/special materials. The following typical process descriptions are provided to illustrate the functional activities and operations associated with each of the major production processes. These processes are based on traditional secondary and case fabrication methods and represent upper bounds to the types and number of processes that would be continued in the downsized and reconfigured Complex. Alternative sites for performing secondary and case fabrication are Y-12, LANL, and LLNL. The site-specific descriptions provided in sections A.3.2.1 to A.3.2.3 are based on more streamlined and less unit operations than described in this section. When comparing data between site alternatives, it is important to note that there are differences in the facility designs. The Y-12 alternative considers all the necessary support facilities to conduct the missions, not just the production and storage facilities. The LANL and LLNL alternatives only consider the incremental changes for operating the production facilities. The actual production footprint size of each alternative is almost identical; however, the production capacities vary between site alternatives. For example, base case, multiple-shift capacities at Y-12 and LANL are about 150 units, whereas at LLNL the equivalent production capability would be about 50 units. This creates significant differences in some of the data.

Process Descriptions

Uranium. The uranium process provides finished uranium parts and products. The operations are capable of all uranium handling and processing functions, from raw materials handling to finished parts manufacturing. In addition, uranium storage areas need to be provided for storage of in-process uranium materials and, at ORR only, for the HEU strategic reserve. In the event secondary and case fabrication is phased out at ORR and performed at LANL or LLNL, the storage of the HEU strategic reserve would be addressed at the weapons A/D site (i.e., Pantex or NTS).

The production of uranium parts and products involves casting or wrought processing; metal- working; machining, inspection, and certification; chemical recovery; assembly, disassembly, and quality evaluation; and in-process storage. The products from casting or wrought processing are billets and cast parts that feed directly to machining and metalworking. Billets are cropped and cast parts are delugged before they are sent to the next operation. The input to casting consists of retired weapons parts, metal buttons from storage, and recycled scrap metal from metalworking and machining. A casting charge is made up and processed in a critically safe configuration in a vacuum induction furnace. Scrap metal and machine turnings are degreased, cleaned, and briquetted before direct recycle.

Metalworking prepares a wrought product as feed for machining. Cropped billets from casting are preheated in a salt bath, rolled into a sheet, annealed in a salt bath, blanked, and pressed. The blanking operations are a major source of recycled metal for casting. Formed parts are cleaned, debrimmed, and machined.

Both formed and cast blanks are machined to finished dimensions and inspected. Scrap metal and machine turnings are returned to casting for cleanup and reuse. Miscellaneous solids are sent to the chemical recovery systems for treatment to recycle the material back to metal buttons. Product inspections and certification is accomplished with coordinate measuring machines, optical gaging, high-energy x-ray radiography, ultrasonic and dye penetrant flaw-inspection methodology, plating thickness gaging, and mechanical properties testing.

Uranium chemical recovery receives feed from virtually all areas in the process. The major feeds are residuals from casting, impure metal chips from machining, and a miscellaneous array of combustibles from all areas. The feeds are incinerated and processed in a head-end treatment consisting of acid dissolution, leaching, and feed preparation for solvent extraction. The feed solution is processed through primary extraction by which it is purified, concentrated by evaporation, and purified further by secondary extraction. The resulting solution is converted to oxide, then to uranium tetrafluoride, and then to uranium metal buttons. Secondary residues are returned to the head-end treatment. Finished metal is returned to casting for reuse.

Assembly operations assemble piece parts into subassemblies using joining techniques such as welding, adhesive bonding, and mechanical joining. Disassembly takes retired weapons apart and recycles all materials of value. The quality evaluation function receives weapons from the stockpile for disassembly, evaluation, and lifecycle testing. Shipping containers for weapons parts and subassemblies are certified and refurbished as part of the A/D process.

Uranium storage includes storage vaults for in-process uranium materials, which includes buttons and other scrap materials directly recycled, as well as semi-finished and finished components. The vaults at ORR are also for the strategic reserve, which includes assembled secondaries and HEU metal castings.

Lithium. The lithium process provides finished lithium hydride and deuteride parts. Primary functional elements of this process include powder production and forming, finishing and inspection, and deuterium production. These systems are briefly described below.

The lithium hydride and deuteride from storage, recycled weapons parts, and manufacturing scrap are broken, crushed, and ground to produce powder. The powder is loaded into molds and cold isostatically pressed to form solid blanks.

The blanks are unloaded from the molds and placed into vacuum furnaces where they are outgassed by heating under vacuum. After cooling, the outgassed blanks are loaded into form-fitting bags, heated, and then warm pressed. After being warm pressed, the blanks are cooled to room temperature and removed from the bags. The fully dense machining blanks that result from forming operations are radiographed to detect any high-density inclusions. Powder production, mold loading, and radiography are all performed in dry glove boxes to minimize reaction of the lithium hydride and deuteride with moisture in the atmosphere. Mold unloading, furnace loading and unloading, and bag loading and unloading are all conducted in an inert glove box. The lithium hydride or deuteride is handled outside inert-atmosphere glove boxes only when it is sealed in a mold or bag.

The blanks from forming operations are machined to final shapes and dimensions on lathes using single-point machining methods in finishing operations. Most machine dust is collected for direct recycle salvage operations. The finished part weight and dimensions are inspected using certified balances and contour measuring machines. All machining and inspection activities are conducted in dry glove boxes to minimize any reaction with moisture in the atmosphere. Certified parts receive a final vacuum outgassing treatment before final assembly.

Deuterium is required for many of the products and will be stored for future use. Deuterium oxide, or heavy water, is electrolytically reduced. The resulting deuterium is compressed and stored for use. The compressed deuterium gas is used to reconvert the lithium metal to deuteride in the final step of wet chemistry if needed.

Lithium wet chemistry can be used to pre-produce lithium hydride and deuteride to meet production requirements for many decades. The principal function of wet chemistry is to purify lithium hydride and deuteride by removing oxygen and other trace elements. The principal feeds to this system are retired weapon components from the disassembly operation, machine dust, powder, and killed parts from other operations. Purification is accomplished by transforming the lithium hydride and deuteride through a chemical dissolution process; then the solution is evaporated and crystallized. The crystals are then reduced to lithium metal and impurities are removed. The lithium metal is then reconverted to lithium hydride and deuteride by combining it with hydrogen or deuterium gas. The resulting lithium hydride and deuteride billet, sealed in a thin stainless-steel can, is transferred to lithium storage.

The production of lithium hydride and deuteride components creates a considerable amount of scrap that must be recycled to recover the lithium and deuterium. Much of the machine dust, unacceptable formed parts, machined parts that fail inspection, and stockpile returned parts are directly recycled. Salvage operations typically process material that is too impure to be recycled. Salvage operations primarily involve washing and chemical recovery. Items that require washing include machining tools and fixtures, filters used throughout the processes, and sample bottles. Oil-soaked lithium hydride and deuteride blanks from the powder-forming operations are also prepared for storage. Solutions from the purification and wash operations, including mop and dike water streams, are neutralized, filtered, crystallized, and sent to storage or waste disposal.

Long-term storage is required for chemicals and pre-produced lithium hydride and deuteride billets. Interim storage is to be provided for lithium hydride and deuteride components from disassembly or retired weapons and rejected components from forming and finishing operations.

Special Materials. Special materials such as diallyl-phthalate are required to support the lithium processes. Diallyl-phthalate based molding compound is formed into near-net-shape blanks that are later machined to finished parts. The primary forming operation is compression or transfer molding, which is followed by a drying and final curing step.

Nonnuclear. The nonnuclear process is responsible for producing certain weapon components composed of nonnuclear materials and for providing the uranium and lithium processes with specialized material and support services. Many types of materials are processed to provide a diverse product line consisting of both nonnuclear metal components and tooling and a variety of polymer-based items. The principal manufacturing technologies employed are hydroforming, hydrostatic forming, rolling, forging, heat treating, welding, machining, cold/hot isostatic pressing, grinding, winding, casting, plating, molding, and coating.

The nonnuclear process handles several product streams, which are described briefly in the following paragraphs.

Several types of urethane foams are required to be produced. The urethane components and blowing agents are pumped into molds and allowed to expand to fill the mold. After curing, the foam moldings are ejected and trimmed to final shape.

Steel and aluminum are construction materials for both components and support tooling, making this a relatively high throughput product line. The usual fabrication route for both materials is rough machining, heat treatment, and finish machining.

Operations to produce stainless steel cans consist of blanking, followed by hydroforming and hydrostatic forming with subsequent machining and heat treatment. Ultrasonic cleaning is required before heat treatment to ensure cleanliness for welding, which completes the assembly.

Ceramic finished parts are finished from blanks or procured. Procured parts are inspected and certified prior to final assembly.

Polyvinyl chloride is formed into bags and castings and also applied as a coating. Items to be coated are dipped into a tank of curable, plasticized polyvinyl chloride formulation, whereas castings are produced by transferring the polyvinyl chloride liquid into a mold. All items are heat cured.

A.3.2.1 Downsize at Oak Ridge Reservation

Y-12 has performed the secondary and case fabrication mission in the Complex for over 40 years. This mission includes the production of materials and components for thermonuclear weapons secondary assemblies and the associated functions such as depleted uranium for radiation cases and other miscellaneous materials for other applications. Figure A.3.2.1-1 shows the location of Y-12 at ORR.

The Y-12 secondary and case fabrication mission requires approximately 30 ha (75 acres) of the existing 328-ha (811-acre) Y-12 site. This, unlike the LANL and LLNL alternatives, includes significant area for support facilities. There would be no new developed land outside the currently existing Y-12 boundary. Land for construction laydown and warehousing would be minimal and would use existing Y-12 developed areas; construction parking requirements, about 0.8 ha (2 acres), can be satisfied by existing unused parking facilities.

The Y-12 complex consists of an array of production and support facilities. The physical configuration for the Y-12 secondary and case fabrication mission consists of five main production buildings, one shared production facility, and a number of office, utility, and changehouse facilities.

During the past 12 years, major restoration projects (such as Production Capability Restoration, Utility System Restoration, and the Capability Assurance Program) have brought the infrastructure supporting this facility up to current standards and should allow the use of these facilities for up to an additional 40 years. Figure A.3.2.1-2 is a plot plan of Y-12 showing these main and shared facilities.

The secondary and case fabrication mission would be located in the following Y-12 production buildings: 9996, 9212, 9215, 9201-5N, 9204-2E, 9204-2 (isostatic press), 9720-19, and 9998. The secondary and case fabrication mission footprint comprises *61,800* m *2* (665,000 ft *2*) of total DP area including a production footprint of *21,840* m *2* (235,000 ft *2*). The total proposed footprint includes all DP functions: production, storage, maintenance, dedicated utilities, and administration. Buildings 9204-2 and 9201-5W would be placed in cold standby to enable reactivation in the event of unforeseen additional capacity demands. Activation of these buildings would require separate NEPA evaluation.

The following production buildings would be used to support the Stockpile Stewardship and Management Program.

Building 9212

- E-wing--Enriched uranium casting and storage would continue in this area. All but two of the west line casters would be placed in standby as would one auxiliary caster. Adjacent to E-wing is the process area for enriched uranium metal recovery, which would be operated by programs other than DP or placed in cold standby.
- A2-wing--This wing would be used as now configured for depleted uranium and binary operations.
- Equipment for metal production from uranium oxide would be held in cold standby.

Building 9998

- Foundry--The staging area and six furnaces would be used.
- H2-Area--This area would contain all of the enriched uranium machining and the associated dimensional inspection. The existing storage area would remain, and G3-Area would be used for ceramic machining and other special materials.
- F-Area--This area would be used in its current configuration for depleted uranium binary and nonnuclear metalworking with the *3,175* t (3,500 ton) press added.

Building 9215

- M-wing--This area would be used for enriched uranium storage.
- O-wing--Enriched uranium rolling and forming would be performed in this area.
- P-wing--This area would continue to be used for hydroforming and would house the can shop, relocated from Building 9210-1.
- N-wing--The third mill area would continue to function as the depleted and alloyed uranium rolling and blanking operation.

Building 9996

- This building would be used as a laydown and tool storage area for the equipment now in service in the Building 9212-A2 Area and the F-Area of Building 9998.

Building 9204-2

- The largest isostatic press would continue to be used for the lithium forming operation. This press is in a self-contained small section of Building 9204-2 that would be sealed. The remainder of Building 9204-2 would be placed in cold standby.

Building 9201-5N

- This building houses machine tools and other preparation and plating equipment dedicated to the production of depleted uranium/ binary alloy/nonnuclear components.

Building 9201-5W

- This building would be placed in cold standby.

Building 9720-19

- The rubber curing shop is located in this facility. This area would not be modified or its function altered.

Building 9204-2E

- This building would be modified to be used for lithium forming and machining. It would continue to function as the assembly facility, a testing (nondestructive testing) facility, and for storage.

No new facilities are required at Y-12 to support the secondary and case fabrication mission. Table A.3.2.1-1 summarizes key facility data, such as plant functions, nuclear materials present, building square footage, number of floors in the building, and type of construction.

Construction. Modification of Y-12 facilities to support the secondary and case fabrication mission would require 6 years to complete. The materials and resources that would be consumed during this period are summarized in table A.3.2.1-2. Emissions generated during construction are provided in table A.3.2.1-3. The principal sources of airborne emissions from construction are fugitive dust, construction activities, and exhaust from construction equipment and vehicles. Construction employment for the Y-12 Secondary and Case Fabrication Facility modification is shown in table A.3.2.1-4.

Operations. The secondary and case fabrication mission processes require the following utilities during operations: electricity, diesel fuel, natural gas, coal, air (compressed, dehumidified, and breathing), water (demineralized, fire, potable, plant, and cooling tower), and steam. Table A.3.2.1-5 presents the estimated utilities consumed during surge operation of the Y-12 secondary and case fabrication facilities. Chemicals consumed during secondary and case fabrication surge operations are summarized in table A.3.2.1-6.

Emissions. The contaminated and potentially contaminated zones within the plant facilities that handle uranium materials have high efficiency particulate air (HEPA) filtered ventilation systems that exhaust to the atmosphere. Some exhausts are provided with liquid scrubbing prior to HEPA filtration to remove chemical vapors such as nitric acid. The annual emissions for surge operation of the Y-12 secondary and case fabrication mission are shown in table A.3.2.1-7.

Table A.3.2.1-1.-- Y-12 Plant Secondary and Case Fabrication Facility Data

Building Number	**Upgraded Uranium/ Lithium Plant Function**	**Upgraded Uranium/ Lithium Facility Usage (percent)**	**Nuclear Materials Present**	**Total Size (m^2)**	**Number of Floors**	**Type of Construction [1]**
9103	Communication/support	10		6,780	3	B-1
9117	Communication/support	10		1,810	1	A-5
9119	Administration/support	100		6,660	4	B-5
9201-5N	Uranium/nonnuclear	85	Uranium	7,480	2	B-2
9204-2E	Uranium	85	Uranium	14,050	3	B-1
	Lithium	10	Lithium			
	Maintenance/support	5				
9212 [2]	Uranium	40	Uranium	28,930	3	B-2
9215	Uranium	90	Uranium	14,590	3	B-2
	Nonnuclear	10				
9401-3	Steam plant support	10		3,130	3	B-4
9404-2	Compressed air/support	40		430	1	B-2
9706-2	Emergency Operations Center	20		2,040	2	A-2
	Medical/support	20				
9710-2	Fire station	10		1,760	1	B-2
9710-3	Security/support	60		3,820	4	B-3
9711-5	Cafeteria/support	10		5,360	2	B-1
9723-31	Changehouse/support	50		2,710	2	B-3
9995	Plant laboratory			7,810	2	B-3
	Uranium	6	Uranium			
	Lithium	3	Lithium			
	Nonnuclear	1				

9996	Uranium	100	Uranium	3,110	2	B-3
9998	Uranium	70	Uranium	12,740	2	B-3
	Nonnuclear	20				

Table A.3.2.1-2.-- Y-12 Plant Secondary and Case Fabrication Construction Materials/Resources Requirements

Material/Resource	Total Consumption	Peak Demand [3]
Concrete (m3)	100	
Electricity (MWh)	2.7	0.2 MWe
Industrial gases [4] (m *3*)	300	
Liquid petrochemicals (L)	10,000	
Steel (t)	20	
Water (L)	2,000,000	

Table A.3.2.1-3.-- Y-12 Plant Secondary and Case Fabrication Construction Emissions

Pollutant	Quantity (t)
Carbon monoxide	2.4
Nitrogen oxides	0.8
Particulate matter	0.6
Sulfur dioxide	0.1
Total suspended particles	1.0
Volatile organic compounds	1.2
OR MMES 1996j .	

Table A.3.2.1-4.-- Y-12 Plant Secondary and Case Fabrication Construction Workers

Employees	97	98	99	00	01	02	Total [5]
Craftworkers							
Carpenter	0.4	0.4	0.4	0.4	0.4	0	2
Concrete mason	0.2	0.2	0.2	0.2	0.2	0	1
Electrician	1	1	1	1	0.5	0.5	5
Iron worker	2	2	2	2	2	2	12
Laborer	1	1	2	1	1	1	7
Millwright		0.5	0.5	0.5	0.5		2
Operator	0.5	0.5	0.5	0.5	0.5	0.5	3
Other craftworkers	0.2	0.2	0.2	0.2	0.2		1
Pipe fitter	0.5	0.5	0.5	0.5	0.5	0.5	3

Sheet metal worker	0.4	0.4	0.4	0.4	0.4		2
Sprinkler fitter							0
Teamster	0.3	0.3	0.3	0.4	0.4	0.3	2
Total Craftworkers	6.5	7.0	8.0	7.1	6.6	4.8	*40*
Construction management and support staff	5.2	5.6	6.4	5.7	5.3	3.8	32
Total Employment	11.7	12.6	14.4	12.8	11.9	8.6	*72*

Table A.3.2.1-5.-- Y-12 Plant Secondary and Case Fabrication Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand [6]
Coal (t)	500	
Diesel fuel (L)	250,000	
Electricity	118,000 MWh	19.0 MWe
Natural gas [7] (m ^{3})	17,000,000	
Raw water (L)	1,510,000,000	

Table A.3.2.1-6.-- Y-12 Plant Secondary and Case Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)
Solid Chemicals	
Aluminum trihydride	3,000
Barium nitrate	15
Borax	15
Calcium hydroxide	30,000
Calcium nitrate	150
Calcium oxide	150
Curing agent	4
Diatomaceous earth	2,500
Epoxy resin	10
Erbium oxide	75
Ferric sulfate	7,500
Graphite	2,000
Lithium carbonate	1,200
Magnesium sulfate	100
Methylene diphenyl diisocyanate	100
Nickel compounds	75
Polycure	75
Potassium carbonate	3,000

PVC plastisol	1,500
Silicon carbide	40
Sodium bicarbonate	75
Sodium carbonate	450
Sodium molybdate dihydrate	5
Sodium nitrate	1,500
Sodium potassium	3
Trisodium phosphate	250
Tungsten carbide	1
Yttria	150
Zirconium oxide	180
Liquid Chemicals	
Acetic acid	15
Acetone	8
Acetonitrile	150
Anisol	200
Corrosion inhibitor	800
Diamond paste	1
Diesel fuel	75,000
Ethanol	1,000
Gasoline	110,000
Hydraulic oil	3,000
Hydrogen peroxide	750
M-pyrol	50
Methanol	2,500
Micro/oakite detergent	12
Mineral oil	1,500
Mold release	7.5
Nitric acid	1,000
Nitrogen tetroxide	150
Oxalic acid	2
Petroleum oils (lubricants)	1,500
Potassium chloride	15
Propylene glycol	150
Pump oil	3
PVC primer	2
Solvent 140	750
Toluene 2,4-diisocyanate	100
1,1,1-Trichloroethane	800
Gaseous Chemicals	
Ammonia, anhydrous	*7.5*
Argon	*1,400,000*
Carbon dioxide	*30,000*
Chlorine	*75*
Freon or equal (cleaning)	*750*

Helium	*6,000*
Hydrogen	*1,500*
Nitrogen	*5,000,000*
Oxygen	*50,000*
Note: PVC- polyvinyl chloride. Source: OR MMES 1996j; ORR 1995a:4 .	

Employment. Y-12 generally operates with one shift per day, 5 days per week, except for some utility systems and security functions that operate continuously. Surge capacity would be accommodated by operating multiple shifts. The employment during surge operation for the secondary and case fabrication mission is summarized in table A.3.2.1-8. The data presented includes employees from the management and operating contractor, support organizations, and DOE.

Table A.3.2.1-7.-- Y-12 Plant Secondary and Case Fabrication Surge Operation Annual Emissions

Pollutant	**Quantity** (t)
Carbon monoxide	7.4
Chlorine	0.15
Hydrogen chloride	4.8
Methyl alcohol	14
Nitric acid	7.1
Nitrogen oxides	195
Ozone	0.07
Particulate matter	0.5
Pressing lubricant	0.3
Sulfuric acid	1.8
Sulfur dioxide	80
Total suspended particles	10
Volatile organic compounds	1.2
Radiological Isotope	**Estimated Release**
Uranium-235 (microcuries)	420
Uranium-238 (microcuries)	1,490
OR MMES 1996j; ORR 1995a:4.	

Approximately 20 percent of the dosimeter badged population at Y-12 routinely work inside the radiological area (uranium handling areas). Based on current design definition, 20 percent is also assumed for the Y-12 secondary and case fabrication mission. Therefore, it is estimated that 174 of the badged employees would be at risk of radiological exposure as shown in table A.3.2.1-8. In addition, on a nonroutine basis, a small fraction of badged visitors may enter the radiological area.

Table A.3.2.1-8.-- Y-12 Plant Secondary and Case Fabrication Surge Operation Workers

Labor Category	**Number of Employees**	**Risk of Radiological Exposure**
Craftworkers	131	61
Laborers	8	--

Officials and managers	88	7
Office and clerical	95	--
Operatives	93	43
Professionals	284	35
Service workers	584	--
Technicians	93	28
Total Employees	*1,376*	174
OR MMES 1996j; ORR 1995a:4.		

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor. Uncontaminated wastewater would be managed per site practice. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. A small amount of solid LLW consisting of contaminated steel and concrete would be generated. This waste would be placed in an appropriate container and shipped to an approved LLW disposal facility.

The project design considers and incorporates waste minimization and pollution prevention. Production processes would be configured with minimization of waste production given high priority. Future D&D considerations have also been incorporated into the design.

Table A.3.2.1-9 presents the estimated annual waste volumes from the secondary and case fabrication facilities during modifications and surge operations. Solid and liquid waste streams are routed to the waste management system. Figures A.3.2.1-3 through A.3.2.1-6 [figure A.3.2.1-4] [figure A.3.2.1-5] depict the waste management system. Solid wastes would be characterized and segregated into low-level, hazardous, and mixed wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire-sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

Table A.3.2.1-9.-- Y-12 Plant Secondary and Case Fabrication Waste Volumes

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	320	None
Solid	8	1,120 [8]	570 [9]
Mixed Low-Level			
Liquid	None	3,400	3,400
Solid	1	92 [10]	92
Hazardous			
Liquid	None	Included in mixed	Included in mixed
Solid	2	Included in mixed	Included in mixed
Nonhazardous (Sanitary)			
Liquid	27	320,000	319,400 [11]
Solid	30 [12]	13,500 [13]	7,670 [14]
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	2	10,000 [15]	Included in sanitary

Spent Nuclear Fuel. The Secondary and Case Fabrication Facility would not generate any spent nuclear fuel.

Transuranic Waste. The Secondary and Case Fabrication Facility would not generate any TRU wastes.

Low-Level Waste. LLW would be generated by operation of the Secondary and Case Fabrication Facility and would consist primarily of depleted uranium oxide in drums and contaminated scrap metal, air filters, and HEPA filters. Approximately 10 percent of all LLW generated would currently be suitable for disposal onsite. The remaining waste would be packaged for offsite treatment and disposal at the waste feed preparation facility and stored at K-25, pending disposal at an approved disposal facility. Scrap metal would be sent offsite for smelting into shielding blocks for DOE use.

Mixed Low-Level Waste. Mixed LLW would be generated from operation of the Secondary and Case Fabrication Facility and would consist primarily of ash and sludge immobilized in grout, compacted gloves, and wipes. Mixed LLW would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. Waste suitable for incineration would be sent to the K-25 TSCA incinerator. After compaction, if appropriate, the remaining solid wastes would be packaged and stored onsite awaiting disposal by an offsite commercial vendor.

Hazardous Waste. These materials are included in the mixed LLW.

Nonhazardous (Sanitary) Waste. Sewage wastewater would be discharged directly to the Oak Ridge Municipal Wastewater Treatment System sewer system. Process wastewater would be treated in the sanitary wastewater treatment facilities and discharged through permitted NPDES outfalls. Sludge would be stored onsite, pending treatment by a commercial vendor. Nonhazardous solid wastes including small amounts of classified nonhazardous waste would be generated from operation of the Secondary and Case Fabrication Facility and disposed of in a State of Tennessee permitted Class II landfill.

Nonhazardous (Other) Waste. Nonrecyclable (other) wastes would be disposed of in a permitted landfill or discharged through permitted NPDES outfalls.

A.3.2.2 Relocate to Los Alamos National Laboratory

LANL secondary and case fabrication facilities would include all of the functional operations required to physically and chemically process, machine, inspect, assemble, certify, and disassemble secondary materials to produce canned subassemblies and radiation case components for the nuclear weapons physics package.

The secondary and case fabrication facilities would occupy 21,739 m2 (234,000 ft2) of floor space inside existing structures within their current footprint of 1.1 ha (2.7 acres). Additional land area for the construction of new buildings would not be required. A nominal area would be required for equipment staging, material laydown, and parking during the modifications of these facilities.

Facility Description. Secondary and case fabrication would utilize existing facilities within the boundaries of TAs -3, -8, -50, -54, and -55 (figure A.3.2.2-1). Facilities within each of these technical areas include the TA-3 Sigma Complex (SM-35, SM-66, and SM-141), the TA-3 Chemistry and Metallurgy Research building (SM-29), the TA-3 main machine shop (SM-39 and SM-102), the TA-8 Nondestructive Evaluation Facility (Buildings 22 and 23), the TA-55 Nuclear Material Storage Facility for overflow capacity, the TA-50 Liquid Radioactive Waste Treatment Facility, and the TA-54 Solid Radioactive Waste Treatment Area.

The flow of fissile material would be contained within the Chemistry and Metallurgy Research building (SM-29). Manufacturing operations would take their feeds from both incoming stockpile returns and the chemical recovery process. Components from manufacturing would be sent back out for assembly. Low-equity waste (graphite, booties, and machining fluids) would be sent back to waste management for processing, storage, and disposal. Recoverable quantities of fissile material would be reprocessed in chemical recovery and returned as feed stock to manufacturing.

Figure A.3.2.2-2 shows the major structures located in TA-3. The buildings shown on this plot plan for use in stockpile stewardship and management operations are SM-29, SM-35, SM-39, SM-66, SM-102, and SM-141. Modifications are required for the following facilities:

- Renovations to Chemistry and Metallurgy Research building Wings 2, 4, and 9
- SM-102 change room and ventilation upgrades
- SM-66-D103 lithium forming, machining, and inspection
- SM-35 lithium purification, salvage, and storage

Table A.3.2.2-1 summarizes key facility data for the building and support structures to be utilized in secondary and case fabrication.

The Chemistry and Metallurgy Research building is a large reinforced concrete building with a basement, a first floor, and an attic floor. This building has been classified as a Performance Category PC-3 Nuclear Facility (per DOE-STD-3009-94). The administration wing and

Wing 1 contain second-floor office areas. The plan of the building is centered on a spinal corridor oriented in a north-south direction with an administration wing and seven laboratory wings (Wings 1, 2, 3, 4, 5, 7, and 9) that extend from the corridor. Wings 2, 3, 4, 5, and 7 have equipment/change rooms located at the front of each wing and filter towers located at the end of the wings, which house the filter plenum and other large mechanical equipment for the exhaust ventilation system. The building also contains a waste assay facility located at the loading dock between Wings 1 and 4 and a Category I special nuclear material vault. The Chemistry and Metallurgy Research building replaced the World War II "D" building and was designed to house analytical chemistry facilities, plutonium metallurgy, uranium chemistry, engineering design and drafting, electronics, and other support functions. At the time it was built, the Chemistry and Metallurgy Research building represented the state-of-the-art instrumentation and safety controls for a modern chemistry laboratory.

Table A.3.2.2-1.-- Los Alamos National Laboratory Secondary and Case Fabrication Facility Data

Building	Footprint (m2)	Number of Levels	Special Materials	Construction Type
SM-29 Chemistry and Metallurgy Research	51,097	3	Special nuclear materials	Concrete post and beam with concrete masonry unit in-fill walls
SM-66 Sigma	15,794	3	NA	Concrete post and beam with concrete masonry unit in-fill walls
SM-39 Nonnuclear Shops	14,202	3	NA	Concrete post and beam with concrete masonry unit in-fill walls
SM-102 Uranium Shops	2,090	3	NA	Concrete post and beam with concrete masonry unit in-fill walls
SM-141 Rolling Mill	1,858	2	NA	Concrete post and beam with concrete masonry unit in-fill walls
SM-35 Press	929	2	NA	Concrete foundation with steel pillars and sheet metal walls
SM-67 Guard Station Sigma	22.9			
SM-127 Cooling Tower	138			
SM-145 Switchgear Station	39			
SM-147 Air Plenum and Fan	15.2			
SM-154 Chemistry and Metallurgy Research Cooling Tower	37.2			
SM-159 Forming	14.9			
SM-161 Magazine	1.5			
SM-169 Warehouse	581			
SM-187 Cooling Tower	37.2			
SM-317 Graphite Flour Storage	140.5			
SM-451 Micro Machining	160			
TA-8-22 Nondestructive Evaluation Lab	843			

TA-8-23 Nondestructive Evaluation Support	316			
NA - not applicable. **LANL 1995e.**				

The Sigma Complex comprises three main processing buildings located in TA-3 just east of the Chemistry and Metallurgy Research building. The fenced area encompassing the Sigma Facility contains a total of 16 buildings. The three buildings designated as SM-66, SM-141, and SM-35 contain the majority of laboratory space. Other structures house utilities, support functions, and storage areas. The Sigma Complex has been classified as a low-hazard chemical (PC-1), nonnuclear facility.

The Press building (SM-35) is the oldest building in this complex. Construction was completed in 1953. The building was originally designed to house the 4,536-t (5,000-ton) press for the Materials Technology Group. Building construction consists of a concrete foundation and supporting steel pillars with insulated double sheet metal walls outside. Inside walls (separating various work areas and offices) are similar or made of concrete block.

The Rolling Mill building (SM-141) has reinforced concrete foundations, floors, support columns, and beams with concrete block exterior walls. Interior walls separating various work areas and offices are made of concrete block and/or metal studs with gypsum board. The roof is built of tar and gravel over rigid insulation and is supported by steel joists. The building was designed to house areas for powder metallurgy and fabrication. Today the Rolling Mill building continues to house these activities in addition to work areas for ceramics research, beryllium technology, and development and rapid solidification research.

The Sigma building (SM-66) was constructed in 1959 and was originally designed to house activities in physical metallurgy, ceramics, powder metallurgy, plastics, a metal foundry, electrochemistry, fabrication, and other support functions. Today the Sigma building continues to house all these functions except plastics. The building is built on a reinforced concrete foundation using reinforced concrete post and beam construction techniques. The exterior walls are constructed of concrete block fill between the supporting posts and beams. The mezzanine spaces are constructed of supported metal decking. Interior walls separating various work areas and offices are also concrete block or metal studs and gypsum board. The roof is built of tar and gravel over rigid insulation and metal decking supported by steel joists. The building has a basement, a first floor, and a small second floor. The plan of the building is on a spinal corridor oriented in a north-south direction. SM-66 has 11 major work areas that extend from the corridor.

Building SM-102 is connected to the Main Shops building, SM-39, by a 38-m (125-ft) long corridor. Constructed in the late 1950s, it originally housed a foundry, a heat-treating operation, a graphite machining shop, and a radioactive materials machine shop. Since that time, the northeast corner of the building, which provided programmatic support to the Rover Project, has been decommissioned and now is dedicated to the support of Engineering, Sciences, and Applications division operations. Currently, the southern half of the building is occupied primarily by Shop 13, the uranium and lithium machine shops. The building is constructed of cinder block and has a concrete floor. Shop 13 contains machines that are used for machining operations on uranium. The majority of the building houses pyrophoric, toxic, and radioactive material machining and a dimensional inspection area. SM-102 has been classified as a low-hazard chemical (PC-1), nonnuclear facility.

Building SM-39 is of concrete and cinder block construction. The main bay is aligned from north to south and is 183 m (600 ft) in length by 37 m (120 ft) in width. Three wings extend eastward from the north and south ends of the bay, as well as the middle of the main bay. The south main (high) bay section, the middle wing, and the south wing contain metal and machining shops owned by the Mechanical Fabrication Group. SM-39 has been classified as a low-hazard chemical (PC-1), nonnuclear facility.

The north wing contains offices occupied by the Materials Technology Polymers & Coatings Group (MST-7) and the Standard and Calibration Group (ESH-9). It also contains Mechanical Fabrication Group beryllium machining and inspection, a glass shop operated by MST-7, and a Standards and Calibration Laboratory operated by ESH-9. Three transportable equipment storage trailers are located on the south side of the north wing.

Construction. Modification to the LANL facilities to perform the stockpile management secondary and case fabrication mission would require approximately 7 years for design, construction, mission transfer, and operational startup. With conceptual design beginning in 1997, operational startup could commence in 2004. The materials and resources consumed during modification activities are provided in table A.3.2.2-2.

Emissions generated during modification activities are provided in table A.3.2.2-3. The principal sources of airborne emissions during modification are fugitive dust, construction debris, and exhaust from construction equipment and vehicles.

Table A.3.2.2-2.-- Los Alamos National Laboratory Secondary and Case Fabrication Construction Materials/Resources Requirements

Material/Resource	Total Consumption	Peak Demand 16
Concrete (m^3)	245	
Electricity	4,130 MWh	0.75 MWe
Industrial gases 17 (m^3)	11,500	
Liquid fuel (L)	22,700	
Steel (t)	54	
Water (L)	4,160,000	

Table A.3.2.2-3.-- Los Alamos National Laboratory Secondary and Case Fabrication Construction Emissions

Pollutant	Quantity (t)
Carbon monoxide	<1 *18*
Lead	0
Nitrogen dioxide	<1 *18*
Particulate matter	<1 *18*
Sulfur dioxide	<118
Volatile organic compounds	0

Employment needs during the modification phase are presented in table A.3.2.2-4.

Operation. The secondary and case fabrication processes require the following utilities during operation: electricity, natural gas, diesel fuel, air, water, and steam. Table A.3.2.2-5 presents a listing of the utilities consumed during Secondary and Case *Fabrication Facility surge operations*. Chemicals consumed during operation are summarized in table A.3.2.2-6.

The annual emissions from surge operation required in the Secondary and Case Fabrication Facility are based on historical emissions and amounts of materials to be processed as shown in table A.3.2.2-7.

Employment. The employment needs in support of secondary and case fabrication surge operation activities at LANL are summarized in table A.3.2.2-8.

Table A.3.2.2-4.-- Los Alamos National Laboratory Secondary and Case Fabrication Construction Workers by Year

Labor Category	Year 1	Year 2	Year 3	Year 4	Total
Total craftworkers	34	45	45	45	169
Construction management and support staff	6	10	10	10	36
Total Employment	40	55	55	55	205
LANL 1995e.					

Table A.3.2.2-5.-- Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand [19]
Diesel fuel (L)	100,000	
Electricity	36,000 MWh	5 MWe
Natural gas [20] (m^3)	0	
Water (L)	55,000,000	

Table A.3.2.2-6.-- Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)
Solid Chemicals	
Aluminum nitrate	75
Aluminum trihydride	3,000
Barium nitrate	15
Borax	15
Calcium hydroxide	30,000
Calcium nitrate	150
Curing agent	4
Epoxy resin	10
Ferric sulfate	7,500
Graphite	2,000
Lithium chloride	6,000
Magnesium sulfate	100
Methylene diphenyl diisocyanate	100
Nickel compounds	75
Polycure	75
Potassium carbonate	3,000
PVC plastisol	1,500
Silicon carbide	40
Sodium bicarbonate	75
Sodium carbonate	450
Sodium molybdate dihydrate	5
Sodium nitrate	1,500
Trisodium phosphate	250
Tungsten carbide	1
Yttria	300
Liquid Chemicals	
Acetic acid	15
Acetone	20

Acetonitrile	150
Anisol	200
Corrosion inhibitor	800
Diamond paste	1
Dibutyl carbitol	1,000
Ethanol	1,000
Gasoline and diesel	100,000
Hydraulic oil	3,000
Hydrogen peroxide	750
Kerosene, high grade	150
M-pyrol	50
Methanol	2,500
Micro/oakite detergent	12
Mineral oil	1,500
Mold release	7.5
Nitric acid	1,000
Nitrogen tetroxide	150
Oxalic acid	2
Petroleum oils (lubricants)	1,500
Potassium chloride	15
Propylene glycol	150
Pump oil	3
PVC primer	2
Solvent 140	750
Toluene 2,4 diisocyanate	100
Gaseous Chemicals	
Ammonia, anhydrous	*7.5*
Argon	*1,000,000*
Carbon dioxide	*10,000*
Chlorine	*75*
Freon or equal (cleaning)	*750*
Helium	*6,000*
Hydrogen	*1,500*
Nitrogen	*500,000*
Oxygen	*50,000*
Note: PVC- polyvinyl chloride. Source: LANL 1995b:4; LANL 1996e:1.	

Table A.3.2.2-7.-- Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Annual Emissions

Pollutant	Quantity (t)
Carbon monoxide	4.5
Lead	0.1
Nitrogen dioxide	117

Particulate matter	0.3
Sulfur dioxide	48
Volatile organic compounds	0.6
Radiological Isotope	*Estimated Release*
Uranium 235 (microcuries)	486
Uranium 238 (microcuries)	1776
LANL 1995b:4.	

Table A.3.2.2-8.-- Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Workers

Labor Category	Number of Employees	Employees at Risk of Radiological Exposure
Office and clerical	26	0
Officials and managers	34	4
Professionals	37	13
Service workers	244	61
Technicians	182	73
Total Employees	523 [21]	151

Nearly all of the personnel performing operations in the secondary fabrication facilities would be dosimeter-badged. As shown in table A.3.2.2-8, it is estimated that approximately 151 workers would be at risk of radiological exposure. In addition, a small fraction of badged visitors may nonroutinely enter radiological areas.

Waste Management. Wastes generated during secondary and case fabrication operations include radioactive, mixed, hazardous, and nonhazardous byproducts. Secondary and case fabrication operations would not generate any high-level or TRU wastes. Low-level radioactive waste would consist primarily of depleted uranium oxide chips, contaminated scrap metal, and filter media. Mixed and hazardous wastes would consist of ash, sludges, filters, rags, and wipes. Liquid radioactive and inorganic chemical wastes that meet the LANL waste acceptance criteria are sent either by truck or industrial drain to be processed at TA-50, Building 1. Mixed wastes are currently stored at TA-54; liquids in Area L and solids in Area G. Hazardous and organic chemical (RCRA) wastes are packaged and shipped to TA-54, Area G, for interim storage and subsequently shipped offsite. Nonhazardous solid waste is collected in dumpsters and taken to the landfill operated by Los Alamos County. Sanitary liquids are disposed of by either sanitary drain or permitted outfall. Sanitary process and support liquids are sent by drain to the sanitary wastewater treatment plant, TA-46, and treated similarly to municipal sewage. Table A.3.2.2-9 provides an estimate of the annual quantities of these waste categories for Secondary and Case Fabrication Facility surge operation.

Table A.3.2.2-9.-- Los Alamos National Laboratory Secondary and Case Fabrication Waste Volumes

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	192	None
Solid	134	690	349 [22]
Mixed Low-Level			

Liquid	None	30	30
Solid	10	108	108
Hazardous			
Liquid	None	60	60
Solid	37	216	216
Nonhazardous (Sanitary)			
Liquid	890	20,240	20,370
Solid	120	1,160	639 [23]
Nonhazardous (Other)			
Liquid	Included in sanitary	None	None
Solid	10 [24]	3,000	3,000

A.3.2.3 Relocate to Lawrence Livermore National Laboratory

The LLNL secondary and case fabrication facilities would be housed within existing buildings at the Livermore Site (figure A.3.2.3-1). All of the structures required to house the secondary and case fabrication functions are in place; finalizing the capability would require installing some new equipment, moving existing equipment to other locations, and modifying some facilities to meet production requirements. A new structure, a 167-m2 (1800-ft2) steel framed, Butler-type building would be required to provide covered space within the Superblock protected area in which to house the enriched uranium inventory. At the Livermore Site, the existing security system for the fenced Superblock could be used with minor modifications to include Building 239, the radiographic facility for enriched uranium fabrication, assembly, disassembly, storage, and surveillance operations.

Manufacturing and assembly of the canned secondary assemblies would take place in the buildings indicated on the Livermore Site plan, figure A.3.2.3-2. The overall site occupies approximately 332 ha (821 acres) and is surrounded by security fencing. The individual facilities to be used for secondary and case fabrication are within protected areas, limited areas, or exclusion areas as required for security and safeguards. Support facilities are located both inside and outside the security areas but inside the overall site perimeter fence, which is controlled at the entrances to the perimeter fenced area. The required facilities comprise approximately 19,500 m2 (210,000 ft2) and cover approximately 2 ha (5 acres). The Livermore Site has sufficient yard area and warehousing space to accommodate required laydown areas for receipt and staging of equipment and construction materials. In addition, parking for construction workers is available onsite.

Facility Description. Uranium parts are fabricated within a high-security, fenced area of the Livermore Site Superblock. Building 332 would house casting, machining, chemical recovery, destructive testing, nondestructive testing, dimensional inspection, storage, and A/D/ surveillance operations. LLNL would use Building 334 as an additional site for A/D/surveillance operations and for metalworking of uranium parts.

The uranium processing facility is divided into three heating ventilation and air conditioning zones for radioactive contamination confinement. Zone 1 comprises areas where radioactive materials are handled and processed and includes enriched uranium receiving, processing, and storage areas. Zone 2 consists of areas where there is normally no radioactive contamination, but where there is the possibility of contamination. This zone includes the rooms containing glove boxes, process operating areas, and service corridors surrounding Zone 1 areas. Building 332 is a reinforced-concrete structure meeting the requirements of DOE 430.1, Life-Cycle Asset Management. The existing fire protection; radiation monitoring; heating, ventilation, and air conditioning; and emergency power facilities in Building 332 would be used. Building 239 would be used for radiography. Other buildings used in enriched uranium operations would include Building 177 for mass spectroscopy and Buildings 222, 235, and 251. These buildings are existing facilities that are adequate for this mission, and only minor modifications and upgrades would be needed.

As in the uranium parts manufacture, Building 239 is used for radiography, Building 177 for mass spectroscopy, and Buildings 222 and 251 for chemical laboratory analysis. The existing facilities in Building 235 are used for chemical laboratory analysis and nondestructive testing. Additional non-destructive testing functions take place in Building 327. Building 322 is used for some uranium part plating operations. The existing facilities in Buildings 322 and 327 are adequate for this mission. All of these facilities have been reviewed and approved for adequacy of building construction in accordance with applicable design codes and standards for the planned mission to be performed.

The special materials fabrication operations are performed in Buildings 231 and 241. Mass spectroscopy will be done in the existing facilities in Building 177, and chemical laboratory analysis in Buildings 222 and 235. Dimensional inspection is done in Building 321. Special materials would be fabricated in existing facilities in Building 231, with finishing operations to take place in Building 241. Again, all of these facilities have been reviewed and, with the exception of Building 241, approved for adequacy of building construction in accordance with applicable design codes and standards for the planned mission to be performed. Building 241 would require some minor, additional seismic retrofits before operations could commence.

The nonnuclear component fabrication capabilities would be housed in the extended Building 321 area complex at the Livermore Site. This includes the major Buildings 321 (with Wings A, B, C), 327, 329, and 322. Mechanical specimen testing would be performed in Building 231.

Table A.3.2.3-1 summarizes key facility data for the buildings and support structure to be utilized in secondary and case fabrication. While table A.3.2.3-1 summarizes all the facilities that are proposed for the canned secondary assemblies mission at LLNL, many of the facilities are used only for sample tests and are existing facilities that would be used as is and shared with other LLNL programs. Buildings 177, 222, 235, 251, 322, 327, and 329 fit into this category. The remaining facilities are discussed because they are the main processing facilities for the canned secondary assemblies mission.

Table A.3.2.3-1.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Facility Data

Building Name	Footprint (m2)	Number of Levels	Special Materials	Construction Type
B-175	734	1	None	Reinforced concrete
B-177	28	1	SNM	Steel frame
B-222	113	1	SNM	Steel frame
B-231	1,661	1	None	Steel frame
B-235	140	2	SNM	Steel frame
B-239, Radiography	136	2 + basement	SNM	Reinforced concrete
B-241	620	1	None	Steel frame
B-251	19	1	SNM	Steel frame
B-321	13,945	2	None	Steel frame
B-322	149	1	None	Steel frame
B-327	143	1	None	Steel frame
B-329	484	1	None	Steel frame
B-332	738	2	SNM	Reinforced concrete
B-334	438	3	SNM	Reinforced concrete
New, Butler storage building	167	1	SNM	Steel frame

SNM - special nuclear materials.

LLNL 1995e.

Construction. Modification to the Livermore Site facilities, as discussed above, to perform the secondary and case fabrication mission would require approximately 3 years based on a fiscal year 1998 start date, with the first production unit scheduled for the beginning of 2004. To meet this milestone, facilities would have to be in place several years before that date to provide for certification of equipment and processes and for training and certification of personnel. It is anticipated that facilities would be required to be in place for this activity no later than 2001.

The materials and resources consumed during the modification phase are provided in table A.3.2.3-2. Information is based on a 3-year construction schedule.

Table A.3.2.3-2.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Construction Materials/ Resources Requirements

Material/ Resource	Total Consumption	Peak Demand
Concrete (m3)	612	

Electricity	3,500 MWh	400 kW [25]
Gasoline, diesel fuel, and lube oil (L)	908,000	
Industrial gases [26] (m3)	142	
Steel (t)	73	
Water (L)	8,710,000	

Estimated emissions generated during modification activities for the secondary and case fabrication mission at LLNL are provided in table A.3.2.3-3. The principal sources of airborne emissions during facility modification would be fugitive dust, construction debris, and exhaust from construction equipment and vehicles. The peak year is defined as the year when modification activities would be the highest and equipment is anticipated to be arriving for installation.

Table A.3.2.3-3.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Construction Emissions

Pollutant	Quantity (t)
Carbon monoxide	635
Oxides of nitrogen	63.5
Particulate matter	544
Sulfur dioxide	5.44
Volatile organic compound	6.53
LLNL 1995e.	

Employment needs during the modification period are presented in table A.3.2.3-4. The modification activities would include some site work on the secondary fence enclosure of Building 239; seismic upgrades to Buildings 231 and 242; upgrades to building utilities such as electrical distribution systems, heating, ventilation and air conditioning, and security systems; and installation and checkout of equipment.

Table A.3.2.3-4.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Construction Workers

Employees	Year 1	Year 2	Year 3	Total
Construction management and support staff	15	15	10	40
Craftworkers	115	115	60	290
Total Employment	130	130	70	330
LLNL 1995e.				

During modification activities, some support personnel and crafts would be at risk of radiological exposure. Approximately 20 personnel involved in decontamination of the 5 rooms in Building 332 would be at risk during the first year of construction. However, since the building is a certified plutonium handling facility, all construction personnel working in this building during the modification phase would be at some risk of radiological exposure.

Operations. The secondary and case fabrication processes would require consumable materials and resources to maintain facility operations. Annual utility consumption for surge operations secondary and case fabrication at the Livermore Site is presented in table A.3.2.3-5.

Table A.3.2.3-5.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand 27
Electricity	15,000 MWh	2 MWe
Liquid fuel (L)	85,200	
Natural gas 28 (m3)	566,000	
Raw water (L)	194,000,000	

Table A.3.2.3-6 lists the estimated annual chemicals consumed during surge operation of the secondary and case fabrication mission at LLNL.

Table A.3.2.3-6.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Mission Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)
Solid Chemicals	
Aluminum trihydride	875
Barium nitrate	4
Borax	4
Calcium hydroxide	8,730
Calcium nitrate	45
Calcium oxide	45
Curing agent	1
Diatomaceous earth	730
Epoxy resin	3
Erbium oxide	25
Ferric sulfate	2,200
Graphite	590
Lithium carbonate	350
Magnesium sulfate	30
Methylene diphenyl diisocyanate	30
Nickel compounds	25
Polycure	25
Potassium carbonate	875
PVC plastisol	450
Silicon carbide	15
Sodium bicarbonate	25
Sodium carbonate	135
Sodium molybdate dihydrate	1
Sodium nitrate	440
Sodium potassium	1
Trisodium phosphate	75
Tungsten carbide	0.3
Yttria	45

Zirconium oxide	55
Liquid Chemicals	
Acetic acid	4
Acetone	2
Acetonitrile	45
Anisol	60
Corrosion inhibitor	240
Diamond paste	0.3
Diesel fuel	21,850
Ethanol	300
Gasoline	32,000
Hydraulic oil	875
Hydrogen peroxide	220
M-pyrol	15
Methanol	730
Micro/oakite detergent	3
Mineral oil	440
Mold release	2
Nitric acid	300
Nitrogen tetroxide	45
Oxalic acid	0.1
Petroleum oils (lubricants)	440
Potassium chloride	4
Propylene glycol	45
Pump oil	1
PVC primer	1
Solvent 140	220
Toluene 2,4-diisocyanate	30
1,1,1-Trichloroethane	235
Gaseous Chemicals	
Ammonia, anhydrous	*2*
Argon	*407,300*
Carbon dioxide	*8,750*
Chlorine	*25*
Freon or equal (cleaning)	*220*
Helium	*1,750*
Hydrogen	*440*
Nitrogen	*1,450,000*
Oxygen	*14,550*

Note: PVC- polyvinyl chloride.

LLNL 1995e; LLNL 1995i:3.

The estimated annual emissions from surge operation of the Secondary and Case Fabrication Facility are based on historical emissions and amounts of materials to be processed and are shown in table A.3.2.3-7.

Table A.3.2.3-7.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Surge Operation Annual Emissions

Pollutant	Quantity (t)
Carbon dioxide	3,100
Carbon monoxide	1.0
Chloride	1.6
Chlorine	0.05
Methyl alcohol	4.5
Nitric acid	2.3
Nitrogen dioxide	1.9
Ozone	0.03
Particulate matter	0.1
Pressing lubricant	0.1
Sulfur dioxide	0.02
Sulfuric acid	0.6
Total suspended particulates	3.2
Volatile organic compounds	0
Water vapor	1,040
Radiological Isotope	Estimated Release
Uranium-235 (microcuries)	135
Uranium-238 (microcuries)	480
LLNL 1995e; LLNL 1995i:3.	

Employment. The additional employment needs in support of secondary fabrication surge activities at LLNL are summarized in table A.3.2.3-8.

Approximately 250 (33 percent) badged employees would work inside radiological areas and are considered to be at risk for radiological exposure. In addition, a small fraction of badged visitors may nonroutinely enter radiological areas. Table A.3.2.3-8 provides a breakdown of those employees who may be at risk of radiological exposure.

Table A.3.2.3-8.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Surge Operation Workers

Labor Category	Number of Employees	Employees at Risk of Radiological Exposure
Office and clerical	120	0
Officials and managers	45	10
Operatives	330	150
Professionals	120	50
Technicians	145	40
Total Employees	760 [29]	250

Waste Management. Radioactive wastes generated from construction activities would be from the five rooms in Building 332 which must be decontaminated before the installation of new equipment. Included in this waste is some ducting, flooring, equipment that would need to be disposed of, and building partitioning materials. Hazardous waste would consist primarily of lubricants and coolants that would be recycled or disposed of in accordance with RCRA guidelines. Nonhazardous solids include construction debris, metal, containers, and packaging materials. Liquid nonhazardous wastes would be treated locally and discharged to the sanitary sewer or hauled to an offsite facility for treatment and disposal. Wastes generated during replacement secondary fabrication operations include radioactive, mixed, hazardous, and nonhazardous byproducts. Table A.3.2.3-9 provides an estimate of the quantities of these waste categories effluent volumes as a result of secondary fabrication construction and surge operations. Secondary and case fabrication operations would not generate any spent nuclear fuel, HLW, or TRU wastes.

LLW generated from fabrication activities includes protective clothing, abrasive materials, cutting tools, filters, small equipment, and mop water contaminated with uranium. This waste would be treated by sorting, separation, concentration, and size reduction processes. Processed LLW would be surveyed and shipped to an offsite facility for land disposal.

Mixed wastes would consist of analytical solutions, wipes and rags with acetronitrile and acetone, and organic wastes contaminated with uranium. These wastes would be packaged and shipped to a DOE waste management facility for temporary storage pending treatment and disposal.

Hazardous wastes would include analytical solutions, rags with acetonitrile and acetone, coolants, hydraulic fluid, curing agents, epoxy resins, and plastics. These wastes would be managed and shipped to a commercial waste facility for treatment and disposal.

Nonhazardous (sanitary) wastes would consist of such solid items as office waste, paper, spent tools, and scrap materials. These materials would be hauled to an offsite sanitary landfill for disposal. Sanitary liquids would include sewage waste, uncontaminated process fluids, and mop water. These wastes would be discharged to the local municipal sewage system.

Table A.3.2.3-9.-- Lawrence Livermore National Laboratory Secondary and Case Fabrication Waste Volumes

Category	**Annual Average Volume Generated from Construction (m3)**	**Annual Volume Generated from Surge Operations (m *3*)**	**Annual Volume Effluent from Surge Operations (m *3*)**
Low-Level			
Liquid	None	105	None
Solid	5	370	304
Mixed Low-Level			
Liquid	None	550	550
Solid	None	12	12
Hazardous			
Liquid	11	540	540
Solid	41	18	18
Nonhazardous (Sanitary)			
Liquid	5,050	102,000	102,000
Solid	2,820	4,320	4,320
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	255	3,200 30	None

Nonhazardous (other) wastes would be collected and examined before being reclaimed for other recycled use or release to the environment. Examples of this type of waste are paper, glass, and recyclable metals.

1

Building construction key:

Single story building with: A-1 wood frame, A-2 masonry bearing walls with wood roof framing, A-3 masonry bearing walls with structural steel roof stem, A-4 masonry bearing walls with precast concrete roof system, and A-5 prefabricated metal building with metal wall panels.

Multistory building with: B-1 reinforced concrete structure with masonry walls, B-2 reinforced concrete and structural steel with masonry walls, B-3 structural steel skeleton with masonry walls, B-4 structural steel skeleton with cement-asbestos wall panels, and B-5 structural steel skeleton with metal wall panels.

2
Not all of Building 9212 is within the DP footprint.

OR MMES 1996j; ORR 1995a:4.

3
Peak demand is the maximum rate expected.

4
Cubic meters measured at standard temperature and pressure.

OR MMES 1996j; ORR 1995a:3; ORR 1995a:4 .

5

Full-time equivalent.

Source: OR MMES 1996j; ORR 1995a:3; ORR 1995a:4.

6

Peak demand is the maximum rate expected during any hour.

7

Cubic meters measured at standard temperature and pressure.

OR MMES 1996j; ORR 1995a:3; ORR 1995a:4.

8

Includes 10 m^3 of classified waste, 40 drums depleted uranium ash from chip oxidation (one 55 gal drum = 0.2 m^3), and 1,100 m^3 of unclassified waste.

9

Assumes 100:1 wastewater to sludge ratio for the treatment of liquid LLW followed by 2:1 for solidification. Assumes 2/3 of LLW is compactible by a factor of 4:1. LLW in drums is not compactible.

10

Includes 2 m^3 of classified waste and 90 m^3 of unclassified waste.

11

Y-12 only pretreats industrial wastewater prior to discharge to the city of Oak Ridge Municipal Sanitary Sewer System.

12

Includes 3.4 m^3 of concrete and 4.1 t of steel.

13

Includes 5 m *3* of classified waste.

14

Assumes 2/3 of solid is compactible by a factor of 4:1.

15

Recyclable wastes.

OR MMES 1996j; ORR 1995a:4.

16

Peak demand is the maximum rate expected.

17

Cubic meters measured at standard temperature and pressure.

LANL 1995b:4; LANL 1995e.

18

The total of all criteria pollutants is estimated to be less than 1 metric ton.

LANL 1995b:4; LANL 1995e.

19

Peak demand is the maximum rate expected during any hour.

20

Cubic meters measured at standard temperature and pressure.

Source: LANL 1995b:4; LANL 1995e.

21

Total surge employment. Increment to current employment would be 321.

Source: LANL 1995b:4.

22

Assumes 2/3 of the solid LLW is compactible by a factor of 4:1. The wastewater to sludge ratio for liquid LLW treatment is 100:1, followed by 2:1 solidification ratio.

23

Assumes 2/3 of the solid waste is compactible by a factor of 4:1. The wastewater to sludge ratio for liquid sanitary treatment is 350:1.

24

Includes 300 t of recyclable steel and 18 t of recyclable copper.

LANL 1995b:4; LANL 1995e.

25

Peak demand is the maximum rate expected.

26

Cubic meters measured at standard temperature and pressure.

LLNL 1995e.

27

Peak demand is the maximum rate expected during any hour.

28

Cubic meters measured at standard temperature and pressure.

LLNL 1995e; LLNL 1995i:3; LLNL 1996i:2.

29

Total surge employment. Increase to current employment would be 290.

Source: LLNL 1995e.

30

Recyclable wastes.

LLNL 1995e; LLNL 1995i:3.

A.3.3 Pit Fabrication and Intrusive Modification Pit Reuse

A nuclear weapon has a primary assembly that contains a pit subassembly surrounded by HE. The nuclear material in a pit, typically plutonium, is encased in a shell of nonnuclear metal such as stainless steel. Fabricating and processing the plutonium, and assembling the pit components, is the task that LANL or SRS would perform under this option. For both pit fabrication and intrusive modification, plutonium would be supplied from existing pits that have been retrieved and disassembled.

In order to fabricate replacement pits, the plutonium from disassembled pits first would be processed (dissolution, purification, reduction to metal). Processing also provides means to convert manufacturing scrap and residue (oxides) to metal usable in fabrication operations. Plutonium fabrication involves foundry and mechanical operations, including casting, shaping, machining, bonding, assembly, inspection, and packaging. Intrusive modification would disassemble an existing pit, keeping the plutonium component intact. Modification would be made external to the plutonium and a new outer shell applied. These operations are similar to the assembly and inspection functions for replacement pit fabrication.

Waste management and analytical chemistry activities would also be required for all of the plutonium operations. The block flow diagram of pit fabrication is shown in figure A.3.3-1. In addition to the actual operational aspects of plutonium fabrication, several other important processing functions are required. For example, the plutonium metal is under strict accountability for security and safeguard reasons. These security and safeguard requirements influence some of the facility and personnel needs at LANL or SRS to accomplish this task. Also, the nuclear weapons design/production process includes pit certification and qualification, which influences the facility and personnel needs.

Process Descriptions

Pit Fabrication. Pit fabrication involves preparation of plutonium components (casting, machining, inspecting, and cleaning), assembly of the pits (assembling the plutonium and nonnuclear components then hermetically sealing the pit with a weld), and post-assembly processing of the pits to the stockpile configuration.

Plutonium Processing. Plutonium processing consists of disassembly and metal preparation (obtaining stockpile pits, extracting the plutonium, and purifying the plutonium metal to a reusable form) and chloride and nitrate processing (recovering plutonium from residues generated by the manufacturing processes by using either the chloride or nitrate plutonium recovery processes).

Waste Management. Waste management includes taking waste generated by the manufacturing processes and placing it in a form suitable for final disposal. Wastes to be managed would consist of liquid or solid, TRU or LLW, and may include hazardous or mixed waste.

Analytical Chemistry. Analytical chemistry consists of all analytical measurements required to support pit manufacturing. These chemical evaluations include metal samples from the metal preparation area, plutonium components, samples from the plutonium processing unit processes, all samples that support the disposition of waste, and samples required to maintain physical and administrative control of special nuclear material. Samples supporting waste disposition must meet standards set by the RCRA and EPA.

Storage. Storage would include interim storage of retired stockpile pits awaiting disassembly and new pits awaiting shipment to the nuclear weapons assembly facility, as well as long-term storage of plutonium and oxide.

A.3.3.1 Reestablish at Los Alamos National Laboratory

Currently, LANL processes plutonium for RD&T and stockpile support purposes on site. Reconfiguring and upgrading these existing plutonium laboratory facilities in TA-55 is the proposed approach to provide a Pit Fabrication and Intrusive Modification Pit Reuse Facility. Other nuclear facilities to be used for this effort are located in TAs -3, -8, -35, -50, and -54 (as shown in figure A.3.3.1-1). Within TA-55 is the Plutonium Facility (PF-4), which includes a Pit Fabrication Facility in the 300 Area and facilities for plutonium and waste processing in the 400 Area (as shown in figure A.3.3.1-2). TA-3 is a key area; it contains the Sigma Complex, Chemistry and Metallurgy Research building, and main machine shop. Another key area, TA-35, has the physical vapor deposition coating building. Nondestructive evaluation is carried out in a facility in TA-8. Radioactive waste is treated in TA-50 (liquid) and TA-54 (solid). The facilities that are currently used by stockpile surveillance activities would be shared with the pit fabrication group until dedicated facilities become available. The current stockpile Pit Rebuild Program at LANL would be absorbed within the pit fabrication effort as the activity is the same; only the number of pits produced would change. The number of pits fabricated annually is projected to be from 20 to 50 (depending on equipment availability), but could be about 80 if surge mode (multiple shifts, personnel overtime, and use of equipment to full capacity) were exercised. The key building descriptions for the Pit Fabrication and Intrusive Modification Pit Reuse Facility at LANL are shown in table A.3.3.1-1.

Table A.3.3.1-1.-- Los Alamos National Laboratory Pit Fabrication Facility Data

Building	Footprint (m2)	Number of Levels	Special Nuclear Material Permitted	Construction
TA-55, PF-4 Plutonium Facility	14,000	2	Yes	Concrete post and beam with concrete masonry unit in-fill walls
TA-55, PF-4 Nuclear Material Storage Facility			Yes	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-29 Chemistry and Metallurgy Research Building	51,100	3	Yes	Concrete post and beam with concrete masonry unit in-fill walls

TA-3, SM-141 Nonnuclear Component Fabrication	1,860	1	No	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-66 Sigma Building	15,800	1	No	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-39 Nonnuclear Shops Building	7,660	1	No	Concrete post and beam with concrete masonry unit in-fill walls
LANL 1995g.				

The pit fabrication process flow at LANL would begin with old pits from the weapons retirement process being routed to a disassembly area. The plutonium metal from disassembled pits would be purified before transfer to the fabrication area. Residues generated in the disassembly/metal purification areas are primarily chloride salts, crucibles, and chloride-contaminated scrap. The bulk of the residual plutonium would be purified and converted to plutonium metal in the chloride recovery area. Recovered plutonium metal would also be sent to the fabrication area. During fabrication, plutonium metal would be cast into the desired near-net-shape and machined to the final shape with desired tolerances. The finished components would then be assembled with other nonplutonium materials into the new weapon pit component.These new pits would then be sent to the weapon assembly facility. During the casting and machining operations, a number of residues would be generated that require processing and would subsequently undergo nitrate recovery operations. In nitrate recovery, the residues are purified and converted to oxide for return to the reduction operations. Solid and liquid wastes from processing areas would be routed to waste management facilities for processing into a disposable waste form. Analytical laboratories provide chemical analyses of plutonium metal, oxides, solutions, and wastes.

Tables A.3.3.1-2 and A.3.3.1-3 summarize resource requirements for facility modification and operation of the Pit Fabrication Facility. Table A.3.3.1-4 summarizes the bulk quantities of chemicals that would be used in the pit fabrication processes. These quantities assume the surge mode of 80 new pits per year.

Table A.3.3.1-2.-- Los Alamos National Laboratory Pit Fabrication Construction Requirements

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	Minimal
Peak electrical demand (MWe)	Minimal
Concrete (m^3)	Minimal
Steel (t)	Minimal
Gasoline, diesel, and lube oil (L)	Minimal
Industrial gases [1] (m^3)	Minimal
Water (L)	Minimal
Land (ha)	None
Employment	
Total employment (worker years)	216
Peak employment (workers)	138
Construction period (years)	3

Table A.3.3.1-3.-- Los Alamos National Laboratory Pit Fabrication Surge Operation Annual Requirements

Requirement	Consumption
Resource	
Electrical energy (MWh)	5,480
Peak electrical demand (MWe)	0.7
Liquid fuel [2] (L)	None

Natural gas [3] (m *3*)	30,900
Water (L)	30,200,000
Plant Footprint (ha)	NA [4]
Employment [5] (Workers)	628

Table A.3.3.1-4.-- Los Alamos National Laboratory Pit Fabrication Surge Operation Annual Chemical Requirements

Chemical	**Quantity (kg)**
Solid Chemicals	
Aluminum nitrate	2,041
Aluminum sulfate	2,041
Bentonite	1,021
Calcium fluoride	62
Calcium carbonate	1,021
Calcium chloride	227
Diatomaceous earth	45,360
Ferrous ammonium sulfate	5
Hydroxylamine hydrochloride	23
Iron, magnesium, calcium	11
Magnesium hydroxide	340
Oxalic acid	748
Portland cement	45,360
Resins	23
Sodium carbonate	57
Sodium hydroxide	28
Sodium nitrite	96
Sodium sulfite	794
Urea	20
Liquid Chemicals	
Carbon dioxide	17
Film developer, fixer, toner	1,043
Hydrochloric acid	1,497
Hydrofluoric acid	340
Hydrogen peroxide	1,996
Hydroxylamine nitrate	658
Nitric acid [6]	3,420
Nitrogen	57
Potassium hydroxide	17,010
Sodium hydroxide	2,268
Gaseous Chemicals	
Argon	170,100
Chlorine	340
Helium	23
Hydrogen chloride	11
Nitrogen	1,360,800

Oxygen	1,814

Waste Management. The liquid and solid hazardous and nonhazardous wastes generated during building modification would include concrete and steel construction waste materials. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. Small amounts of radioactive waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and to provide for cost-effective disposal for recycling. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.3.1-5 presents the estimated annual waste volumes from the Pit Fabrication and Reuse Facility during modification activities and Solid and liquid waste streams are routed to the waste management system. Figures A.3.3.1-3 through A.3.3.1-5 depict the waste management system. Solid wastes would be characterized and segregated into TRU, LLW, hazardous, and mixed wastes, then treated to a form suitable for disposal or storage within the facility. [figure A.3.3.1-4] Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire-sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Spent Nuclear Fuel. The Pit Fabrication and Reuse Facility would not generate any spent nuclear fuel.

Transuranic Waste. TRU waste would be generated from operation of the Pit Fabrication and Reuse Facility and would consist of glass, leaded gloves, plastics, equipment, metals, and heater elements. These wastes would be shipped to WIPP for disposal.

Low-Level Waste. LLW would be generated from operation of the Pit Fabrication and Reuse Facility and would consist primarily of plastics, metal, cement sludge, and vacuum filters. Liquid LLW would be sent either by truck or industrial drain to TA-50 for processing. The liquid LLW treatment facilities include a chemical treatment and ion-exchange plant at the radioactive liquid waste treatment facility and a chemical treatment plant. The waste would be processed, with radioactive constituents removed, in accordance with the NPDES permit. Low-level solids would be disposed of in 0.1-m *3* (2-ft *3*) boxes at TA-54, Area

Mixed Low-Level Waste. No mixed LLW is expected to be generated. If any were to be generated, it would be managed in accordance with LANL Site Treatment Plan.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations. The cleaning solvents selected would be from a list of nonhalogenated solvents. Hazardous chemical wastes would be treated at commercial offsite RCRA-permitted facilities until completion of the Hazardous Waste Treatment Facility. The remaining liquid waste would be treated by gravity settling and discharged through an NPDES-permitted outfall. No solid hazardous wastes are expected to be generated.

Table A.3.3.1-5.-- Los Alamos National Laboratory Pit Fabrication Waste Volumes (80 Pits Per Year)

Waste Category	**Annual Volume Generated from Construction (m3)**	**Annual Volume Generated from Surge Operations (m3)**	**Annual Volume Effluent from Surge Operations (m3)**
Transuranic			
Liquid	None	5	None
Solid	6 7	43	60
Mixed Transuranic			
Liquid	None	None	None
Solid	None	2	2
Low-Level			
Liquid	None	15	None
Solid	12 8	386	393
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None

Hazardous			
Liquid	0.06	2	2
Solid	51	None	None
Nonhazardous (Sanitary)			
Liquid	None	12,300 [9]	12,300
Solid	None	552 [10]	552
Nonhazardous (Other)			
Liquid	None	Included in sanitary	Included in sanitary
Solid	26 [11]	Included in sanitary	Included in sanitary

Nonhazardous (Sanitary) Waste. Sewage wastewater and process wastewater would be sent by drain to the sanitary wastewater treatment plant (TA-46). Treated effluents would be disposed of by either sanitary drains or through permitted NPDES outfalls. Cooling tower blowdown and overflow would be discharged through outfalls permitted by the State of New Mexico. Sludge and other solid sanitary waste would be disposed onsite at the Sandia Canyon site (TA-61).

Nonhazardous (Other) Waste. Nonhazardous (other) wastes would be disposed of in a permitted landfill or discharged through permitted NPDES outfalls.

A.3.3.2 Reestablish at Savannah River Site

The Pit Fabrication and Intrusive Modification Pit Reuse Facility at SRS would use existing hardened facilities but with all new equipment. The facilities available for this mission include the Separations Areas, F-Area, and H-Area (figure A.3.3.2-1). All aspects of pit component fabrication would be included: pit fabrication, plutonium processing, and waste management. Pit fabrication could be located in the 232-H Building or the F-Canyon. Plutonium processing would be in the F-Canyon facilities. The intrasite transfers of plutonium between areas would be in the form of metal ingots, buttons, and scrap as well as small quantities of oxide. Any liquid transfers would be performed through vessels and piping with secondary and tertiary containment systems. The nonnuclear portions of the pit component would be fabricated and manufactured elsewhere, then shipped to SRS as finished parts. Potentially tritium contaminated pits would not be handled at SRS; rather, they would be sent to LANL. The total number of pits fabricated annually is projected to be in the range of 20 (normal operations), 50 (design capacity, normal operations), or 120 in the surge mode (multiple shifts, personnel overtime, and use of equipment to full capacity).

Currently, Building 232-H is being used for tritium processing and handling operations. These missions are being moved to the Replacement Tritium Facility. The building would be refurbished, leaving adequate space for pit fabrication. The space would be in a hardened facility and essentially free of tritium contamination. Those areas with high levels of tritium contamination would be isolated from the pit fabrication areas. Adjacent nonhardened areas would be used for receiving and handling nonnuclear components or direct service support to the pit fabrication process. Figure A.3.3.2-2 shows the H-Area proposed pit fabrication facilities.

The F-Canyon facilities have adequate noncontaminated hardened areas that can house the plutonium processing functions. The canyon includes the new, never operated, plutonium storage facility, the new special recovery facility, and a vacant production space that was previously decontaminated. Only minor modifications would be required to the glove boxes and equipment in the two new facilities. The plutonium processing operations would also handle the receiving, handling, and disposition of surplus plutonium. The existing waste management systems and laboratory facilities can be used to support the process.

The infrastructure at SRS includes liquid and solid waste management; analytical laboratories; security systems; ES&H systems; training facilities; and research, development, and demonstration facilities. The waste management operations are collocated with the plutonium processing facilities. This allows for the expedient transfer of byproducts from the plutonium purification process to the liquid waste stream, which is subsequently vitrified with high-level waste in the existing Defense Waste Processing Facility.

SRS has the existing support infrastructure to handle plutonium processing. Feedstock for the pit fabrication process would be plutonium metal. Plutonium would be received from offsite via safe secure trailer, unloaded into a staging area, then moved to the plutonium storage facility until needed. Once the retired pit is determined not to be contaminated, it would enter the disassembly process where the nonnuclear and other nuclear components would be removed from the plutonium. The plutonium would be collected and purified while the nonnuclear parts would be declassified and sent to solid waste treatment, and the other nuclear parts would be cleaned and sent to staging to await offsite transport. The purified plutonium would be converted back to metal and would enter the pit fabrication process. The listing of the major support facilities for the Pit Fabrication and Intrusive Modification Pit Reuse Facility is shown in table A.3.3.2-1.

The plutonium fabrication process is an abbreviated version used by the Rocky Flats Environmental Technology Site. Though there are several pit types, the process is basically the same. The process consists of casting parts to the near net-shape, machining the surfaces of the casting to achieve the final shape, and performing tests on the completed parts to assure suitability. After this inspection, the plutonium components are cleaned and assembled with the nonnuclear components to form a pit that is then welded together. Once the plutonium is encapsulated, it may then be safely removed from the glove box, certified, and stored or shipped offsite as needed.

Nonnuclear components used in the new pits would be received from offsite. After inspection these parts would be stored in Building 704-55H until needed for either newly fabricated or reused pits. Some nonnuclear parts require a vapor deposition coating of material be applied. Generally all of these coatings would be produced in a vacuum environment using either a thermal evaporation or plasma sputtering process. Tables A.3.3.2-2 and A.3.3.2-3 show resource requirements for facility modification and surge operation of the Pit Fabrication Facility. Table A.3.3.2-4 shows annual chemical usage for surge operation.

Table A.3.3.2-1.-- Savannah River Site Pit Fabrication Facility Data

Building	Facility Type	Footprint (m2)	Number of Levels	Construction
211-F	Supply tanks	NA	NA	Outside/metal frame
221-F	Feed preparation	4,060	6	Concrete/metal frame
292-F	Canyon exhaust fan house	1,160	1	Concrete
294-F	Sand filters	2,230	NA	Concrete
294-1F	Sand filters	3,340	NA	Concrete
703-F	Administration building	1,860	1	Metal frame
704-F	Administration building	1,130	1	Metal frame
707-F	Administration building	1,490	1	Metal frame
707-7F	Administration building	1,490	1	Metal frame
717-F	Mock-up/maintenance shops	1,170	2	Metal frame
723-F	Laundry	1,060	1	Metal frame
772-F	Laboratory	3,850	2	Concrete/metal frame
772-1F	Laboratory	280	1	Concrete/metal frame
232-H	Manufacturing	4,840	3	Concrete
232-1H	Shop and storage	1,210	1	Metal frame
235-H	Tritium facility office	780	1	Metal frame
703-H	Administration building	1,860	1	Metal frame
704-H	Administration building	1,390	1	Metal frame
704-2H	Administration building	4,670	1	Metal frame
704-55H	Administration building	1,230	1	Metal frame
707-H	Administration building	1,770	1	Metal frame
766-H	Training facility	7,620	2	Metal frame

NA - not applicable.

WSRC 1995c.

Table A.3.3.2-2.-- Savannah River Site Pit Fabrication Construction Requirements

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	15
Peak electrical demand (MWe)	0.37
Concrete (m^3)	1,600
Steel (t)	249
Gasoline, diesel, and lube oil (L)	175,000
Industrial gases (m^3) [12]	3,780
Water (L)	30,000,000
Land (ha)	2
Employment	
Total employment (worker years)	801
Peak employment (workers)	288
Construction period (years)	5

Table A.3.3.2-3.-- Savannah River Site Pit Fabrication Surge Operation Annual Requirements

Requirement	Consumption
Resource	
Electrical energy (MWh)	9,700
Peak electrical demand (MWe)	1.6
Liquid fuel (L)	28,400
Natural gas (m^3) [13]	None

Water (L)	46,200,000
Coal (t)	1,090
Plant Footprint (ha)	NA 14
Employment (Workers)	813

Table A.3.3.2-4.-- Savannah River Site Pit Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)
Solid Chemicals	
Calcium carbonate	642
Calcium metal	227
Hydroxylamine nitrate	633
Magnesium oxide	383
Sodium hydroxide	4,983
Sodium nitrite	206
Water treatment chemicals	64
Liquid Chemicals	
Betz 25k series corrosion inhibitor	200
Betz Slimcide (CE-77 PE)	34
Cleaning/developing fluids	340
Hydrofluoric acid	10
Nitric acid 15	3,420
Liquid nitrogen	4,000
Polyphosphate	191
Sodium hypochlorite	96

Gaseous Chemicals	
Argon	3,924
Carbon dioxide	45,360
Hydrogen	6
Hydrogen fluoride	442
Nitrogen	2,790

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. Liquid waste which is primarily sanitary water would be treated as sanitary plant waste. Solid nonhazardous waste would consist primarily of office trash and sludge from sanitary wastewater treatment. Nonrecyclable portions of this waste would be sent to a permitted landfill after volume reduction practices such as compacting and shredding had been performed. No liquid hazardous waste would be generated other than the lubrication oils and coolants needed to maintain the construction equipment. Solid hazardous waste would consist primarily of solvent rags and empty containers of hazardous materials. Hazardous waste would be packaged in DOT approved containers and shipped offsite to commercial RCRA-permitted treatment,storage, and disposal facilities. No radioactive waste would be generated during construction.

The Pit Fabrication Facility considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.3.2-5 presents the estimated annual waste volumes from the Pit Fabrication Facility during modification activities and operation for the base case surge. Solid and liquid waste streams would be routed to the waste management system.

Figure A.3.3.2-3 depicts the overall waste management system at SRS. Additional figures by waste category are available in appendix section H.2.2. Solid wastes would be characterized and segregated into TRU, low-level, mixed, hazardous, and nonhazardous, then treated to a form suitable for disposal or storage. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

Spent Nuclear Fuel. The Pit Fabrication Facility would not generate any spent nuclear fuel.

High-Level Waste. The Pit Fabrication Facility would not generate any operational HLW. However, as a result of the plutonium recovery and purification processes, plutonium processing would generate a liquid TRU waste that would be managed as a high specific activity waste at SRS. As shown in figure A.3.3.2-3, one of the final waste products from the treatment of this waste is a glass log composed of comingled TRU waste from pit fabrication and legacy HLW.

Transuranic Waste. As noted above, plutonium processing would generate a liquid TRU waste as a result of the plutonium recovery and purification processes. This waste would have a high specific activity and would be managed in accordance with the SRS High-Level Waste Management Plan as outlined in appendix H.2.2. Solutions from both processes would be transferred to F-Canyon, evaporated, and the resulting evaporator bottoms neutralized with sodium hydroxide and transferred to the F-Area Tank Farm. Excess oxalic acid in the precipitation filtrates would be destroyed during filtrate evaporation. The residual sludge consisting primarily of americium and plutonium would be fed to the Defense Waste Processing Facility for conversion to a HLW form using borosilicate glass. The waste would then be immobilized by melting and poured into stainless steel cylinders which would be stored until a repository is available.

Table A.3.3.2-5.-- Savannah River Site Pit Fabrication Waste Volumes (120 Pits Per Year)

Category	**Annual Average Volume Generated from Construction (m3)**	**Annual Volume Generated from Surge Operations (m3)**	**Annual Volume Effluent from Surge Operations (m3)**
Transuranic			
Liquid	None	28 [16]	None
Solid	None	129 [17]	129 [17]

Mixed Transuranic			
Liquid	None	None	None
Solid	None	11	11
Low-Level			
Liquid	None	80 [18]	None
Solid	None	88 [19]	34
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	<0.01	<1	None
Solid	8 [20]	None	<0.01 [21]
Nonhazardous (Sanitary)			
Liquid	3,020	46,160	46,140 [22]
Solid	23	1,450	1,580
Nonhazardous (Other)			
Liquid	None	None	None
Solid	500 [23]	1,450 [24]	None

The solid TRU waste would consist primarily of graphite molds, crucibles, failed equipment, leaded gloves, filters, and combustible materials such as plastics and rags used during glove box operations. Approximately one-half of the volume of waste reported as TRU is considered as intermediate-level waste at SRS and would be disposed of in the intermediate-level waste vaults in E-Area. Intermediate-level waste is managed as TRU waste at SRS because it contains beta or gamma emitters that produce a dose equal to or greater than 200 mrem/hr at 5 centimeters (cm) (2 inches [in]) from an unshielded container. TRU waste destined for disposal in a Federal repository would be certified to meet the WIPP waste acceptance criteria and packaged in drums at the Pit Fabrication Facility then placed in interim storage. Disposal is planned for WIPP, once it has been determined to be a suitable repository for TRU wastes, pursuant to the requirements of 40 CFR 191 and 40 CFR 268. Noncertifiable drums would be repackaged and certified for shipment to WIPP in the future TRU waste facility.

Mixed TRU waste consisting of leaded gloves and TRU waste contaminated with organics such as solvents would be managed in accordance with the SRS site treatment plan. Current plans call for disposal at WIPP.

Low-Level Waste. Solid LLW would consist primarily of failed equipment and combustible plastics and cellulose-based products used in maintaining and cleaning the facilities. Combustible LLW may be incinerated using the consolidated incineration facility. Solid LLW would be packaged in B-25 (90 ft^3) metal boxes and transported to the LLW disposal facility for disposal in concrete vaults. Evaporator overheads from the evaporation of the high-specific liquid waste described above and other liquid LLW would be sent to the F/H-Area Effluent Treatment Facility where radionuclide contaminants are removed using filtration, ion exchange, and reverse osmosis. The decontaminated effluent would be discharged through a permitted NPDES outfall. Concentrate from the F/H-Area Effluent Treatment Facility is transferred through the H-Area Tank Farm to Z-Area for solidification and final disposal in onsite vaults in Z-Area as a cement-based waste form called saltstone.

Mixed Low-Level Waste. The Pit Fabrication Facility is not expected to generate any mixed LLW. In the event any mixed LLW is generated, it would be managed in accordance with the SRS site treatment plan.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations. The cleaning solvents selected would be from a list of nonhalogenated solvents. Hazardous wastes would be collected in DOT-approved containers and sent to onsite hazardous waste accumulation areas (B-, M-and N-Areas). The hazardous waste accumulation area would provide a 90-day staging capacity. Incinerable waste would be shipped to an offsite vendor for treatment and disposal. Waste that cannot be incinerated would be placed in storage until the hazardous/mixed waste disposal facility and consolidated incineration facility are operational.

Nonhazardous (Sanitary) Waste. Sewage wastewater would be treated in the new central sanitary wastewater treatment facility prior to discharge through permitted NPDES outfalls. The sludge would be disposed of in a permitted landfill. Other nonrecyclable, nonhazardous, solid sanitary, and industrial wastes would be compacted and disposed of in a permitted landfill.

A.3.4 Nonintrusive Modification Pit Reuse

Unlike the pit fabrication and intrusive modification pit reuse function, the nonintrusive modification pit reuse function does not disassemble the pit. The entire pit is received through the weapons retirement/disassembly process. The pit is then cleaned and inspected, and, if necessary, the exterior of the pit is modified. No plutonium would be exposed in the nonintrusive modification pit reuse function. Since the intrusive modification pit reuse mission described in section A.3.3.1 for LANL and section A.3.3.2 for SRS inherently includes the nonintrusive modification pit reuse capability, a full discussion of the facilities and processes for conducting nonintrusive modification pit reuse activities at LANL and SRS is not included in this section. The nonintrusive modification pit reuse mission at Pantex and NTS are described in sections A.3.4.3 and A.3.4.4.

A.3.4.1 Los Alamos National Laboratory

The facilities necessary to accomplish these functions at LANL are a subset of those used in the intrusive modification pit reuse function and are discussed in section A.3.3.1.

A.3.4.2 Savannah River Site

The facilities necessary to accomplish these functions at SRS are a subset of those used in the intrusive modification pit reuse function and are discussed in section A.3.3.2.

A.3.4.3 Pantex Plant

Pits that are to be reused would be obtained from the weapons A/D Facility that is currently located at Pantex. Pits would be transferred from one facility to another on the same site, and all infrastructure would be shared. Since the plutonium is encapsulated and any modification is made to the outside of the pit, the entire nonintrusive modification pit reuse process can be conducted in an area that will remain free of radioactive contamination. Three classes of nonintrusive modification pit reuse are proposed at Pantex: recertification (minimum requirement for those pits still within their original design life), requalification (more extensive requirement for those pits that have exceeded their original design life), and nonintrusive modification reuse (modifications imposed upon the pit due to design changes). Pantex would have the capability to recertify 120 pits per year with an annual surge, multi-shift capacity of 200 pits. The combined capability for requalified and modified reused pits would be 150 annually, with a surge annual capacity of 250 pits; of these numbers, approximately 20 pits would be modified. Normal operation is considered to be four 10-hour work days per week, 52 weeks per year.

The facilities that would be used to support the pit recertification, requalification, and nonintrusive modification reuse mission include the weapons assembly bays in Buildings 12-64, 12-84, 12-104, and 12-104A and the current support areas in Zone 12 North along with the special nuclear material facility, Building 12-116. Four existing A/D bays in Building 12-104 would be modified to meet the nonreactor nuclear facility requirements. These four bays, along with an area for control, decontamination, and access control portals, would become the Nonintrusive Modification Pit Reuse Facility. The Nonintrusive Modification Pit Reuse Facility and special nuclear materials facility would be used to consolidate the interim storage, staging, and operations that would be necessary to support recertification, requalification, and nonintrusive modification pit reuse activities.

The Nonintrusive Modification Pit Reuse Facility would make extensive use of robotics. The first area would be used for unpacking and receiving to prepare the pit for the reuse process. As the process starts, the pit would enter the qualification bay and an automated processing line. This line would clean, inspect, and verify tolerances and performance to the specified requirements. The pit would then enter the assembly and welding bay, which includes a glove box line for any needed pit modification. After inspection, the pit would go to the purge and backfill bay to be leak tested and cleaned.

The recertification, requalification, and nonintrusive modification reuse processes would generate LLW, hazardous, industrial, and potentially mixed wastes. The operating areas would have accumulation sites and would perform the onsite characterization. The Waste Operations Group would be responsible for establishing the waste streams, scheduling the waste movement from the accumulation sites to the waste packaging areas, and disposing of the wastes. These processes are not intended to generate radioactive contamination and would not generate TRU or mixed waste under normal operations.

A.3.4.4 Nevada Test Site

NTS is an alternative site for the proposed Nonintrusive Modification Pit Reuse Facility. This facility would require a new building, but it would be adjacent and connected to the Device Assembly Facility. It would be within the secure area of the Device Assembly Facility and would be considered a nonreactor nuclear facility handling special nuclear materials. Though new construction would be required, the existing NTS infrastructure would be sufficient to support the facility. The pits to be reused in this facility would come from the weapons A/D Facility. Locating the Nonintrusive Modification Pit Reuse Facility at NTS assumes that the new weapons A/D Facility would also be at NTS. The A/D Facility mission would be performed within the Device Assembly Facility (originally designed to support assembly of test devices) and the pits would be transferred through corridors between these facilities. Since the plutonium would be encapsulated and any modification would be made to the outside of the pit, the entire process can be conducted in an area which will remain free of radioactive contamination. Three classes of pit reuse are proposed at NTS: recertification (minimum requirement for those pits still within their original design life), requalification (more extensive requirement for those pits that have exceeded their original design life), and nonintrusive modification reuse (modifications imposed upon the pit due to design changes). The total nonintrusive modification pit reuse capability at NTS for these three classes is 50 pits per year, which is based upon one full shift per day (maintenance and training included in the same shift).

The new Nonintrusive Modification Pit Reuse Facility would use the same processes as proposed for use at Pantex. The basic services required would include radiography, interim storage, gas analysis, gas preparation, and security. Radiography would be accomplished by a linear accelerator that is a shared resource with the A/D Facility. An interim storage area for 50 pits would be planned for within the 2,230 m2 (24,000 ft2) new Nonintrusive Modification Pit Reuse Facility. Both the gas analysis and preparation services would be incorporated within the facility. Gas analyses would be used to evaluate samples from accelerated aging tests, material compatibility tests, development activities, material certification tests, and production operations. Security in and around the Device Assembly Facility is sufficient (though it would be expanded) for the new facility, and the shipping and receiving functions would be handled through the Device Assembly Facility. The waste streams and utility requirements would be considered a part of the A/D process and are included with that estimate (see section A.3.1.2). The processes would include a waste management facility, waste storage facility, mixed waste storage and LLW disposal facility, sanitary wastewater treatment unit, sanitary and industrial landfill, and stormwater ponds.

1

Cubic meters at standard temperature and pressure.

LANL 1995g.

2

Used only for utility backup.

3

Cubic meters at standard temperature and pressure.

4

Within existing facilities.

5

Total full time equivalent employment. Increment from
current employment would be 260.

NA - not applicable.

LANL 1995b:4; LANL 1995g.

6

Annual makeup requirement with recycling. Total first year requirement is 32,886 kgs.

LANL 1995b:4.

7

Over a 3-year construction period a total of 27 t (30 tons) of associated piping and ventilation ductwork from glove boxes would be generated. For volume conversion, 1,500 kg/m3 was assumed.

8

Over a 3-year construction period a total of 41 t (45 tons) of glove boxes and 14 t (15 tons) of associated piping and ventilation ductwork would be generated. For volume conversion, 1,500 kg/m3 was assumed.

9

Assumes 50 gal/day/person/shift, with parameters of 250 days/yr, and 260 total additional employees for three shifts.

10

Assumes 0.3 ft *3* /day/person/shift, with parameters of 250 days/yr, 3 shifts/day, and 260 total additional employees for three shifts.

11

Includes 0.15 t (0.175 tons) of steel assuming a density of 0.127 t/m3.

LANL 1995g; LANL 1996e:1.

12

Cubic meters at standard temperature and pressure.

***WSRC 1995c* .**

13

Cubic meters at standard temperature and pressure.

14

Contained within existing facilities.

NA - not applicable.

WSRC 1995c.

15

Annual makeup requirement with recycling.

WSRC 1995c.

16

At SRS, this would be managed as high specific activity liquid waste which would be combined with HLW at the Tank Farm and then processed in accordance with the High-Level Waste Management Plan as depicted in appendix section H.2.2. The resultant waste forms include 0.61 glass logs composed of comingled TRU waste from pit fabrication and legacy HLW, and LLW saltstone. Based on aqueous alternative process for Complex 21; denitrated water=49.3 L/kg Pu metal processed and discarded filtrates=6.9 L/kg plutonium metal. Neutralized with 0.2 L of 50 percent caustic per kg of waste.

17

One-half of this volume is considered intermediate-level waste at SRS and would be disposed of in the intermediate-level waste vaults in E-Area. It is managed as TRU waste because it contains beta or gamma emitters that produce a dose equal to or greater than 200 millirem/hr at 5 cm (2 in) from an unshielded container.

18

Based on aqueous alternative process for Complex 21; 166 L of recycle water per kg of Pu metal processed. Assume "recycle" water sent to Effluent Treatment Facility; recovered acid is recycled.

19

Incinerable=58 m3, nonincinerable=30 m3.

20

Includes 7.6 m^3 (9.9 yd^3) of D&D wastes such as wall material contaminated with asbestos.

21

Treatment of liquid hazardous wastes results in solid hazardous ash. Volume reduction is 200:1.

22

Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary waste.

23

Includes 1.5 m^3 (2 yd^3) of concrete and 0.8 t (0.2 tons) of steel. Includes 498 m^3 (651 yd^3) of D&D wastes such as ductwork, concrete, electrical wiring, and equipment.

24

Recyclable wastes.

SRS 1996a:2; WSRC 1995c.

A.3.5 High Explosives Fabrication

The HE fabrication mission requires explosives synthesis, formulation, pressing, machining, testing, evaluation, and component manufacturing. In addition to these fundamental capabilities, a variety of support activities is required.

The explosives fabrication activity is important to the overall mission of the future DOE Complex. Over the past several years, economic trends have dictated a significant reduction in the domestic commercial support for this technology. In today's marketplace it is difficult to secure the small quantities of products necessary to sustain the reduced workload from commercial sources. The meticulous quality required of the explosives and components placed in nuclear weapons also disqualifies most commercial vendors.

Assumptions. In addition to the general assumptions used in preparing this PEIS, the following assumptions apply specifically to the HE fabrication mission:

- Baseline technologies will be used except where alternatives can be shown to meet requirements and be more cost effective.
- All production operations can be housed in existing facilities.
- Raw materials required to manufacture explosive charges are available either from within DOE or from commercial manufacturers.

General Functions and Layout. The general functions of HE fabrication are HE main charge manufacturing, small HE component manufacturing, HE formulation and synthesis, and HE testing and characterization. Production support functions include storage of raw materials and staging, packaging, and shipping of the intermediate and final product. These functions convert commercially available raw materials into HE and related components for weapons. These general functions also provide for testing and safe handling and storage of both raw materials and in-process and finished products.

The facilities required to perform HE fabrication functions can be arranged in a variety of layouts to accommodate existing structures. Structures containing explosives operations are generally constructed with steel-reinforced concrete and are designed to mitigate the effects of an accidental explosion. Although insensitive HE materials can generally be processed in conventional steel structures, concrete construction is typically used to maintain the flexibility to process conventional explosives. The resulting facility design typically consists of a number of separate operating bays that could vent to an unoccupied area should a detonation occur. Structures that do not require concrete construction due to a lack of HE presence are generally constructed of steel, although portions of these buildings may be concrete. Most facilities include support areas for offices, break rooms, rest rooms, electrical equipment, heating, ventilation, and air conditioning equipment, maintenance, and in-process staging of materials, components, tooling, and supplies. Many production and laboratory facilities also include vacuum systems. Utilities required include water, steam, compressed air, and electricity.

High Explosives Main Charge Manufacturing. This function manufactures main charge explosive subassemblies, main charge mock explosive assemblies, and explosive test specimens. An area must also be provided for conducting physical property testing on explosive components and materials. Each subfunction is described below.

High Explosives Pressings . Rough shapes for HE main charge subassemblies and material test billets are manufactured by pressing. These presses also produce rough shapes for mock components from nonexplosive materials. Sufficient area is needed to include presses, ovens, powder inspection tables, loading tables, and shadowgraph equipment.

Explosives Machining. The rough pressings are machined into hemispherical shapes or test elements using a combination of mills and lathes. HE machining is conducted wet, and a recirculating water treatment system is provided. Mock components may be machined in the same area or in the machine shop. Sufficient area is needed to include equipment for conducting density measurements, dye penetrant testing, and dimensional inspection.

Main Charge Subassembly. The explosive hemispheres are assembled with electrical parts and hardware to produce main charge subassemblies. This is a manual operation that generally involves potting and bonding.

Mechanical Properties Testing. The physical properties of explosive components and materials are tested to support War Reserve lot certification for materials and components and to support production development. The test configurations are assembled and tensile, torsion, and compression tests are conducted.

Small High Explosives Component Fabrication. This process fabricates small HE weapon components and test assemblies. Various small components are fabricated from HE powders and binders, metal or plastic components, electrical components, hardware, and assembly materials. The fabrication process requires equipment for explosive powder heating, pellet pressing, laser welding, ultrasonic cleaning, extrusion loading, density testing, and mechanical assembly. Functions are described below.

Pellet Pressing. Small pellets are pressed to density specifications from small energetic components assemblies.

Extrusion Loading. Extrudable (paste) explosive is loaded onto small fixtures for small component assemblies.

Small Component Assembly. Small HE pellets and/or fixtures containing extrudable paste explosives are assembled with inert parts to make small components.

High Explosives Formulation and Synthesis. This process produces a variety of explosive materials from chemical reactants and commercially produced explosives.

High Explosives Formulation. This function produces a variety of explosive materials from chemical reactants and commercially produced explosives. Material lots up to about 91 kg (200 lb) are produced through a series of batch operations. Some products are used to make small HE weapon components, while other products support the development of new explosives or explosives manufacturing processes.

High Explosives Synthesis. The synthesis process integrates a variety of vessels, filters, and transfer pumps which are used to synthesize, recrystallize, blend, and wash explosive powders. The facility includes bays for mixing/milling, particle-size reduction, drying/weighing/packaging, solvent storage, and refrigerated storage for explosives and chemicals.

High Explosives Testing and Characterization. Explosives test configurations are assembled and then detonated. The test data characterize the explosives performance and are required for the qualification of raw materials and production lots. Testing requires explosives containment chambers and an array of special instrumentation including streak cameras, rotating mirror framing cameras, an air image converter system, oscilloscopes and digitizers, flash x-ray systems, and velocity interferometers.

High Explosives Test Firing. Energetic materials components are test fired at a remote firing facility which includes an outdoor firing capability to conduct large-scale explosives tests that cannot be performed in a test chamber, such as main charges for explosives lot certification.

Nondestructive Evaluation. Explosive components are inspected using neutron radiography, x-ray, magnetic particle, and eddy current equipment to detect flaws, cracks, and voids in explosive and inert components.

Mechanical Properties Testing. The mechanical properties of explosive components and materials are tested to support lot certification for materials and components and to support fabrication development. The test configurations are assembled and tensile and comprehensive tests are conducted.

Analytical Laboratory. Chemical analyses are performed on explosive and nonexplosive materials to determine or verify their characteristics. The data obtained yield valuable information about the condition and composition of the material. This information is used to assure reliability of components and to statistically evaluate performance with material characteristics. The methods used include gas chromatography, liquid chromatography, size exclusion chromatography, infrared spectroscopy, thermal analysis, particle characterization, atomic spectroscopy, and emission spectroscopy. Surface chemistry, metallography, optical and scanning electron microscopy, and wet chemistry are also performed.

Material Compatibility Testing. Test coupons are assembled such that the subject materials are in direct contact with each other. These coupons are then placed in environmental ovens to accelerate the aging process. Gas samples are periodically taken from the coupon containers and analyzed by the gas laboratory. Compatibility testing is required to certify new materials for weapon use.

Production Support. The following functions and facilities are needed to support the HE fabrication missions.

Bulk Explosives Storage. This function requires facilities to store collectively 31,800 kg (70,000 lb) of conventional HE powders awaiting transfer to/from the HE staging facility and offsite explosives vendors. These materials are typically received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots. Storage facilities also are needed for storing 182,000 kg (400,000 lb) of insensitive HE that is awaiting transfer to and from the explosive staging facilities. The bulk explosives facilities would be designed to provide separation between incompatible explosives types and would be remotely located from the production operations.

Explosives Staging/Packaging/Shipping. This function would require staging a variety of explosive powders, components, and assemblies for supporting HE operations. These explosive materials include plastic bonded explosives for main charge manufacturing, completed main charges, small HE components, energetic feeds and products for HE formulation and synthesis, and explosive residues for disposal or recycling. The staging facilities would be designed to provide separation between incompatible explosives types.

Process Support Systems. Process support for the HE manufacturing operation would include a machine shop and ES&H laboratory as well as other plant general services facilities. These facilities would directly support the HE fabrication mission as well as RD&T and other activities.

Facility Utilities . HE fabrication utility requirements are a function of the size, condition, and location of the facilities as well as the production requirements. Therefore, the utility requirements vary at each of the three candidate sites. Utilities are described in subsequent sections for each candidate site. A typical water balance for HE fabrication is shown in figure A.3.5-1.

Chemicals Required. The chemicals and materials consumed during operation primarily include water treating chemicals, reactants and solvents for explosives formulation and synthesis, explosives powders, materials for facility equipment and vehicle maintenance, and bottled gases. Specific lists of chemicals used by each site are provided under the site alternative description.

The HE fabrication process also requires the following chemical support materials:

- Solvents and wipes for manual cleaning operations
- Adhesives and bonding agents for manual assembly operations
- Glycerin fluid for preparing the isostatic pressing fluid
- Release agents for coating the inside of mechanical die sets used in pressing operations
- Dye for the penetrant test
- Shipping and packaging materials
- X-ray film
- Bottled nitrogen for extrusion loading
- Bottled argon for laser welding
- Solvents and feedstocks for the synthesis of hexanitrostilbene and triaminotrinitrobenzene powders
- Other miscellaneous materials required for routine operations

Transportation

Intersite Transportation. The HE shipping/receiving facility would be designed to ship and receive bulk HE materials to and from the HE plant. These materials typically would be received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots.

Shipping of completed charges would follow appropriate HE shipping regulations. All hazardous chemicals would be shipped using appropriate DOT requirements. The major type of hazardous material that would be transported to the plant would be HE materials. Bulk explosives powders would be delivered to the site by DOT-approved bulk commercial carriers. The powder would be unloaded at the bulk explosives storage facilities, which would isolate it from other facilities on the site.

Intrasite Transportation. All intrasite transportation required for manufacture would occur within existing site boundaries and would not require use of public roads. Appropriate HE shipping regulations as defined by DOE and DOT would be followed. Shipment of HE components for testing may require the use of public roads. After testing and manufacturing, subsequent movements of HE and explosive components would be performed by trucks and battery-powered vehicles specifically designed for this purpose. The quantity of HE (conventional and insensitive) transported onsite by these trucks would be strictly limited.

Explosives main charges and components would be transferred to staging areas while awaiting transfer to the A/D plant. In a similar manner, explosive components from the A/D plant would be transferred to the explosives production plant for demilitarization, sanitization, and disposition. Small quantities of hazardous wastes generated during operations would be collected, packaged, and transported by electric car to local accumulation sites and then by truck to a staging area. The waste would be transferred by truck for offsite disposal.

Waste Management. The HE fabrication process generates the following waste and residual materials:

- Bulk HE machining scrap
- Off-specification HE components
- HE-contaminated materials, such as gloves and wipes, from manual cleaning operations
- Glycerin pressing fluid
- Developing materials from x-ray and neutron radiography film processing
- Hazardous contaminated materials from chemical bonding operations, packaging/

  repackaging, storage/staging, and shipment for ultimate disposal

The waste management process for HE fabrication at the alternative sites follows in sections A.3.5.1 through A.3.5.3.

A.3.5.1 Downsize at Pantex Plant

Pantex is the current DOE site for HE main charge manufacturing, small HE component manufacturing, HE formulation and synthesis, and HE testing and characterization. To efficiently meet the expected Complex workload, Pantex can downsize current HE fabrication operations. The following description assumes a downsized HE production mission at Pantex along with the A/D functions.

Significant downsizing actions at Pantex focus on functional consolidation. This can be achieved by reducing the number of facilities operating in the explosives area to 11 or 12 and decreasing the direct, direct support, and direct operations support personnel to about 50. There are no processes to be transferred from offsite. All facilities identified under this plan meet Federal regulations and DOE orders as they pertain to explosives manufacturing. Table A.3.5.1-1 indicates specific products and capabilities that comprise the HE fabrication mission at Pantex.

Table A.3.5.1-1.-- Pantex Plant High Explosives Fabrication Products and Capabilities

Products	Capabilities
High Explosives	*Manufacturing Process Development*
	Stockpile stewardship support
	Formulation
	Synthesis
	Surveillance
Binders	*Main Charge Manufacturing*
	Pressing
	Machining
	Subassembly
	Receiving/storage
	QA-mechanical/chemical/test fire
	Disposition
Main Charge Formulations	*Energetic Component Manufacturing*
	Pressing
	Machining
	Subassembly
	Receiving/storage

	QA-mechanical/chemical/test fire
Initiation High Explosives	Detonators
Mock High Explosives Formulations	Testing

Note: QA - quality assurance.
Source: PX DOE 1995e.

Assumptions. Requirements are based on an annual production rate of 150 replacements or retrofits. The 150 replacements or retrofits consist of 100 warheads and 50 bombs. The capability of providing explosives for two weapons systems in any given year is maintained. The Stockpile Evaluation Program consists of 120 disassemblies and inspections, 110 rebuilds, and additional joint test assemblies, joint test assembly post mortems, and test beds consistent with current guidance and stockpile levels. Some existing programs in the enduring stockpile use main charges made from conventional HE. Insensitive HE machining and storage continue to be explosive hazard Class IV operations. All hexanitrostilbene-based explosives and micronized-triaminotrinitrobenzene materials required would be produced at the HE production plant. Spare equipment and facilities are not included in the minimum facility requirements.

Facility and equipment maintenance would occur on the off-shift and the nonwork days when feasible. The Complex would be capable of producing materials and assembling replacement components and units for two weapon systems in any given year. This capability would be achieved by either simultaneous or sequential campaigns, as long as the sum of the product shipments for the year meets the annual production goals. The stockpile stewardship and management alternatives would not impact the ongoing plant missions, either during construction or during the life of the upgraded plant. Ongoing plant missions are defined as those functions performed today.

Strategic reserve requirements for explosives would be stored at the HE production site. The selected site for the HE production mission would be operational within 2 years after the ROD for this PEIS. The baseline technology for HE production comprises the present techniques utilized at Pantex. If transferred, prebuilds at the donor site would fill any production capability gap between the donor and receiver site for the HE operations. If HE production missions are transferred, a 5-year period is required to accomplish the D&D activities at Pantex.

Facility Description. As stated previously, there would be no product or process transfers; however, there would be substantial functional consolidation. For example, Pantex currently has seven functional test fire sites. All test activities identified as required to support the enduring stockpile can be consolidated into two sites: a fully contained indoor test chamber and an outdoor site to accommodate large charges. Explosives components fabrication would be reduced from four buildings to two. Chemical characterization, nondestructive evaluation, and mechanical testing would be consolidated from the current five facilities to two, as well. A comprehensive listing of the planned consolidations can be found in table A.3.5.1-2. Figures A.3.5.1-1, A.3.5.1-2, and A.3.5.1-3 show the locations of the zones and the facilities within these zones.

Table A.3.5.1-2.-- Pantex Plant Functional Consolidation of Explosives Operations

Capabilities	Current Facilities	Consolidated Facilities (Projected)
Synthesis	11-36	11-55
Formulation	12-19E, 12-62	11-50, 12-62
Isostatic pressing	12-63	12-63
Explosives machining	11-50, 12-121	12-121
Explosives subassembly	12-31	12-121
Explosives components	11-20, 12-17, 12-62, 12-63	12-62, 12-63
Evaluation/ characterization	11-5, 11-17, 11-51, 12-21, 12-59	11-51, 12-104A
Test fire	11-18, 11-38, FS-10, FS-11, FS-21, FS-22, FS-24	FS-11, FS-22, FS-24
Explosives storage	11-42, 12-65, 12-83, Zone 4 (8 magazines)	12-65, Zone 4 (4 magazines)
Explosives disposal	Burning Ground	Burning Ground

Source: PX DOE 1995e.

Pantex consists of 425 buildings containing approximately 232,300 m ^{2} (2.5 million ft ^{2}) of floor space of which explosives operations occupy 37,200 m ^{2} (400,000 ft ^{2}). Within 4,119 ha (10,177 acres), approximately 809 ha (2,000 acres) are dedicated to active facility operations. Approximately 3,270 ha (8,080 acres) are devoted to storage, disposal, and miscellaneous activities in support of plant operations.

Pantex structures containing explosives operations comply with the *DOE Explosives Safety Manual,* DOE/EV/06194 and are generally constructed with steel-reinforced concrete and designed to mitigate the effects of an accidental explosion. Although insensitive HE materials can generally be processed in conventional steel structures, concrete construction is typically used to maintain the flexibility to process conventional explosives. The resulting facility design typically consists of a number of separate operating bays with remote and/or contact operating capability that are fully contained or could vent to an unoccupied area should a detonation occur. Most facilities include support areas for offices, break rooms, rest rooms, electrical equipment, heating, ventilation, and air conditioning equipment, maintenance, and in-process staging of materials, components, tooling, and supplies. Many production and laboratory facilities also include vacuum systems. Utilities required include steam, compressed air, and electricity.

The HE facilities are primarily within the Applied Technology Division. These facilities would support main charge manufacturing, small component manufacturing, formulation and synthesis, and explosives testing and characterization, as well as HE storage and disposition.

Design Safety. The following sections identify important safety considerations incorporated in the design of explosives facilities. Performance goals commensurate with the associated hazard are selected for all structures, systems, and components. The term "hazard" is defined as a source of danger, whether external or internal. Natural phenomena such as earthquakes, extreme winds, tornadoes, and floods are external hazards to structures, systems, and components; whereas toxic, reactive, explosive, or radioactive materials contained within the facilities are internal hazards. Usage category is established by DOE management. Guidelines for usage category (performance category) and the corresponding performance goals are given in *Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomena Hazards* (UCRL-15910).

Earthquakes. All existing facilities meet the standards as cited below. Structures, systems, and components are designed for earthquake-generated ground accelerations in accordance with University of California Research Laboratory (UCRL)-15910. The applicable seismic hazard exceedance probability is 2x10 -*3* for general use (performance category 1), 1x10 -*3* for low and moderate hazard (performance categories 2 and 3), and 2x10 -*4* for high hazard (performance category 4) for structures, systems, and components.

Seismic design considerations for performance category 3 and 4 structures, systems, and components include provisions for such structures, systems, and components to function as hazardous materials confinement barriers and for adequate anchorage of building contents to prevent loss of critical function during an earthquake. In essence, design considerations are to avoid premature, unexpected loss of function, and to maintain ductile behavior during earthquakes.

The fire protection system, emergency power, water supplies, and controls for the safety class equipment are some of the necessary emergency items that must be available following an earthquake. As stated in UCRL-15910, earthquake-resistant design considerations extend beyond the dynamic response of structures and equipment to include survival of systems that prevent facility damage or destruction due to fires or explosions.

Wind . All existing plant structures, systems, and components at Pantex meet the wind or tornado load criteria and the corresponding facility usage and performance goals. Wind design criteria are based on annual probability of exceedance, importance factor, missile criteria, and atmospheric pressure changes as applicable to each performance (usage) category as specified in UCRL-15910. Wind loads are based on the annual probability of exceedance of 2x10 -*2* for the general and low hazard (performance categories 1 and 2), 1x10 -*3* for the moderate hazard (performance category 3), and 1x10 -*4* for the high hazard (performance category 4) structures, systems, and components. Since tornadoes are the viable wind hazards, structures are designed for the annual probability of exceedance of 2x10 -*5* as defined in UCRL-15910.

Floods . All facilities required for the HE operations at Pantex are located above the critical flood evaluation. The extent of the flood hazard is determined using the appropriate usage (performance) category for determining the "Annual Hazard Probability of Exceedance": 2x10 -*3* for the general use (performance category 1), 5x10 -*4* for the important or low hazard (performance category 2), 1x10 -*4* for the moderate hazard (performance category 3), and 1x10 -*5* for the high hazard (performance category 4) facility as defined in UCRL-15910.

Whenever possible, all facilities in performance categories above the general use category (performance category 1) are constructed with the lowest floor of the structure, including subsurface floors, above the level of the 500-year flood. This requirement can be met by siting and/or flood protection. Whenever possible, all facilities, including their basements, in all performance categories are sited above the 100-year floodplain.

Fire Protection . The fire protection features for the plant and its associated support buildings are in accordance with DOE orders and the National Fire Prevention Association Fire Codes and Standards. Redundant firewater supplies and pumping capabilities are installed to supply the automatic and manual fire protection systems located throughout the site. Appropriate types of fire protection systems are installed to provide life safety, prevent large-loss fires, prevent production delay, ensure that fire does not cause an unacceptable onsite or offsite release of hazardous material that will threaten the public health and safety of the environment, and minimize the potential for the occurrence of a fire and related perils. Specific production areas and/or equipment are provided with the appropriate fire detection and suppression features, as required, with respect to the unique hazard characteristics of the product process.

Safety Class Instrumentation and Contro l. The safety classification of instrumentation and controls are derived from the safety functions which they perform. The safety classification is based on appropriate DOE orders. Existing facilities at Pantex meet all safety class requirements. Safety instrumentation is designed to monitor identified safety-related variables in safety class systems and equipment over expected ranges for normal operation, accident conditions, and safe shutdown. Safety class controls are provided when required to control these variables. Safety class instrumentation is designed to fail in a safe mode following a component or channel failure. Safety class Uninterruptable Power Supply power is provided when appropriate.

Ventilation . The heating, ventilation, and air conditioning system design of existing facilities meets all general design requirements in accordance with DOE orders, and American Society of Heating, Refrigerating, and Air Conditioning Engineers guides. The design includes engineered safety features to prevent or mitigate the potential consequences of postulated design basis accident events.

Internal Explosion . Buildings containing HE are designed to mitigate the effects of accidental explosion within a bay or cell. The design is in accordance with the *DOE Explosive Safety Manual* , DOE/EV/06194, including the quantity-distance and the level-of-protection criteria for each class of explosives activities.

Overall Facility Layouts and Design Description. Pantex facilities proposed for the HE fabrication mission are listed in table A.3.5.1-3 and described in this section. The table summarizes key facility data for existing buildings and support areas. Data for the facilities include building number, description, construction type (concrete or steel), gross square meters, number of levels in the structure, and explosives present.

Structures containing explosives operations are generally constructed with steel-reinforced concrete and are designed to mitigate the effects of an accidental explosion. Although insensitive HE materials can generally be processed in conventional steel structures, concrete construction is typically used to maintain the flexibility to process conventional explosives.

Table A.3.5.1-3.-- Pantex Plant High Explosives Fabrication Facility Data

Facility Function	**Building Number**	**Construction Type**	**Gross Area (m^2)**	**Number of Levels**	***Special Materials***
Bulk explosives storage	04-101 - 04-104	Concrete	441	1	HE
Synthesis	11-55	Concrete	279	1	HE
HE formulation	11-50	Concrete	2,062	2	HE
Chemical testing/ evaluation	11-51	Concrete	1,078	1	None
HE main charge pressing	12-63	Concrete	223	1	HE
Explosives staging/ packaging/shipping	12-65	Concrete	753	1	HE
Fabrication/ assembly	12-62, 12-63	Concrete	548	1	HE
Explosives machining/gaging/ subassembly/ safety testing/physical testing/ nondestructive evaluation	12-121	Concrete	4,562	1	HE
Test fire assembly	FS-11	Steel	190	1	HE
Outdoor firing site	FS-22	Concrete	167	1	HE
Contained firing site	FS-24	Concrete	701	1	HE
HE disposal	Burning Ground	Concrete	56	1	HE

Source: PX DOE 1995e.

The resulting facility design typically consists of a number of separate operating bays that could vent to an unoccupied area should a detonation occur. Structures that do not require concrete construction due to the presence of HE are generally constructed of steel, although portions of these buildings may be concrete. Most facilities include support areas for offices, break rooms, rest rooms, electrical equipment, heating, ventilation, and air conditioning equipment, maintenance, and in-process staging of materials, components, tooling, and supplies. Many production and laboratory facilities also include vacuum systems. Utilities required include water, steam, compressed air, and electricity.

High Explosives Main-Charge Manufacturing. These facilities manufacture explosive subassemblies, main charge mock explosive hemispheres, and explosive test specimens. An area is also provided for conducting physical property testing on explosive components and materials. Each functional area is described below.

Isostatic Pressing (Building 12-63). Rough pressings for HE main charge subassemblies and material test billets are manufactured in Building 12-63.

Explosives Machining (Building 12-121). The rough pressings are machined in Building 12-121.

Main Charge Subassembly (Building 12-121). The explosives hemispheres are assembled in Building 12-121.

Mechanical Properties Testing (Building 12-121). The physical properties of explosive components and materials are tested in a portion of Building 12-121.

Small High Explosives Component Manufacturing (Buildings 12-63, 12-121) . Various small components are manufactured from HE powders and binders, metal or plastic components, electrical components, hardware, and assembly materials. The manufacturing process requires equipment for explosive powder heating, pellet processing, laser welding, ultrasonic cleaning, extrusion loading, density testing, inspection, and mechanical and electrical assembly.

Test Firing (Buildings FS-11, FS-22, FS-24). Explosives test configurations are assembled and tested at Buildings FS-11, FS-22, and FS-24. The test data characterize the explosives performance and are required for the qualification of raw materials and production lots. Testing requires explosives containment chambers and an array of special instrumentation including streak cameras, rotating mirror framing cameras, digitizers, flash x-ray systems, and velocity interferometers. Outdoor firing sites are used to conduct explosives tests (e.g., skid and hydrodynamic tests greater than 1 kg [2.2 lb]) that cannot be performed in a test chamber. These facilities are remotely located from production operations.

Nondestructive Evaluation (Building 12-121). Explosive components are inspected using neutron radiography, x-ray, magnetic particle, and eddy current equipment to detect flaws, cracks, and voids in explosives and inert components. Nondestructive evaluation also supports the A/D mission.

High Explosives Formulation (Buildings 11-50 and 12-62) and Synthesis (Building 11-55). These facilities have the capability to produce a variety of explosives materials from chemical reactants and commercially produced explosives. Material lots up to about 91 kg (200 lbs) are produced through a series of batch operations. Some products are used to make small HE weapon components, while other products support the development of new explosives or explosives manufacturing processes.

The HE formulation and synthesis facilities include several flexible processing bays that contain a variety of vessels, filters, and transfer pumps used to synthesize, recrystallize, blend, and wash explosive powders. The facilities also include bays for mixing/milling, reducing particle size, drying/weighing/packaging, storing solvent, and refrigerated storing of explosives and chemicals. Building 11-55 replaces the existing synthesis facility (Building 11-36), which is in deteriorating condition. Building 11-50 replaces an existing formulation capability in Building 12-19E.

Production Support. The production support facilities house an analytical laboratory and material compatibility testing.

Analytical Laboratory (Building 11-51). Chemical analyses are performed on explosive and nonexplosive materials in Building 11-51 to determine or verify their characteristics. The data obtained yield valuable information about the condition and composition of the material. This information is used to ensure components' reliability and to statistically evaluate performance with material characteristics. The methods used include gas chromatography, liquid chromatography, size exclusion chromatography, infrared spectroscopy, thermal analysis, particle characterization, atomic spectroscopy, and emission spectroscopy. Surface chemistry, metallography, optical and scanning electron microscopy, and wet chemistry are also performed.

Material Compatibility Testing (Building 11-51). Test coupons are assembled such that the subject materials are in direct contact with each other. These coupons are then placed in environmental ovens to accelerate the aging process. Gas samples are periodically taken from the coupon containers and analyzed by the gas laboratory. Compatibility testing is accomplished in Building 11-51 and is required to certify new materials for weapon use.

Bulk Explosives Storage (Buildings 4-101 through 4-104). These facilities are designed to store collectively 31,800 kg (70,000 lb) of conventional HE powders while awaiting transfer to or from the HE staging facility and offsite explosives vendors. These materials are typically received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots. These facilities also are used for storing 182,000 kg (400,000 lb) of HE awaiting transfer to or from the explosives staging facilities. The bulk explosives facilities would be designed to provide separation between incompatible explosives types and would be located remotely from the production operations.

Explosive Staging/Packaging/Shipping (Building 12-65). These facilities are designed to stage a variety of explosives powders, components, and assemblies for supporting HE operations. These explosives materials include plastic bonded explosives for main charge manufacturing, completed main charges, small HE components, energetic feeds and products for HE formulation and synthesis, and explosives residues for disposal or recycling. These facilities are designed to provide separation between incompatible explosives types.

Resource Requirements During Construction/Modification. Requirements during construction and modification to implement the downsized configuration for HE fabrication at Pantex are described below.

Land Area Requirements During Modification. Downsizing in place of the explosives production operations at Pantex requires approximately 0.*12* ha (0.3 acres) of land for construction laydown and warehousing and an additional *0.04* ha (0.1 acres) to accommodate construction parking. These activities would occur in previously developed land areas.

Materials and Resources Consumed During Modification. The materials and resources consumed during downsizing of the explosives production operation at Pantex are shown in table A.3.5.1-4. These resources include utilities, construction materials, liquid fuels, and industrial gases.

Table A.3.5.1-4.-- Pantex Plant High Explosives Downsizing Materials/Resources Requirements

Material/Resource	Total Consumption	Peak Demand [1]
Electricity	257 MWh	2 MWe
Water (L)	644,000	
Concrete (m^3)	356	
Steel (t)	6	
Liquid fuel (L)	12,200	
Industrial gases [2] (m^3)	258	

Emissions During Modification. Air pollutants are emitted during modification activities required for the downsizing of the explosives production operations. The principal sources of such emissions are fugitive dust from site preparation for material laydown areas, other construction activities, and exhaust from construction equipment and vehicles. The estimated annual emissions generated during a 1-year period with peak construction activity are shown in table A.3.5.1-5.

Employment During Modification. The number of workers required during each year of construction at Pantex for the HE downsizing alternative is presented in table A.3.5.1-6.

Table A.3.5.1-5.-- Pantex Plant High Explosives Downsizing Construction Emissions

Pollutant	Quantity (t)

Carbon monoxide	0.54
Nitrogen oxides	0.19
Particulate matter	0.08
Sulfur dioxide	0.02
Total suspended particles	0.19
Volatile organic oxides	0.09

PX DOE 1995e.

Table A.3.5.1-6.-- Pantex Plant High Explosives Downsizing Construction Workers

Employees	**Year 1**	**Year 2**	**Year 3**	**Total**
Craftworkers				
Carpenter	1	3	1	5
Construction management and support staff	0	3	1	4
Concrete mason	1	2	1	4
Electrician	0	3	2	5
Iron worker	1	3	1	5
Laborer	1	3	1	5
Millwright	0	1	1	2
Operator	0	1	0	1
Other craftworkers	0	2	1	3
Pipe fitter	0	2	1	3
Sheet metal worker	0	3	1	4
Sprinkler fitter	0	2	1	3
Teamsters	0	1	1	2
Total Employment	4	29	13	46

Source: PX DOE 1995e.

Resource Requirements During Operations--High Explosives Fabrication Mission. No additional land is required to operate the HE downsizing alternative at Pantex.

The utilities consumed during operation include electric power, liquid fuels, natural gas, and water.

Annual utility consumption rates and peak electric power rates for surge operation are shown in table A.3.5.1-7 and are incremental to the A/D mission at Pantex.

All activities would be accomplished on a single, 40 hours-a-week shift. Any surge production would be achieved by increasing personnel and adding shifts (1-year lead time). The facilities would be operated under existing site labor agreements. Surge operation of the HE Fabrication Facility would require 37 direct workers (PX 1996e:1). Support workers for the A/D mission would provide sufficient support for the HE fabrication mission.

Table A.3.5.1-7.-- Pantex Plant High Explosives Downsizing Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand [3]
Electricity	3,250 MWh	1 MWe
Liquid fuel (L)	55,600	
Natural gas [4] (m^3)	500,000	
Water (L)	12,500,000	

Chemicals Consumed During Operation. The chemicals and materials consumed during operations primarily include water treating chemicals, reactants and solvents for explosives formulation and synthesis, explosive powders, materials for facility equipment and vehicle maintenance, and bottled gases. No radioactive materials are required for explosives production. Materials with annual consumption in excess of 227 kg (500 lb) during surge operations are listed in table A.3.5.1-8.

Table A.3.5.1-8.-- Pantex Plant High Explosives Downsizing Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)
Calcium chloride	4,080
Ethyl acetate	1,360
HE powders, insensitive	31,600
HE powders, conventional	15,800

Hydraulic/lubricating oil	4,310
Nitrogen	1,810
Paint	2,380
Source: PX 1995a:6; PX DOE 1995e.	

Emissions During Operation. Gaseous environmental releases would result from operation of the thermal treatment units for bulk HE waste and nonradioactive HE-contaminated waste generated by Pantex for the explosives production operations. Emissions would also result from plant boiler operation, cleaning operations using solvents, and formulation and synthesis operations. The thermal treatment units would be designed and operated to attain and maintain temperatures which result in the destruction of hazardous constituents. Hazardous particulates would be trapped in filters. The releases would be limited to what is possible, using the best available control technology. The annual chemical emissions for the explosives production surge operations are shown in table A.3.5.1-9.

Table A.3.5.1-9.-- Pantex Plant High Explosives Downsizing Surge Operation Annual Emissions

	Quantity (kg)
Pollutant	**Incremental with Assembly/ Disassembly**
Criteria Pollutant	
Carbon monoxide	413
Nitrogen oxides	1,560
Particulate matter	68
Sulfur dioxide	0.01
Volatile organic compounds	122
Hazardous and Other Toxic Compounds	
Acetonitrile	0.45
Aldehydes	2.04
Ammonia	0.02
Benzene	3.00
Cresylic acid	0.0014
Cyclohexane	1.70

1,2-Dichloroethane	0.03
Dimethyl formamide	0.01
Dioxane	0.04
Hexane	0.09
Hydrogen chloride	3.20
Hydrogen fluoride	4.50
Mercury	2x10 -*8*
Methanol	2.7
Methyl ethyl ketone	349
Toluene	9.5
1,1,1-Trichloroethane	0.54
Trichloroethylene	0.45
Xylene	8
PX DOE 1995e.	

Waste Management

Wastes Generated During Construction. The liquid and solid wastes generated during construction would include concrete and steel waste construction materials, hazardous wastes, and sanitary wastewater. The steel construction waste material would be recycled as scrap metal. No radioactive or mixed wastes would be generated during construction.

The liquid and solid wastes generated during HE downsized fabrication functions are discussed in the subsections below. The annual quantity of solid and liquid waste generated by the explosives production operations at Pantex during surge operation is shown in table A.3.5.1-10.

Hazardous toxic wastes would consist of solid residue (ash) from thermal treatment units, solvents from operations, wash water and residual reactants from explosives formulation and synthesis, and residue from painting and bonding operations. This waste would be stabilized and sent to an approved permitted RCRA disposal site.

Solid nonhazardous, nonradioactive wastes generated by the explosives production operations would consist primarily of solid sanitary waste, residue from facility and vehicle maintenance, spent desiccants, and sanitized and demilitarized paper and parts. Nonrecyclable portions of this waste would be sent to an offsite landfill. Liquid sanitary wastewater and process wastewater would be treated and discharged to a permitted drainage channel.

Transportation. The major type of hazardous material that would be transported to Pantex would be HE materials. Bulk explosives powders would be delivered to the site by DOT-approved bulk commercial carriers. The powder would be unloaded at the bulk explosives storage facilities, isolated from other facilities on the site. Subsequent movements of HE and explosives components would be performed by trucks and battery powered vehicles specifically designed for this purpose. The quantity of HE (conventional and insensitive) transported onsite by these trucks would be strictly limited.

Explosives main charges and components would be transferred to staging areas for transfer to the A/D plant. In a similar manner, explosives components from the A/D plant would be transferred to the explosives production plant for demilitarization, sanitization, and disposition. Small quantities of hazardous waste generated during operations would be collected, packaged, and transported by electric car to local accumulation sites and then by truck to a staging area. The waste would be transferred by truck for offsite disposal.

Table A.3.5.1-10.-- Pantex Plant High Explosives Fabrication Facility Waste Volumes

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	0.23	0.23
Solid	0.06	30	30
Nonhazardous (Sanitary)			
Liquid	146	7,120	7,120
Solid	None	17	8 [5]
Nonhazardous (Other)			
Liquid	Included in sanitary	None	None
Solid	2 [6]	Included in sanitary	Included in sanitary

A.3.5.2 Relocate to Los Alamos National Laboratory

The HE processing facilities at LANL (figures A.3.5.2-1 and A.3.5.2-2) were designed and built for production scale operations and were operated as production facilities supplying nuclear weapons HE components for many years. LANL has continued to upgrade and modernize processing equipment in these existing facilities to provide prototype HE components to meet hydrodynamic and NTS program requirements. Using the existing HE manufacturing infrastructure along with state-of-the-art processing equipment, LANL produces high-quality complex HE components to meet one-of-a-kind prototype requirements or limited production runs of HE components used in test programs. Typically, LANL fabricates an average of 1,200 to 1,500 HE parts per year. Surveillance (returned stockpile) HE components are also processed for weapon aging studies.

LANL's full range of HE-processing capabilities includes HE storage magazines, HE synthesis, HE formulation, pressing, machining, assembly, and subassembly of HE devices, proven quality assurance processes, and stringent disposal requirements. In addition, LANL has facilities for environmental, safety, and performance testing of HE and HE assemblies. In all, the inherent capacity of the LANL HE plant exceeds weapons R&D testing program requirements. Furthermore, expanding workloads at LANL to support the projected production would not tax or require full capacity of LANL's existing infrastructure.

LANL would assume the responsibility for providing all HE feedstock, main charge, and component procurement, and fabrication as required by the HE fabrication mission. The products and capabilities for which LANL would be responsible are shown in table A.3.5.2-1.

Table A.3.5.2-1.-- Los Alamos National Laboratory High Explosives Fabrication Products and Capabilities

Products	Capabilities
High Explosives	*Manufacturing Process Development*
	Stockpile stewardship support
	Formulation
	Surveillance
	Synthesis
Binders	*Main Charge Manufacturing*
	Pressing
	Machining

	Subassembly
	Receiving/storage
	Quality assurance-mechanical/chemical/test fire
	Disposition
Main Charge Formulations	*Energetic Component Manufacturing*
	Pressing
	Machining
	Subassembly
	Receiving/storage
	Quality assurance-mechanical/chemical/test fire
	Disposition
Initiation High Explosives	Detonators
Mock High Explosives Formulations	Testing
LANL 1995d.	

Assumptions. The general and facility assumptions on which the data in this section are based follow.

General Assumptions

- LANL currently has adequate infrastructure in place to meet all ES&H safeguards and security and waste management requirements for the HE fabrication mission.
- Additional staff would be required to support new HE production.
- Transition from Pantex and qualification and process prove-in will take approximately 2 years, beginning in fiscal year 1997 after the ROD.
- Steady state operations begin at LANL in fiscal year 1999.
- Steady state operations include manufacturing, testing, and quality assurance evaluation of parts and returned stockpile surveillance components (approximately 10 percent of the production rate).

Facility Capacity/Capabilities Assumptions

- The capacity is defined as 150 sets of explosives components for new builds and 110 sets of explosives components for rebuilds.
- All products and capabilities defined by the HE manufacturing block flow diagrams will be supported.

- Some existing programs in the enduring stockpile use main charges made from conventional HE. All new weapon programs will use main charges made from insensitive HE. Insensitive HE machining and storage continue to be explosive hazard Class IV operations.
- Appropriate portions of the existing storage facilities will be upgraded and reserved to provide adequate storage for the HE fabrication mission, estimated as 182,000 kg (400,000 lb) of insensitive HE and 31,750 kg (70,000 lb) of conventional HE.
- Existing S-Site facilities will be operated according to the current shift system (four 10-hour days per week) to meet normal production requirements. The facilities will be operated under existing labor agreements.
- No new facility construction will be needed.

Facility Description. LANL has all the facilities and equipment needed to carry out the HE fabrication mission. These HE processing facilities are located primarily in TAs -9 and -16. The synthesis, analytical laboratory, and pilot scale formulation activities are located at TA-9. These facilities, including administrative support and HE storage, comprise 39 buildings with over 3,700 m ^{2} (40,000 ft ^{2}) of floor space. Formulation, pressing, machining, receiving, storage, subassembly, radiography, and disposal processes are carried out at TA-16, which houses 65 buildings covering over 8,900 m ^{2} (96,000 ft ^{2}). Testing and nondestructive evaluation would be carried out in a variety of other TAs. TA-37 would provide storage of HE parts and components. All LANL facilities are designed to meet the requirements of the *DOD Ammunition and Explosive Safety Standards* (DOD 6055.9) and the *DOE Explosives Safety Manual* (DOE/EV/06194) for quantity-distance and operational criteria. The HE safety requirements applicable to operations involving the development, testing, handling, and processing of explosives or assemblies containing explosives are identified in DOE/EV/06194. This manual reflects the state of the art in HE safety. Again, no new construction or major equipment transfers from Pantex are required to support the HE fabrication mission at LANL.

State- and Federal-permitted waste disposal facilities are located at TA-54 for hazardous materials (non-HE contaminated) and at TA-16 for HE and HE-contaminated waste. LANL operates in compliance with all state and Federal requirements and regulations, applying a process of continuous process improvements to drive an effective "best practices" program in waste minimization.

Currently, processing routing flow sheets accompany HE components as they are moved through each processing step. Operators sign off as each process is completed. When the processing is completed, the flow sheets are sent to production control where the processing and inspection data are entered into databases and then filed in production control files. Database inventories and task order files are kept on all components, assemblies, and raw materials used in the HE Fabrication Facility.

Although the facilities are in remote locations, they are well integrated into the infrastructure of LANL. They all have intrasite transportation connections so that transportation of explosives and components on public roads is not of concern for operations. Because of their location, HE facilities are well buffered and are not subject to population pressures.

The HE facilities are primarily centralized in the Dynamic Experimentation and Engineering Sciences and Application Divisions and are used in support of DOE and DOD programs. These facilities will be used for the HE fabrication processes including synthesis and formulation, main-charge manufacturing, testing and characterization, small component manufacturing, HE storage, and disposition. The TAs used to support the production include TAs -8, -9, -11, -14, -15, -16, -21, -22, -28, -36, -37, -39, and -40. The majority of the HE processing operations are located at TAs -9, -16, -28, and -37.

HE performance testing and characterization can be conducted at any of several firing sites operated by DX Division. TAs include TAs -14, -15, -16, -21, -22, -36, -39, and -40. Hazardous waste treatment and disposal facilities are located at TA-54, while HE disposal facilities are located at TA-16.

Design Safety. Important safety considerations are incorporated into the design of DOE facilities. Performance goals commensurate with the associated hazard are selected for all structures, systems, and components. The term "hazard" is defined as a source of danger, whether external or internal. Natural phenomena such as earthquakes, extreme winds, tornadoes, and floods are external hazards to structures, systems, and components; whereas, toxic, reactive, explosive, or radioactive materials contained within the facilities are internal hazards. Usage category is as established by DOE management. Guidelines for usage category (performance category) and the corresponding performance goals are given in UCRL-15910.

Earthquake. All existing HE fabrication structures located in Dynamic Experimentation and Engineering Sciences and Application Divisions meet all current applicable standards. An engineering study showed that the reinforced concrete structures used for HE processing buildings used for blast loading requirements exceed the seismic loading for structural capacity. New structures, systems, and components, when required, shall be designed for earthquake-generated ground accelerations in accordance with UCRL-15910, with applicable seismic hazard exceedance probability of 2x10 *-3* for general use (performance category 1), 1x10 *-3* for low and moderate hazard (performance category 2 and 3), and 2x10 *-4* for high hazard (performance category 4) structures, systems, and components.

Wind. All existing HE fabrication structures at TA-9 and TA-16 meet the wind criteria as discussed below. All new structures, systems, and components would be designed for wind or tornado load criteria when required in accordance with UCRL-15910 and the corresponding facility usage and performance goals. Wind loads shall be based on the annual probability of exceedance of 2x10 *-2* for the general and low hazard (performance categories 1 and 2), 1x10 *-3* for the moderate hazard (performance category 3), and 1x10 *-4* for the high hazard (performance category 4) structures, systems, and components. Wind design criteria is based on annual probability of exceedance, importance factor, missile criteria, and atmospheric pressure change, as applicable, to each performance (usage) category as specified in UCRL-15910.

Floods. All HE facilities and buildings at the LANL HE Fabrication Facility are located above the critical flood elevation from the potential flood source (river, dam, levee, precipitation, etc.). The extent of the flood hazard is determined using the appropriate usage (performance) category for determining the annual hazard probability of exceedance: 2x10 *-3* for general use (performance category 1), 5x10 *-4* for important or low hazard (performance category 2), 1x10 *-4* for moderate hazard (performance category 3), and 1x10 *-5* for high hazard (performance category 4) facilities as defined in UCRL-15910.

The critical flood elevation is determined by obtaining the design basis flood level. The design basis flood level is the peak hazard level (flow rate, depth of water, etc.) corresponding to the mean annual hazard probability of exceedance or combinations of flood hazards (river flooding, wind-wave action, etc.) and corresponding loads associated with the peak hazard level and applicable load combination (hydrostatic and/or hydrodynamic forces, debris loads, etc.). LANL run-off site drainage conforms to the State of New Mexico and NPDES requirements. The minimum design level for the stormwater management system is the 25-year, 6-hour storm, but potential effects of larger storms up to the 100-year 6 hour storm are also considered.

Fire Protection. The fire protection features for the existing HE Fabrication Facility and its associated support buildings are in accordance with DOE orders and the National Fire Prevention Association Fire Codes and Standards.

Redundant firewater supplies and pumping capabilities (electric motor drivers with diesel generator backup) would be installed to supply the automatic and manual fire protections systems located throughout the site. One tank and one set of pumps would be designed to meet design basis event requirements. Appropriate types of fire protections systems would be installed to provide life safety, to prevent large-loss fires, to prevent production delay, to ensure that fire does not cause an unacceptable onsite or offsite release of hazardous material that would threaten the public health and safety or the environment, and minimize the potential for the occurrence of a fire and related perils. Specific production areas and/or equipment would be provided with the appropriate fire detection and suppression features, as required, with respect to the unique hazard characteristics of the product or process.

A fire hazards analysis would be performed to assess the risk from fire within the individual fire areas of the facility. All fire sprinkler water that has been discharged during and after a fire would be collected in building sump systems, monitored, sampled, and, if required, retained until it could be disposed of.

Safeguards and Security Systems Description. The HE fabrication facilities located at TA-9 and TA-16 are located within a security parameter with multiple fences surrounding the areas. The main large scale HE processing buildings, assembly area, and magazine storage areas at TA-16 and TA-37 are located within a separate fenced HE exclusion area.

Safety Class Instrumentation and Control. The safety classification of instrumentation and controls is derived from the safety function each performs. This safety classification is based on appropriate DOE orders. HE facilities at LANL that utilize instrumentation for explosives operations currently meet all the safety class requirements.

Ventilation. The heating, ventilation, and air conditioning system provides environmental conditions for the health and comfort of personnel and for equipment protection.

Internal Explosion. New and existing buildings are designed for the effects of accidental explosion within a bay or cell. The design is in accordance with the *DOE Explosives Safety Manual* (DOE/

EV/06194), including the quantity-distance and the level of protection criteria for each class of explosives activities.

Overall Facility Layouts and Design Descriptions. The existing HE fabrication facilities at LANL would be used to support the production mission for HE fabrication. These facilities were designed to meet the *DOD Ammunition and Explosives Safety Standards* (DOD 6055.9) and DOE/EV/06194. Operations are segregated by hazard class: Class I processes, the most hazardous processes, were designed for remote operations with an accidental detonation venting the process bay via a frangible (blow-out) wall away from inhabited areas. Fragment distances and blast overpressure (interline distance) set the criteria for locating operating buildings.

All LANL HE processing facilities are designed for Class I (remote) and Class II (operated attended) operations as defined by DOD 6055.9. While some processing operations require some minimal changes for processing conventional HE, there are no major differences in equipment or facilities. The just-in-time flexible manufacturing approach allows the facilities to alternately process both insensitive HE and conventional HE in the same equipment and facilities. This operational philosophy allows optimized fabrication of all HE and gives the flexibility to make production lots of materials, as required (i.e., plane wave lenses), as well as to manufacture a single quantity of weapon HE components for local hydrodynamic tests and custom HE part requirements.

Structures containing HE and those in which HE operations are conducted are constructed with thick (0.6-m [2-ft]) thick, steel-reinforced, concrete walls designed to mitigate the effects of an accidental explosion. These facilities contain protective berms and are located to meet quantity-distance criteria. Most facilities include support areas for offices; break rooms; restrooms; electrical equipment; heating, ventilation, and air conditioning equipment; maintenance; and in-process staging of materials, components, tooling, and supplies. Table A.3.5.2-2 lists functional HE processing technology, building numbers, and working floor space. No new facilities or structures are required to support the HE manufacturing production mission.

High Explosive Main-Charge Manufacturing. The HE processing facility is used to manufacture main charge subassemblies, mock main charge hemispheres, and explosive test specimens. An area is also provided for conducting physical property testing on explosives components and materials. Each functional area is described below:

Isostatic Pressing. Rough pressings for HE main charge subassemblies, material test billets, and pellets for small components and boosters are fabricated in TA-16-430.

Explosives Machining. Rough pressings are radiographed, inspected, and machined into hemispherical shapes or test charges in TA-16-260.

Inspection. HE components are inspected in TA-16-260.

Main Charge Subassembly. The explosives hemispheres are assembled in TA-16-410.

Table A.3.5.2-2.-- Los Alamos National Laboratory High Explosives Fabrication

Facility Data

Functional Area	**Existing Facilities**	
High Explosives Technology	**Gross Area (m *2*)**	***Building Number***
Main Charge Fabrication		
HE pressing	740	TA-16-430
HE machining, inspection	930	TA-16-260
HE subassembly	370	TA-16-410
Physical property testing	185	TA-11, All
High Explosives Staging, Insensitive High Explosives, and Conventional High Explosives	280	TA-16-261 TYPICAL
Main Charge Test Fire	93	TA-15, TA-40
Energetic Components		
Small component fabrication	700	TA-16-340
Test fire	93	TA-15, TA-40
Component nondestructive evaluation	560	TA-8-22, -23
Formulation and Synthesis		
HE synthesis	460	TA-9-45, -46
HE formulation	700	TA-16-340
Chemical storage	47	TA-16-344
HE staging	47	TA-16-341, -343, -345
Production Support		
Analytic/environmental lab	460	TA-9-21 and -32
Metrology	185	TA-16-260, -410
Materials compatibility testing	280	TA-9-21, -40, -42
Machine shop	185	TA-16-370
High Explosives Shipping/Receiving	230	TA-16-280
Outdoor Test Fire	93	TA-15, TA-11
High Speed Test Machining	18	TA-16-340, -476

High Explosives Storage, Insensitive High Explosives, and Conventional High Explosives	930	TA-37-1 through -37
High Explosives Tech Ramps	2,790	TA-16-413, -332
Component Warehouse	280	
Total	10,655	
LANL 1995d.		

Small High Explosives Component Manufacturing. This facility manufactures small HE weapon components and test assemblies and conducts qualification and development testing for explosives components and materials. Various small components are manufactured in TAs-16-340, -430, -260, and -410 from HE powders and binders, metal or plastic components, electrical components, hardware, and assembly materials. The manufacturing process requires equipment for explosives powder heating, pellet pressing, laser welding, ultrasonic cleaning, extrusion loading, density testing, and mechanical assembly.

Inert Machining. Small components are manufactured in TA-16-370 and TA-3-39. Additional facilities at the central shop (TA-13-39) include full service, high precision metal manufacturing capability.

Synthesis (Technical Areas 9-45, -46) and Formulation (Technical Area 16-340). These facilities have the capability to produce a variety of explosives materials from chemical reactants or to formulate HE composites from commercially produced explosives. Material lots up to about 91 kg (200 lb) are produced through a series of batch operations. Some products are used to make small HE weapons components, while other products support the development of new explosives or explosives manufacturing processes. Blending capabilities for producing uniform blends up to 454 kg (1,000 lb) to minimize batch-to-batch variations are available at the TA-16-340 complex. The HE formulation and synthesis facility includes several flexible processing bays that contain a variety of vessels, filters, and transfer pumps which are used to synthesize, recrystallize, blend, and wash explosive powders. The facility also includes six bays for mixing/milling, particle size reduction (micronization), drying/weighing/packaging, solvent storage, and refrigerated storage for explosives and chemicals.

High Explosives Shipping and Storage. The HE shipping/receiving facility in TA-16-280 and TA-37-1 through TA-37-26 is designed to ship and receive bulk HE materials to and from the HE Fabrication Facility. These materials are typically received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots. Parts would be shipped out as needed in small lots to the A/D Facility.

High Explosives Disposal (Technical Area 16-389). LANL disposal facilities is in place and permitted by the State of New Mexico for disposal of HE waste and HE-contaminated materials. There is a large flash pad that thermally decontaminates items subject to trace HE contamination prior to burial. Two aboveground burning trays are used to destroy HE scrap and residue, and two sand filters are used to remove HE-contaminated water from sump sludge for drying and burning. One aboveground tray burns contaminated oil. An incinerator burns room trash from the HE area (potential contamination due to association only). All water is filtered to remove HE; treated with activated carbon for solvent removal; and measured for chemical oxygen demand, suspended solids, and acidity prior to release to the environment.

Explosives Testing and Characterization. HE testing and characterization cover a wide range of activities and processes and provide quality assurance data that can be used to certify a HE lot for production use or to provide test firing information to qualify small HE component lots for use in production assemblies. LANL has facilities, instrumentation, and test equipment to support the certification of HEs and HE components that would be used for production. These facilities can be used for analytical chemistry evaluation, physical testing, nondestructive evaluation, materials compatibility testing, and firing sites for performance and safety evaluations of HEs and HE assemblies. The full complement of testing and characterization activities is used for surveillance evaluation of returned stockpile HEs.

Analytical Laboratory. Chemical analyses are performed in TA-9-21 on explosives and on explosives materials to determine or verify their characteristics. Analysis methods include gas chromatography, liquid chromatography, ion chromatography, size exclusion chromatography, infrared spectroscopy, thermal analysis, particle characterization, mass spectroscopy, atomic spectroscopy, and emission spectroscopy. Small-scale safety tests required for evaluation of HEs are conducted in this facility. Tests include drop weight impact, friction, electrostatic discharge, and thermal tests.

Material Compatibility Testing. Test coupons are assembled in TA-9-40, TA-9-21, and TA-9-42 so that the subject materials are in direct contact with each other. These coupons are then placed in environmental chambers to accelerate the aging process. Temperatures can be cycled between -55 °C (-67 °F) and +75 °C (+167 °F) in the chambers. Gas samples are periodically taken from the coupon containers and analyzed. Compatibility testing is required to certify new materials for weapon use and HE compatibility. Two large environmental chambers that can be used for cycling full scale weapons systems are located in TA-9-42.

Physical Properties Testing. The physical properties of explosives components and materials are tested in TA-16-340 and TA-9-37 to support lot certification for materials and components and to support production development. The test configurations are assembled, and tensile, torsion, and compression tests are conducted.

Nondestructive Evaluation. Explosives and nonexplosives components are inspected in TAs-8-22, -23, -70 and TA-16-260 with neutron, x-ray, magnetic particle, and eddy current equipment to detect flaws, cracks, voids, and foreign materials.

Test Firing. LANL assembles and detonates explosive test configurations in TA-15, TA-40, and TA-11-25. Tests require explosive containment chambers and an array of special instrumentation including streak cameras, rotating mirror framing cameras, an air image converter system, digital oscilloscopes, flash x-ray systems, and velocity interferometers. LANL conducts large-scale safety tests such as skid tests and spigots at the TA-11 drop tower facility. Vibration test capabilities are also located in this area and can be used for full scale weapons tests as well as components tests.

High Explosives Staging Areas and Corridors. In-process storage in TA-16 is required for a variety of HE powders, components, and assemblies for supporting the HE fabrication operations. These explosives materials include PBXs for main charge manufacturing, completed main charges, small HE components, energetic feed materials and products for HE formulation and synthesis, and explosives residues for disposal or recycle. Staging magazines exist in conjunction with each operational building. The staging magazines are connected with the operational buildings with enclosed corridors. These corridors are used for equipment and material transfers only. Major process buildings are not interconnected.

Resource Requirements During Construction/Modification/Transition. Since only minimal new equipment is needed at LANL, there are no facility construction or modification requirements to conduct the HE fabrication mission at LANL. LANL already has all the technologies needed to provide HE materials, component fabrication, characterization, surveillance, and quality assurance for the future nuclear weapons requirement. The capacity of LANL HE fabrication facilities exceeds R&D mission requirements and can easily accommodate the required production load.

LANL has a full spectrum of HE research, development, fabrication, and test capabilities managed by the Dynamic Experimentation and Engineering Sciences and Applications Divisions. The existing facilities, equipment, and infrastructure would be used to satisfy future production requirements for the HE fabrication mission. The existing capabilities are used to manufacture prototype weapon components for full scale testing that provide the basis for production specifications. Additionally, LANL has demonstrated the capability to manufacture limited production quantities of HE components. Typically, LANL produces 1,200 to 1,500 HE parts per year for use in the weapons research development and testing programs, which include requirements for small production lots (~500) of HE components. These components are manufactured to strict quality assurance requirements and are used in complex hydrodynamic and NTS program requirements.

The equipment and processes used in the HE fabrication processes are very similar and in some cases identical to those used at Pantex for production. By using the same equipment and processing technologies, both LANL and Pantex manufacture parts by the same methods. The processes used by Pantex for HE component production would be used by LANL, except in rare cases where process and/or product improvements can be demonstrated to be cost effective and still meet production requirements. Transition of the HE fabrication processes from Pantex to LANL would require very little press development since equipment and processes are almost identical.

The transition period for transferring the HE fabrication mission to LANL is estimated to take 2 years after the ROD of this PEIS. HE main-charge components may exhibit dimensional instabilities (material creep) when stored for periods of time in excess of 6 to 8 months. Production scheduling plans for "just-in-time" manufacturing of HE components to be used in weapon assemblies. Additionally, extrudable HE used in weapons application, must be stored at -30 °C (-22 °F), and have a 24-hour room temperature working life before the materials cure and setup. The shelf life of the extrudables, when stored at -30 °C (-22 °F), is typically on the order of 6 to 8 months. Because of these concerns, it is not feasible to prebuild HE components during the transition period. It will be necessary for Pantex to remain operational for producing HE components until the receiver site becomes operational. For LANL, this transition period would require 2 years, with steady state operations beginning in fiscal year 1999.

Resource Requirements During Operations-High Explosives Fabrication Mission. HE operations are conducted within the existing LANL boundaries and occupy approximately 5,180 ha (12,800 acres). Table A.3.5.2-2 lists all the required facilities for HE fabrication operations at LANL and the footprint or area on the ground required for each facility.

General utilities and resource requirements including electric power, steam, natural gas, liquid fuels, and water would be supplied by existing LANL infrastructure. Capacity of the general utilities support is sufficient to meet the current requirements of the HE Fabrication Facility for R&D operations and an increase in capacity to meet production requirements is not needed. The utilities and resources consumed during operations include electric power, liquid fuels, natural gas, and water. Annual utility resource consumption rates and peak electric power rates for surge operation are estimated in table A.3.5.2-3.

Table A.3.5.2-3.-- Los Alamos National Laboratory High Explosives Fabrication Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand 7
Electricity	5,600 MWh	1.0 MWe
Liquid fuel (L)	94,600	
Natural gas 8 (m^3)	3,650,000	
Coal (t)	0	
Water (L)	13,000,000	

LANL's HE fabrication processing facilities currently operate on a 4-day week, 10 hours per day, for 50 weeks per year. Maintenance personnel that support the HE processing equipment work a 5-day week, 8 hours per day. Routine and preventive maintenance is conducted on Fridays, as scheduling permits. Actual operational schedules will be dependent on workload and scheduling requirements.

Table A.3.5.2-4 provides the estimated number of additional direct operating and direct support personnel required at LANL to meet the HE fabrication requirements under base case surge (three shifts per day) operation. The DOE production control documents for the enduring stockpile systems would be used for planning and scheduling of the HE components needed to meet the production requirements. In addition, manpower estimates for manufacturing quality assurance parts and preparing surveillance samples for testing and evaluation have been included.

Table A.3.5.2-4.-- Los Alamos National Laboratory High Explosives Fabrication Surge Operation Workers

Labor Category	Number of Workers
Direct workers	35
Direct support workers	30
Operations support workers	40
Indirect support workers	95
Total	200 9

Chemicals Consumed During Operation. The chemicals consumed during all HE fabrication operations are shown in table A.3.5.2-5.

Emissions During Operations. The HE fabrication operations at LANL do not require radiological materials. Under normal operations, no workers could be exposed to radiation. Emissions during operation are listed in table A.3.5.2-6. Gaseous environmental releases would result from operation of the thermal treatment units (incinerator baseline) for bulk HE waste and nonradioactive HE-contaminated waste. Emissions would also result from plant boiler operation, cleaning operations using solvents, and small scale synthesis operations, although the incremental amount of emissions over current operations would be very small. The thermal treatment units would be designed and operated to attain and maintain temperatures which would result in the destruction of hazardous constituents. Hazardous particulates would be trapped in filters. The releases would be limited to as low as achievable using the best available control technology.

Waste Management. Liquid and solid waste streams generated by the HE fabrication operations are processed to meet state, Federal, and DOE requirements for the various types of nonhazardous, hazardous, radioactive, and mixed wastes. LANL waste management facilities would be used to receive, track, characterize, treat, package, store, and ship wastes generated by HE plant operations. These facilities include a waste management operation, waste storage facility, sanitary wastewater treatment unit, and a sanitary and industrial landfill.

Table A.3.5.2-5.-- Los Alamos National Laboratory High Explosives Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)	Chemical	Quantity (kg)

Acetone	2,722	Ethylene glycol	227
Acetonitrile	1,814	X-Ray film developer, fixer, and toners	227
Acid neutralizers/spill kits	272	HE powders	45,360
Adiprene polyurethane composition	45	Hydrochloric acid	45
Activated carbon	454	Hydraulic lube oils	2,268
Aluminum metal	454	Mild steel	454
Argon	907	Nitrogen	227
Carbon dioxide	227	Silicone elastomer	91
Cyanuric acid	454	Sodium hydroxide	227
Degreaser	45	Stainless steel	454
Desiccants/molecular sieves	136	Talc	454
Elastomer binders	227	Tetrahydrofuran	113
Ethanol	272	Toluene	680
Ethyl acetate	454	**Water chemicals**	91
LANL 1995b:4; LANL 1995d.			

Table A.3.5.2-6.-- Los Alamos National Laboratory High Explosives Fabrication Surge Operation Annual Emissions

Pollutant	Quantity (kg)
Criteria Pollutants	
Carbon monoxide	4,540
Nitrogen oxides	22,700
Particulate matter	227
Volatile organics	4,540
Hazardous and Other Toxic Compounds	

Ammonia	454
Acetonitrile	4.5
Cyclohexane	2.3
Dioxane	2.3
Hydrogen chloride	113
Hydrogen fluoride	45.4
Methyl ethyl ketone	22.7
Toluene	22.7
LANL 1995d.	

Nonhazardous wastes generated at the HE Fabrication Facility would primarily consist of solid sanitary waste, sludge from sanitary wastewater treatment, maintenance residues, and scrap parts. Materials unsuitable for recycle would be appropriately disposed of in an approved landfill. Liquid sanitary wastewater will be discharged to the environment after treatment, subject to the NPDES requirements.

Hazardous wastes generated by the HE Fabrication Facility would consist of solid residue from thermal treatment of scrap explosives and explosive-contaminated combustible materials, spent carbon from HE- and solvent-contaminated water treatment, and waste oils and paint residues from routine maintenance operations. LANL would stabilize all hazardous materials for disposal/treatment at an approved RCRA disposal site.

Low-level radioactive waste would only be generated from A/D operations involving depleted uranium parts, or from processing of surveillance materials or other HE charges returned from stockpile with slight contamination. There would be no radioactive wastes associated with HE fabrication. In all cases, compliance with all appropriate regulations and standards concerning all wastes, including mixed waste, would be met.

HE residual materials, such as bulk HE machining scrap, off-specification HE components, HE-contaminated materials (including gloves, wipes, and rags) and process water generated during HE fabrication operations are the source of most of the waste material that must be processed. LANL uses waste minimization and recycle processes to reduce the amounts of material that ultimately must be subjected to waste treatment processes. Recycled scrap HE and HE-contaminated process water are not considered waste and are handled as in-plant operations.

Currently, thermal treatment of HE and HE-contaminated materials (open air burning and incinerators) are the preferred permitted techniques used to dispose of and decontaminate solid materials. LANL is looking at several alternative processes in the event state and Federal agencies do not approve permit applications. Some of these processes include base-hydrolysis decomposition of HE, followed by supercritical water oxidation, molten salt destruction, and bioremediation techniques. The open burning and incineration techniques at LANL are subject to environmental monitoring, and emissions must meet permit requirements.

HE-contaminated process water generated by synthesis and formulation processes, vacuum pump seal water, and HE machining processes, would be collected in tanks and then treated with activated carbon filters to remove residual HEs and solvents. The water would then be recycled or discharged to the environment subject to NPDES permit requirements. LANL collects sanitary wastewater in a separate system and routes it to septic tanks or sanitary waste water treatment facilities. Stormwater is collected separately, and a stormwater pollution prevention plan is in place.

The thermal treatment of HE scrap and HE-contaminated materials would result in emission of decomposition gases. Typical decomposition gases include carbon monoxide, oxide of nitrogen, volatile organics, hydrogen chloride, hydrogen fluoride, and ammonia. Small amounts of organic solvent vapors from materials such as toluene, acetone, methyl ethyl ketone, and ethyl acetate can also be generated during treatment processes as well as normal plant operations.

All LANL operations involving HE, including waste disposal, must comply with DOE/EV/106194 and meet explosives safety requirements. Buildings meet blast-resistant building construction standards and quantity distance criteria. Remote operations capabilities exist for disposal processes.

The HE fabrication process would generate the following waste and residual materials:

- Bulk HE machining scrap
- Off-specification HE components
- HE-contaminated materials, such as gloves and wipes, from manual cleaning operations
- Glycerin pressing fluid
- Developing materials from x-ray and n-ray film processing
- Hazardous contaminated materials from chemical bonding operations, packaging/repackaging, storing/staging, and shipping for ultimate disposal.

Several facilities exist within LANL's waste management infrastructure that process the plant non-HE wastes. These facilities are used to receive, track, characterize, treat, package, store, and ship wastes generated by HE fabrication operations. Included are a waste storage facility, a sanitary wastewater treatment unit, a sanitary and industrial landfill, and stormwater ponds. Hazardous waste that has been HE decontaminated would be handled through the LANL waste management operations at TA-54. The increased loading on the LANL infrastructure which handles these types of wastes would be minimal, requiring no additional capacity or facilities. The radioactive wastes, mixed wastes, hazardous wastes, and nonhazardous wastes generated during the surge operations are quantified in table A.3.5.2-7.

Transportation. All intrasite transportation required for manufacturing is done within existing site boundaries and does not require use of public roads. Appropriate HE shipping regulations as defined by DOE and DOT are followed.

The HE shipping and receiving facility is designed to ship and receive bulk HE materials to and from the HE Fabrication Facility. These materials are typically received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots. All completed charges are shipped following appropriate HE shipping regulations. All hazardous chemicals are shipped using appropriate DOT requirements.

Table A.3.5.2-7.-- Los Alamos National Laboratory High Explosives Fabrication Waste Volumes

Category	Annual Average Volume Generated from Construction (m3)	Annual Volume Generated from Surge Operations (m3)	Annual Volume Effluent from Surge Operations (m3)
Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	4 [10]	4
Solid	None	13	13
Nonhazardous (Sanitary)			
Liquid	None	5,900	5,880 [11]
Solid	None	Included in liquid	17
Nonhazardous (Other)			
Liquid	None	6,930 [12]	6,930
Solid	None	28	• 28

A.3.5.3 Relocate to Lawrence Livermore National Laboratory

LLNL maintains self-contained HE RD&T, and fabrication capabilities at the remote explosives testing area, Site 300, and at the HE Applications Facility at the Livermore Site. LLNL has the facilities, equipment, and infrastructure to satisfy the current production requirements for the HE fabrication mission for all weapon systems in the enduring stockpile. The health and safety, materials management, and materials characterization (nondestructive examination, test fire, and chemical analysis) infrastructures are already in place and available to support the production function as well as the R&D function. No significant HE Applications Facility or Site 300 upgrades are anticipated to receive the mission for HE fabrication in the Complex. No deviations from the current baseline technologies at Pantex are anticipated.

Site 300 is dedicated to all aspects of HE RD&T and is remotely situated on 2,800 ha (7,000 acres) in California's Central Valley, 24 km (15 mi) east of the Livermore Site (figure A.3.5.3-1). Large-scale synthesis, formulation, and test firing is done at Site 300. The HE Applications Facility staff administers the technical work from the Livermore Site. Small-scale process development/prove-in would be done in the HE Applications Facility. The HE Applications Facility meets or exceeds all the applicable ES&H requirements for explosives R&D and production support. Synthesis and formulation would be performed in this building and would be locally supported by the theory and modeling efforts in the HE Applications Facility. A full spectrum of other HE activities take place at this facility, ranging from detonator development to experiments involving 10-kg (22-lb) detonations.

Table A.3.5.3-1.-- Lawrence Livermore National Laboratory High Explosives Fabrication Products and Capabilities

Products	**Capabilities**
High Explosives	*Manufacturing Process Development*
	Support stockpile stewardship
	Formulation
	Synthesis
	Surveillance
	Main charge manufacturing
Binders	Pressing
	Machining
	Subassembly
	Receiving/storage
	Quality assurance-mechanical/chemical/test fire
	Disposition
Main Charge Formulations	*Energetic Component Manufacturing*
	Pressing

	Machining
	Subassembly
	Quality assurance-mechanical/chemical/test fire
Initiation High Explosives	*Detonators*
Mock High Explosives Formulations	*Testing*
LLNL 1995j.	

No significant upgrades to the HE Applications Facility would be required. Larger-scale work at Site 300 is done in parallel with the HE Applications Facility's small-scale process development. Both sites are fully self-contained installations. Site 300's synthesis and formulation complex provides the capability to conduct both remote and contact HE operations in facilities that meet current DOE design levels of environment, safety, and health protection criteria, as well as the current regulatory requirements of applicable Government agencies. LLNL would assume responsibility for providing all HE feedstock, main charge and component procurement, and fabrication as required by the production mission. The products and capabilities for which LLNL would be responsible are shown in table A.3.5.3-1.

Assumptions. The specific assumptions for the HE fabrication mission at LLNL are as follows:

- All production operations can be housed within existing buildings with one exception: modifications would be undertaken only when necessary or where it could be shown to be cost-effective. Modifications include moving, adding or subtracting walls, relocating existing equipment, purchasing new equipment and all associated costs.
- DOE R&D funding for present HE activities would continue at the current level in fiscal year 1995 dollars, adjusted for inflation. This includes mutually dependent R&D missions and interfacing activities. The Work for Others category of activities in energetic materials would remain at least at constant fiscal year 1995 levels and would likely increase.
- Baseline technologies would be employed except where alternatives could be shown to meet requirements and be more cost effective (i.e., faster, better, and/or cheaper). Technical shortfalls identified in the current baseline technology would be addressed with alternative technology.
- The LLNL health and safety structure is adequate to support production needs. Additional staff would be added, if required.
- The LLNL materials management infrastructure could fulfill all material, control, and accountability plus shipping and receiving requirements for the production operation. Additional staff would be added, if required.
- The LLNL waste management infrastructure is adequate to deal with any new or additional waste streams. Additional staff would be added, if required.
- LLNL has adequate safeguards and security infrastructure to deal with the production mission. Additional staff would be added, if required.

- LLNL would not store excessive quantities of conventional HE or insensitive HE. In certain cases, there would be room to expand existing storage capacities by moderate amounts, as necessary, to accommodate production throughput requirements.
- A separate management structure, capable of implementing the production operation and fulfilling all quality assurance and certification requirements, would be put in place if LLNL is selected for the HE production mission.
- A site-specific EIS would most likely not be needed to fulfill NEPA requirements for the overall production mission. The need for further NEPA documents would be assessed, as appropriate.
- The first production unit for new HE production would be October 1, 1998.
- A 27-month period, commencing July 1, 1996, would be an adequate transition time with the only exception being Pantex D&D overhead costs and safe shutdown costs.
- Dismantlement schedules would not affect first production unit for HE production.

Transition of High Explosives Fabrication Mission to Lawrence Livermore National Laboratory. LLNL maintains a full-spectrum HE RD&T and fabrication capability. The energetic materials program is conducted at Site 300 and in the HE Applications Facility at the Livermore Site. LLNL has maintained the ability to fabricate sizable numbers of HE components on an annual as-needed basis in support of the nuclear test schedule and in support of DOD projects and missions. Assumption of the production and fabrication of HE components and materials mission would be a readily accommodated incremental increase to the workload currently supported by the HE technology at LLNL.

Small-scale process development/prove-in would be done at the HE Applications Facility, which meets or exceeds all applicable ES&H requirements for explosives R&D and production support. Synthesis and formulation would be performed in this building. The full spectrum of other HE-required activities takes place here, ranging from detonator development to experiments involving 10-kg (22-lb) detonations. No significant upgrades to the HE Applications Facility would be required.

Large-scale synthesis and formulation is currently done at Site 300. The HE Applications Facility staff administers the technical work performed at Site 300 to ensure full program synergy. Thus the larger scale work at Site 300 is done in parallel with the HE Applications Facility's small-scale process development. It is not necessary to ship significant quantities of HE (>10 g) between the locations: Site 300, like the HE Applications Facility, is a fully self-contained installation. There are no public roads at the site, and population encroachment is not an issue. LLNL would be able to perform synthesis and formulation manufacturing of required energetic materials and main charge fabrication at Site 300 for the foreseeable future. Site 300 facilities contain the necessary equipment for fabrication work. Specialized equipment needed for R&D of new processes and of the next generation of explosives, which may be required by the enduring stockpile, are currently available at Site 300. For example, three deaerator loaders for injection loading of explosives that range in capacity from 50 g to 23 kg (1 ounce to 50 lb) are fully operational.

Both the HE Applications Facility and the synthesis, formulation, and production area at Site 300 have local analytical capability. To enhance capabilities in a cost-effective fashion, the HE program also extensively utilizes LLNL's main analytical laboratories. The Site 300 synthesis and formulation complex is located near the associated HE activities (e.g., the processing area, the engineering area, the radiography laboratory, the environmental test facilities, and the hydrodynamic test bunkers). LLNL analytical capabilities are such that no problems are anticipated in developing the appropriate characterization infrastructure to support the new mission. Test fire capabilities at many levels of charge size exist at Site 300 and in the HE Applications Facility.

LLNL synthesis and formulation staff with present facilities can produce plastic bonded explosives fabrication levels of 450 kg/week (1,000 lb/week) which would be sufficient to meet anticipated production requirements. There would be no facility capacity restrictions for the envisioned material quantities.

The LLNL waste minimization program has reduced the waste associated with HE manufacturing. The HE fabrication mission quantities would involve levels of HE waste generation that are well within disposal capability limits and NEPA/CEQ requirements.

Facility Description. The facility at LLNL would consist of a fabrication facility consisting of one main functional area; HE technology with four main functions: HE main-charge fabrication, small HE formulation and synthesis; and HE testing and characterization. LLNL has the facility infrastructure shown in table A.3.5.3-2 available to support the HE fabrication mission.

Table A.3.5.3-2.-- Lawrence Livermore National Laboratory High Explosives Fabrication Facility Infrastructure

23 buildings (Site 300 and Livermore Site)
66 magazines (200,000 lb limit)
Working space (68,000 ft2)
Waste tanks for all buildings
Backup power for all buildings and equipment
Independent boilers for all buildings
Independent compressors for all buildings
Air exchange cycle rate of 4 per hour per laboratory
Facilities meet all DOE explosives safety requirements
Operations are fully permitted
Open burning for disposal of minimized HE waste permitted
LLNL 1995j.

In addition to the facilities listed in table A.3.5.3-3 that are to be used directly in support of HE fabrication, 11,000 m^2 (119,000 ft^2) of other support facilities at Site 300 and at the Livermore Site would be available for support of HE fabrication efforts. There are also 8,600 m^2 (92,935 ft^2) of support facilities at Site 300 and at the Livermore Site. The nondestructive evaluation, chemical analysis, or characterization areas that directly support the HE effort are critically important support facilities for other LLNL missions and would remain whether or not HE fabrication is carried out as a LLNL mission.

Design Safety. The following sections identify important safety considerations incorporated in the design of DOE facilities. Performance goals commensurate with the associated hazard are selected for all structures, systems, and components. The term "hazard" is defined as a source of danger, whether external or internal. Natural phenomena such as earthquakes, extreme winds, tornadoes, and floods are external hazards to structures, systems, and components; whereas, toxic, reactive, explosive, or radioactive materials contained within the facilities are internal hazards. The usage category is established by DOE management.

Earthquake. All existing HE plant structures at Site 300 meet all current applicable standards. New plant structures, systems, and components, when required, shall be designed for earthquake-generated ground accelerations in accordance with *Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomena Hazards* (UCRL-15910), with applicable seismic hazard exceedance probabilities of $2x10^{-3}$ for general use (performance category 1), $1x10^{-3}$ for low and moderate hazard (performance categories 2 and 3), and $2x10^{-4}$ for high hazard (performance category 4) structures, systems, and components.

Wind. All existing HE plant structures at Site 300 meet the wind criteria as discussed below. All new plant structures, systems, and components would be designed for wind or tornado load criteria when required in accordance with UCRL-15910 and the corresponding facility usage and performance goals. Wind loads shall be based on the annual probabilities of exceedance of $2x10^{-2}$ for the general and low hazard (performance category 1 and 2), $1x10^{-3}$ for the moderate hazard (performance category 3), and $1x10^{-4}$ for the high hazard (performance category 4) structures, systems, and components. Wind design criteria is based on annual probability of exceedance, importance factor, missile criteria, and atmospheric pressure change as applicable to each performance (usage) category as specified in UCRL-15910.

Floods. All HE facilities and buildings at Site 300 are located above the critical flood elevation from the potential flood source (river, dam, levee, and precipitation). The extent of the flood hazard is determined, using the appropriate usage (performance) category for determining the Annual Hazard Probability of Exceedance: $2x10^{-3}$ for general use (performance category 1), $5x10^{-4}$ for important or low hazard (performance category 2), $1x10^{-4}$ for moderate hazard (performance category 3), and $1x10^{-5}$ for high hazard (performance category 4) facilities as defined in UCRL-15910.

The critical flood elevation is determined by obtaining the appropriate design basics flood level. The design basics flood level is the peak hazard level (flow rate and depth of water) corresponding to the mean Annual Hazard Probability of Exceedance or combinations of flood hazards (river flooding and wind-wave action), and corresponding loads associated with peak hazard level and applicable load combinations (hydrostatic and/or hydrodynamic forces and debris loads). LLNL site drainage conforms to the governing local agency regulations. The minimum design level for the stormwater management system is the 25-year 6-hour storm, but potential effects of larger storms up to the 100-year 6-hour storm are also considered.

Fire Protection. The fire protection features for the existing plant and its associated support buildings are in accordance with DOE orders and the National Fire Protection Association Fire Codes and Standards. A fire hazards analysis would be performed to assess the risk from fire to the HE Fabrication Facility within the individual fire areas of the facility. All fire sprinkler water that has been discharged during and after a fire would be contained, monitored, sampled and, if required, retained until it could be disposed.

Safety Class Instrumentation and Control. The safety classification of instrumentation and controls is derived from the safety functions each performs. This safety classification is based on appropriate DOE orders. HE facilities at Site 300 that utilize instrumentation for explosives operations currently meet safety class requirements.

Ventilation. The heating ventilation and air conditioning system provides environmental conditions for the health and comfort of personnel and for equipment protection.

Internal Explosion. New and existing buildings are designed for the effects of accidental explosions within a bay or cell. The design is in accordance with DOE/EV/06194, including the quantity-distance and the level-of-protection criteria for each class of explosives activities. Additional resource documents for the siting and design of explosives facilities listed in the above-referenced manual are utilized to provide a safe design where applicable.

Safeguards and Security System Description. Site 300 is surrounded by multiple fences for security. Although not indicated on the plot plan, there are two security access areas within which various components of the HE Fabrication Facility are located: the limited area and the property protection area. The property protection area surrounds the limited area. Main-charge pressing, machining, and inspection; HE and conventional explosives shipping and receiving; and explosives storage would be performed within a limited area. Synthesis and formulation and test firing would also be performed within a limited area. Most other support facilities would be in a property protection area. All security access areas meet DOE safeguards and securities standards for the proscribed activities associated with HE main-charge fabrication and associated activities for nuclear weapons applications.

Table A.3.5.3-3.-- Lawrence Livermore National Laboratory High Explosives Fabrication Facility Data

Facility Function	**Building 13**	**Construction Type**	**Footprint (m2)**	**Number of Levels**	**Special Materials**	**Access Area**
Main Charge Fabrication						LA
Pressing		Concrete		1	HE	
Machining	817		300			
	806		600			
	809		150			
Subassembly						
Physical prop	810		500			
	HEAF		66			
Small High Explosives Components	HEAF	Concrete	30	1	HE	LA
	826		160			
Main Charge Test Fire	851	Concrete	1,000	1	HE	LA
High Explosives Formulation and Synthesis	826		160			LA
	827A		155			
	827C		168			
	827D		168			
	827E		168			
Conventional High Explosives Storage	New	Concrete	116	1	HE	LA
Explosives Storage	854J	Concrete	500	1	HE	LA
Explosives Shipping, Receiving, and Inspection	805	Concrete	636	1	HE	LA

High Explosives Test Firing and Characterization	HEAF	Concrete	28	2	HE	LA
	222		28	1	non-HE	LA
	235		28	2	non-HE	LA
	241		9	2	non-HE	PPA
Nondestructive Evaluation	823	Steel	255	1	HE	LA
Metrology	806 (room 105)	Concrete	90	1	HE	LA

Table A.3.5.3-4.-- Lawrence Livermore National Laboratory Support Facilities Description

Facility Name	Building	Construction Type	Footprint (m2)	Number of Levels	Special Materials	Access Area
Central shipping and receiving warehouse	875	Steel	1,380	2	None	PPA
Effluent monitoring/ meteorological tower						PPA
Facility maintenance shops	873	Steel	1,400	2	None	PPA
Vehicle maintenance facility	879	Steel	255	1	None	PPA
Fire station and security	870 and 882	Steel	557	1	None	PPA/LA
Medical center	877	Steel	310	1	None	PPA
Administration	871	Steel	930	1	None	PPA

Change house/ laundry	813	Steel	262	1	None	PPA
Cafeteria	880	Steel	218	1	None	PPA
ES&H lab	222					LA
Helicopter pad						PPA
Storage yard			1,860			PPA
Parking						PPA

LA - limited area; PPA - property protection area.

LLNL 1995j.

Table A.3.5.3-5.-- Lawrence Livermore National Laboratory Support Function Facilities Description

Facility Name	Building	Construction Type	Footprint (m2)	Special Materials	Access Area
Plant Utilities					
Utility building	All located in General Services Area	Steel	670	None	PPA
Water storage tanks			76		PPA
Raw water supply			186		PPA
Plant water treatment			427		PPA
Tower cooling water facility			560		PPA
Firewater storage tank and pumphouse			370		PPA
Switchyard			186		PPA
Emergency generator		Steel	130	None	PPA

Diesel fuel storage			93		PPA
Nitrogen tanks			200		PPA
Waste Management		Concrete		HE	
Explosives waste management, handling, storage, and treatment	816, M1 through M5		96		PPA
			129		
			827		
Sanitary wastewater treatment	845		4,645	non-HE	PPA

PPA - property protection area.

LLNL 1995j.

Overall Facility Layouts and Design Descriptions. The HE fabrication facilities are described in tables A.3.5.3-3, A.3.5.3-4, and A.3.5.3-5, which summarize facility data for buildings and support areas including the structure footprint area, construction material, and the security area. Structures containing explosives are generally constructed from steel-reinforced concrete and are designed to mitigate the efforts of a potential accidental explosion. Although insensitive HE materials can generally be processed in conventional steel structures, concrete construction is typically used in current facilities to maintain the flexibility to process conventional explosives. The resulting facility design typically consists of a number of separate operating bays that could vent to an unoccupied area should a detonation occur. This is true for existing buildings which meet current and anticipated explosives safety requirements. Structures that do not require concrete construction due to the presence of HE are generally constructed of steel, although portions of these buildings may be concrete. One-half of Building 875 would be used for inert storage for this mission.

High Explosives Main-Charge Manufacturing. These buildings compose the facility that fabricates main-charge hemispheres, mock main-charge hemispheres, and explosive test specimens. The various functional areas are described below:

Isostatic Pressing. Rough pressings for HE main-charge hemispheres and material test billets would be fabricated in Buildings 817A, B, C, D, E, and F, which are moderate hazard (performance category 2) facilities.

Explosives Machining. The rough pressings are machined into hemispherical shapes or test elements in Buildings 806 and 809.

High Explosives Main-Charge Subassembly. The explosive hemisphere assembly would be done in Buildings 810A and 810B.

High Explosives Shipping and Receiving. Building 805 is designed to ship, receive, and inspect HE bulk and parts (both conventional and insensitive HE).

High Explosives Storage. Building 854J comprises 378 m^2 (4,068 ft^2) and has more than adequate space available for bulk and parts storage and staging.

Conventional High Explosives Storage. A facility would be constructed at the HE storage area near M30 and M34. This 116-m^2 (1,250-ft^2) facility would have a 11,350-kg (25,000-lb) conventional HE bulk and parts storage and staging capacity.

Small High Explosives Component Fabrication. This activity fabricates small HE weapon components and test assemblies. Various small components are fabricated from HE powders and binders, metal or plastic components, electrical components, hardware, and assembly materials. The fabrication process requires equipment for explosive powder heating, pellet pressing, laser welding, ultrasonic cleaning, extrusion loading, density testing, and mechanical assembly. Functions are described below.

Pellet Pressing. Small pellets are pressed to density specifications for small energetic component assemblies in Building 191 (HE Applications Facility).

Extrusion Loading. Extrudable (paste) explosive is loaded onto small fixtures for small component assemblies in Building 826.

Small Component Assembly. Small HE pellets and/or fixtures containing extrudable paste explosive are assembled with inert parts to make small components in Building 810A.

High Explosives Formulation and Synthesis. This activity has the capability to produce a variety of explosive materials from chemical reactants and commercially produced explosives.

High Explosives Formulation. For purposes of this analysis, material lots up to about 90 kg (200 lb) are assumed to be produced through a series of batch operations in Buildings 826 and 827C, D, and E. Some products are used to make small HE weapon components while other products support the development of new explosives or explosives fabrication processes.

High Explosives Synthesis. Buildings 827C, D, and E contain a variety of vessels, filters, and transfer pumps which are used to synthesize, recrystallize, blend, and wash explosive powders. The facility also includes bays for mixing/milling, particle-size reduction, drying/weighing/packaging, solvent storage, and refrigerated storage for explosives and chemicals.

High Explosives Testing and Characterization. Explosives test configurations are assembled and detonated. The test data characterizes the explosives performance and are required for the qualification of raw materials and production lots. Testing requires explosives containment chambers and an array of special instrumentation, including streak cameras, rotating mirror framing cameras, an air image converter system, oscilloscopes and digitizers, flash x-ray systems, and velocity interferometers.

High Explosives Test Firing. Energetic materials components are test fired at the HE Applications Facility, Building 191, at the Livermore Site. This facility has a considerable gas gun capability with 10-kg (22-lb) (trinitrotoluene [TNT]-equivalent) rated contained-firing tank. This facility has a total of six contained firing chambers which range in HE capacity from a few grams to 10 kg (22 lb) (TNT-equivalent).

The remote firing facility, Building 851 at Site 300, is remotely located from HE fabrication operations and includes an outdoor firing capability to conduct large-scale explosives tests that cannot be performed in a test chamber, such as main charges for explosives lot certification.

Nondestructive Evaluation. Building 823 is an area where explosive and inert components are inspected with radiography equipment to detect flaws, cracks, and voids.

Mechanical Properties Testing. The mechanical properties of explosive components and materials are tested in Building 191 (Livermore Site) to support lot certification for materials and components and to support fabrication development. The test configurations are assembled, and tensile and compressive tests are conducted.

Analytical and Materials Characterization Laboratories. Chemical analyses are performed on explosive and nonexplosive materials in Buildings 191, 222, 235, and 241 (Livermore Site) to determine or verify their characteristics. The data obtained yield valuable information about the condition and composition of the material. The methods used include gas chromatography, liquid chromatography, size exclusion chromatography, infrared spectroscopy (Building 222), particle characterization (Building 241), atomic spectroscopy, emission spectroscopy (Building 235), and thermal analysis (Building 191).

Material Compatibility Testing. Test coupons are assembled such that the subject materials are in direct contact with each other in Building 810A. These coupons are then placed in environmental ovens to accelerate the aging process. Gas samples are periodically taken from the coupon containers and analyzed. Compatibility testing is required to certify new materials for weapon use.

Process Support Systems. Process support for the HE fabrication operation includes a machine shop and ES&H laboratory, as well as other plant general services facilities. These facilities directly support the HE fabrication mission, as well as existing, ongoing missions such as RD&T and other activities at LLNL.

Resource Requirements During Construction. All HE fabrication operations can be housed within existing buildings except for the conventional HE storage building. This building would have 11,350 kg (25,000 lb) conventional HE bulk and parts storage capacity and a 116 m2 (1,250 ft2) staging capacity. The total construction requirements for materials and utilities are shown in table A.3.5.3-6. Peak construction year emissions and construction worker requirements are shown in tables A.3.5.3-7 and A.3.5.3-8, respectively.

Table A.3.5.3-6.-- Lawrence Livermore National Laboratory High Explosives Fabrication Construction Materials/Resources Requirements

Material/Resource	Total Consumption 14	Peak Demand
Electricity (MWe)	15MWh	0.2 MWe
Water (L)	1,230,000	
Concrete (m3)	190	
Steel (t)	15	
Liquid fuel, and lube oil (L)	9,500	
Industrial gases 15 (m3)	3	

Table A.3.5.3-7.-- Lawrence Livermore National Laboratory High Explosives Fabrication Construction Emissions

Pollutant	Quantity (kg)
Carbon monoxide	7.3
Oxides of nitrogen	2.7
Particulate matter	0.9
Sulfur dioxide	0.23
Volatile organic compounds	1.4
LLNL 1995i:3; LLNL 1995j.	

Table A.3.5.3-8.-- Lawrence Livermore National Laboratory High Explosives Fabrication Construction Workers

Employees	Year 1

Craftworkers	
Carpenter	3
Concrete mason	1
Electrician	1
Iron worker	1
Laborer	1
Millwright	1
Operator	1
Other craftworkers	1
Pipe fitter	1
Sheet metal worker	1
Sprinkler fitter	1
Teamster	1
Construction management and support staff	5
Total Employment	19
LLNL 1995i:3; LLNL 1995j.	

Table A.3.5.3-9.-- Lawrence Livermore National Laboratory High Explosives Fabrication Surge Operation Annual Utility Requirements

Utility	**Consumption**	**Peak Demand** 16
Electricity	4,300 MWh	1 MWe
Liquid fuel (L)	53,100	
Natural gas 17 (m^3)	None	
Water (L)	58,200,000	

Table A.3.5.3-10.-- Lawrence Livermore National Laboratory High Explosives Fabrication Surge Operation Workers

Labor Category	Number of Employees
Direct workers	52.5
Direct support workers	42
Operations support workers	17
Facilities support workers	8.9
Indirect support workers	112
Total	232 18

Resource Requirements During -High Explosive Fabrication Mission. Table A.3.5.3-3 lists all the required facilities for HE fabrication operations at LLNL and the footprint or area on the ground required for each facility. Requirements to operate the LLNL HE fabrication facilities are shown in tables A.3.5.3-9, A.3.5.3-10, and A.3.5.3-11. The HE Fabrication Facility is located on approximately 2,800 ha (7,000 acres) of land at Site 300. The additional utilities and fuel required for conducting the HE fabrication mission at LLNL are shown in table A.3.5.3-9.

The facility operations required to meet the HE fabrication mission at LLNL are based on a single shift per day, 50 weeks per year, 40 hours per week, for 250 days of operational time annually. Maintenance time and scheduling for manufacturing operations would be based on equipment and facility-specific requirements and, as such, routine maintenance would be performed as needed and scheduled such that there is minimal impact to operation schedules by correlating equipment maintenance with maintenance schedules for plant activities.

The number of workers required at LLNL to accomplish the HE fabrication mission at LLNL are shown in table A.3.5.3-10.

Chemicals Consumed During Operations. The chemicals consumed during all HE fabrication operations at LLNL are shown in table A.3.5.3-11. The HE fabrication operations do not require radiological materials and no workers would be exposed to radiation under normal operations.

Emissions During Operations. The additional emissions that would result from accomplishing the HE fabrication mission are shown in table A.3.5.3-12.

Table A.3.5.3-11.-- Lawrence Livermore National Laboratory High Explosives Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity (kg)	Chemical	Quantity (kg)
Acetone	227	Helium	45
Acetonitrile	91	Heptane	45
Activated charcoal	45	Hydraulic/lubricating oil	908
Adiprene polyurethane composition	45	Hydrochloric acid	68
Aluminum metal	454	Joint compound	45
Ammonia	454	Kimwipes	908
Aqueous film forming foam	91	Micro liquid lab cleaner	5
Circlene Fg 20	91	Mild steel metal	454
CLEPOX 143	91	Molecular sieve	45
Copper/CuO wire	9	Neutrasorb acid neutralizer	45
Copper metal	23	Nitrogen	227
Cyanuric acid	45	Paint	454
Degreaser	5	PLANISOL-M concentrate	23
Desiccants	91	Polyalkylene and ethylene glycol	14
Dispersant	23	Potassium hydroxide	45
Dry air	136	Silicone elastomer	91
DUST-OFF	23	Siliconized ammonium phosphate base	5
ECO-STAR	23	Sodium hydroxide	45
Electrode/probe solutions	23	Solksorb solvent absorbent	227
Ethyl alcohol	91	Sulfuric acid	23
Ethyl acetate	136	TALC	5
Fixer and replenisher	91	Tetrahydrofuran	227
Glass cleaner	45	TISAB with CDTA	14
Glass beads	145	Toluene	227
Glycerine	68	Toner	23
HE powders, insensitive	54,432	Trichlorotrinitobenzene	23
HE powders, conventional	18,144	Water treating chemicals	91

LLNL 1995i:3; LLNL 1995j.

Waste Management. The liquid and solid waste streams generated by the HE fabrication mission would be processed to meet Federal, state, and DOE requirements for the various types of nonhazardous, hazardous, and radioactive wastes. Waste management facilities and assets would be used to receive, track, characterize, treat, package, store, and ship wastes generated by HE fabrication. Facilities would include a waste management operation, waste storage facility, sanitary wastewater treatment unit, and a sanitary and industrial landfill.

Nonhazardous waste generated at the HE Fabrication Facility would consist primarily of solid sanitary waste, sludge from sanitary wastewater treatment, maintenance residues, and scrap parts. Materials unsuitable for recycling would be disposed of appropriately. Liquid sanitary wastes would be collected by independent underground septic tanks at HE fabrication buildings and by sewer pipe systems from most of the support buildings in the General Services Administration area and routed to the domestic sewage lagoon for evaporation and percolation. Excess water would be discharged to a natural drainage channel. Sewage sludge would be disposed of in offsite sanitary and industrial landfills. Process wastewater would be sent to holding tanks for treatment and recycling, where appropriate. Stormwater from all areas of Site 300 would go into natural drainage channels. Nonhazardous rinsewater from HE formulation and machining operations is discharged to a surface impoundment for evaporation.

Table A.3.5.3-12.-- Lawrence Livermore National Laboratory Incremental Annual Emissions During Operations

Pollutant	**Quantity (kg)**
Criteria Pollutant	
Carbon monoxide	1,315
Nitrogen oxides	349
Ozone (as VOC)	45
Particulate matter	27
Sulfur dioxide	24
Hazardous and Other Toxic Compounds	
Ammonia	4.5
Acetonitrile	14

Bisphenol alpha epichlorohydrin	0.5
Benzene	0.2
Chloroform	0.5
Cresylic acid	0
Cyclohexane	0.5
Dibutyl phthalate	0.05
1,2-Dichloroethane	0.9
Dimethyl formamide	0.5
Dioxane	0.5
Ferric ferrocyanide	0
Hexane	0.5
Hydrogen chloride	11.3
Hydrogen fluoride	22.7
Hydrogen sulfide	0.2
Mercury	0
Methanol	4.5
Methyl ethyl ketone	22.7
n-Butyl glycidyl ether	0.2
Propylglycol methyl ether	0.5
Toluene	2.3
Trichloroethylene	0.2
Triethylamine	0.2
2,2,4-Trimethyl-1, 3-pentane-diol isobutyrate	0.5
Xylene	2.3

LLNL 1995i:3; LLNL 1995j.

Hazardous wastes generated by the HE fabrication mission would consist of solid residue from thermal treatment (open burning) of scrap explosives and explosives-contaminated combustible materials. This residue and other hazardous wastes, such as waste oils and paint residues, would be properly packaged and managed for offsite treatment and disposal at RCRA-permitted facilities.

HE residual materials such as bulk HE machining scrap and off-specification HE components and HE-contaminated materials, including gloves, wipes, rags, and process water generated during HE fabrication operations, would be the source of most of the waste material that would be processed. Waste minimization and recycle processes would be used to reduce the amounts of material that ultimately must be subjected to waste treatment processes. Scrap HE and HE-contaminated process water that are recycled are not considered waste and would be handled as in plant operations.

Currently, thermal treatment of HE and HE-contaminated materials (open air burning) is the preferred permitted technique used to dispose of and decontaminate solid materials. Next generation, more environmentally benign destruction technologies are being developed and would be incorporated when available and appropriate.

HE-contaminated process water generated by synthesis and formulation processes, and vacuum pump seal water would be collected in tanks and analyzed for appropriate waste classification and then disposed of as appropriate. Water from HE machine processes would be filtered through a weir and clarifier system and then discharged to holding ponds. Sanitary wastewater would be collected in a separate system and routed to septic tanks or sanitary wastewater treatment facilities. Stormwater would go into natural drainage channels at Site 300.

The utilities required for operation of waste treatment functions associated with the HE fabrication processes would include water, electric power, liquid fuels, steam, compressed air, and propane gas. These utilities are also used in normal HE plant operations and would not pose any significant increase in consumption nor any unique requirements.

The wastes and emissions generated during HE fabrication waste treatment operations would include gaseous decomposition products of combustible materials, hazardous solid waste, and nonhazardous solid and liquid wastes. Hazardous wastes consisting of solid residue (ash) from the thermal treatment process would be characterized, packaged, and sent to an approved RCRA-permitted disposal site. Nonhazardous wastes generated by HE fabrication would consist of solid sanitary waste, sludge from sanitary wastewater treatment, and other noncombustible parts. Materials that cannot be recycled would be sent to an approved landfill.

All operations involving HE must comply with DOE/EV.106194 and meet explosives safety requirements. Buildings must meet blast-resistant building construction standards and quantity-distance criteria. A capability for remote operations would also be necessary for disposal processes. The design would incorporate spill-prevention control and countermeasure elements.

The Livermore Site and Site 300 waste management facilities to support the HE fabrication mission include:

- The waste management facility, which provides space and equipment for receiving, tracking, packaging/repackaging, and shipping of solid and liquid wastes. Areas are segregated by waste type. Operating areas are provided for waste staging and container storage.
- The waste storage facility, which stores hazardous waste for up to 1 year of operation prior to offsite treatment/disposal. An explosive waste storage facility is currently being constructed and permitted to manage explosive wastes. Storage and staging areas are segregated by waste type. Equipment and design features are provided for handling drums, controlling spills, and monitoring.
- The open burn facility, which treats scrap explosives and explosive-contaminated combustible material. Plans and permits are being pursued for a new open burn and open detonation facility

to treat high explosives.
- The Livermore Site, which has the ability to handle and store mixed and LLW wastes, and the HE Fabrication Facility would have the ability to handle these types of wastes if required.
- The HE fabrication facilities, all of which have a septic tank system. Industrial wastewater would be placed in holding tanks for chemical analysis to determine proper disposal method. Nonhazardous HE rinsewater is disposed of onsite in a permitted surface impoundment. Other liquid industrial wastes are shipped offsite for disposal.

Table A.3.5.3-13 lists the incremental quantities of the types of wastes that would be generated at LLNL to accomplish the HE fabrication mission.

Transportation. Transportation requirements exist at both the Livermore Site and Site 300 (intrasite) and between the HE Fabrication Facility and the A/D site (intersite).

Intrasite Transportation. Transportation of products within the HE Fabrication Facility would be performed by LLNL transportation, meeting all applicable DOT and DOE criteria for transportation of the energetic materials. Transportation of classified products within the HE Fabrication Facility would be performed by LLNL transportation which meets DOE safeguards and security criteria for transporting classified products. Subsequent movements of HE and explosive products would be performed by vehicles specifically designed for this purpose. The quantity of HE (conventional and insensitive) transported onsite by these trucks would be strictly limited. HE products would be transported by appropriate vehicle to an HE staging area for eventual recycle or disposal onsite. HE waste would be collected, transported, and disposed of, as appropriate, for explosives materials.

Intersite Transportation. Transportation of the products from the HE Fabrication Facility would be performed by commercial vendors that meet all applicable DOT and DOE criteria for transportation of the specified materials. Transportation of classified products from the HE Fabrication Facility to the A/D plant would be performed by commercial vendors that meet DOE safeguards and security criteria for transporting these classified products, as well as DOT requirements for safe packaging and shipping of HE products. Other inert or ancillary materials that would require transportation would also be transported by qualified commercial vendors.

Table A.3.5.3-13.-- Lawrence Livermore National Laboratory High Explosives Fabrication Waste Volumes

Category	Annual Average Volume Generated from Construction (m3)	Annual Volume Generated from Surge Operations (m3)	Annual Volume Effluent from Surge Operations (m3)

Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	1	3	3
Solid	2	54	54
Nonhazardous (Sanitary)			
Liquid	454	7,270	7,250 [19]
Solid	11	69	55 [20]
Nonhazardous (Other)			
Liquid	946	568	566
Solid	8 [21]	36	20

1

Peak demand for electricity is the maximum rate. Peak demand for water is the average daily consumption during a 1-year period with peak construction activity.

2

Cubic meters measured at standard temperature and pressure.

PX 1995a:6; PX DOE 1995e.

3

Peak demand is the maximum rate expected during any time.

4

Cubic meters measured at standard temperature and pressure.

PX 1995a:5; ***PX 1995a:6; PX DOE 1995e.***

5

Assumes 2/3 of solid sanitary waste is compactible by a factor of 4:1.
6

Includes 2 m^3 of concrete and 0.25 t (0.28 tons) of recycled steel. Density of steel was assumed to be 0.127 m^3 /t for volume conversion.

PX 1995a:5; PX 1995a:6; PX DOE 1995e.

7

Peak demand is the maximum rate expected during any time.
8

Standard cubic meters standard temperature and pressure.

LANL 1995b:4; LANL 1995d.

9

Total surge employment. Increase to current employment would be 67.

Source: LANL 1995b:4; LANL 1995d.
10

Includes HE process solvents and contaminated oils.
11

Assumes 350:1 wastewater to sludge ratio in treatment of liquid sanitary waste.
12

Treated process water to NPDES permitted outfalls.

LANL 1995b:3; LANL 1995b:4; LANL 1995d.

13

High Explosives Applications Facility (HEAF) is Building 191 on the Livermore Site; all other buildings are at Site 300.

LA - limited area; PPA - property protection area.

LLNL 1995j.

14

Total construction period is 1 year.
15

Cubic meters at standard temperature and pressure.

Source: LLNL 1995i:3; LLNL 1995j.
16

Peak demand is the maximum rate expected during any time.
17

Cubic meters measured at standard temperature and pressure.

Source: LLNL 1995i:3; LLNL 1995j.
18

Total surge employment. Increase to current employment would be 100.

Source: LLNL 1995i:2; LLNL 1995i:3; LLNL 1995j.
19

Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary waste.
20

Assume 2/3 of solid is compactible by a factor of 4:1.
21

Includes 7.6 m^3 (9.9 yd3) of concrete and 3 t (3.3 tons) of steel which is recycled.

LLNL 1995i:3; LLNL 1995j.

A.3.6 Nonnuclear Fabrication

The nonnuclear fabrication function provides the capability to fabricate nonnuclear components and perform nonnuclear component surveillance. Nonnuclear component products and/or processes fall within the groupings of those manufactured onsite and those procured. Several common subgroups have been identified:

- System Level: e.g., firesets and radars
- Electrical Components: e.g., integrated circuits and semiconductors, interconnect cables, and passive components
- Mechanical Components: e.g., radio frequency and multipin connectors, Rolamites, actuator assemblies, and reservoirs and valves
- Materials and Explosives: e.g., nuclear grade steel and molded plastic parts

The following discussion briefly describes the site alternatives for the nonnuclear fabrication mission:

Kansas City Plant . This alternative consists of three major factories involved in electronics and mechanical and engineered materials product lines, as well as outsourcing some components. KCP would downsize but maintain all of its current missions, reducing the KCP footprint to 167,000 m *2* (1.8 million ft *2*) for DP activities from the current 297,000 m *2* (3.2 million ft *2*). Estimated start would be in April 1998 with steady-state operation proposed in October 2003.

Los Alamos National Laboratory . This alternative is based on the use of existing facilities which are organized into a plastics facility, a pilot plant, a detonator facility, and a reservoir/valve/steel facility. The mission would be to provide high energy detonator inert components and fabrication of reservoirs, valves, and nuclear grade steel. Construction could begin in fiscal year 2000 with steady-state operation starting in fiscal year 2003.

Lawrence Livermore National Laboratory. This alternative has LLNL fabricating nuclear system plastic components, instead of LANL. The LLNL nonnuclear manufacturing facility would provide the plastic components and polymers currently produced at KCP, including filled and unfilled molded parts; syntactic, rigid, and flexible foam parts; composite structures; and specialty polymers currently produced at the KCP pilot plant. The 7,200-m *2* (77,840-ft *2*) facility would be housed in five existing buildings in a limited access area at LLNL. Construction would begin in fiscal year 1998 with steady-state operation starting in fiscal year 2003.

Sandia National Laboratories. This alternative would transfer the majority of current KCP missions to SNL, except for nuclear system plastic components and high energy detonator inert components. SNL could also fabricate reservoirs, valves, and nuclear grade steel instead of LANL. This alternative requires both modification of existing facilities and construction of new facilities. Depending on the specific approach, total area affected would range from *56,100 to 63,200* m *2* (605,000 to 680,000 ft *2*), new construction would range from 33,900 to 58,100 m *2* (365,000 to 625,000 ft *2*), and modifications would range from 5,000 to 22,000 m^2 (55,000 to 240,000 ft^2). Construction would begin in the first quarter of fiscal year 1998 with steady-state operation starting in the first quarter of fiscal year 2004.

A generic set of products and services required to produce a typical bomb or re-entry warhead was defined to provide a common basis for estimating. Current program look-alikes were established to determine the standard hour content of manufactured product, productive material costs, and the cost of procured components and services. Minimum quantities per year were developed to maintain a production capability for "in-house" manufactured product.

A make-buy determination was made for each product or service (see table A.3.6-1). KCP, SNL, LANL, and LLNL used the make-buy analysis to define the manufacturing area requirements, the direct and indirect support staff, the infrastructure support staff, and productive material cost required to support anticipated production requirements. The capacity of this basic capability supports all current schedules and anticipated retrofit needs.

Table A.3.6-1.-- Nonnuclear Fabrication Production Products Make/Buy Matrix

Product	**KCP Fabricate**	**KCP Procure**	**SNL Fabricate**	**SNL Procure**	**LANL Fabricate**	**LANL Procure**
WES/AF&F	X		X			
Firesets	X		X			
Printed wiring boards		X		X		
Printed wiring assemblies	X		X			
Multichip modules	X			X		
Hybrid microcircuits	X		X			
Housings (buy casting, forging, or bulk)	X	X	X	X		
Electronic components		X		X		
Radars (like firesets)	X		X			
Antennas		X		X		
Nose assemblies	X		X			
Electrical component assemblies	X		X			

Lasers and electro optics		X		X		
Programmers	X		X	X		
Filter packs		X		X		
Voltage regulators		X		X		
Accelerometers/ Environmental Sensing Devices	X		X			
Interconnect/junction boxes		X		X		
Preflight controllers	X		X			
Ready-safe switches		X		X		
Option select switches		X		X		
Coded switches	X		X			
Trajectory Sensing Signal Generators	X		X			
Piezoelectric motors		X		X		
Relays		X		X		
Output switches	X		X			
Category F - cases and electronics assemblies	X		X			
Timers	X	X	X	X		
Connectors		X				
Lightning arrester connectors	X		X	X		
Strong links	X	X	X	X		
Actuator assemblies		X		X		
Detonator cables	X				X	X
Interconnect cables		X		X		
Flat flex		X		X		
Fiber optic		X		X		
RF and coaxial		X		X		
High voltage		X		X		
CF round wire		X		X		
Valves	X		X		X	
Reservoirs	X		X		X	

Major mechanical parts	X	X	X	X		
Molded plastic parts		X		X		
Transfer molded		X		X	X [1]	X [1]
Compression molded		X		X	X [1]	X [1]
Injection molded		X		X	X [1]	X [1]
Machined		X		X	X [1]	X [1]
Cushions					X [1]	
RTV	X				X [1]	
Cellular silicone	X				X [1]	
Foam supports	X		X		X [1]	
Syntactic supports	X		X		X [1]	
Filled polymers	X				X [1]	
Desiccants	X		X			
Getters	X		X			
Parachute assemblies		X		X		
Hand T gear		X		X		
Trainer hardware and kits		X		X		
Retrofit kits		X		X		
D/855	X		X			
Joint test assemblies	X	X	X	X		
Transducers/detectors	X	X	X	X		
Data and flight recorders	X	X	X	X		
Special design hardware	X	X	X	X		

Commercial hardware		X		X		
Transportation Safeguards Division-Safe Secure Trailers	X	X	X	X		
Trailers	X	X	X	X		
Escort vehicles	X	X	X	X		
TC firing systems		X		X		
D/50 reprocessing	X		X			
Services-DOE and/or product required						
Test equipment field support	X		X			
Storage	X		X			
Testers	X		X			
Tools	X		X			
Gauges	X		X			
Data/records	X		X			
Material	X		X			
Boron reclamation/certification/storage	X				X	
Polymer pilot facility	X				X [1]	
Cellular silicone compounding	X				X [1]	
Classified automated data processing	X		X			
Logistics and manufacturing center	X		X			
Test equipment maintenance	X		X	X		
Transportation containers	X	X	X	X		
Tool and gauge fabrication	X	X	X	X		
Tool and gauge design	X	X	X	X		
Test equipment design and fabrication	X	X	X	X		

SECOM	X		X			
Nuclear grade steel acceptance/storage	X		X		X	
Kirtland operations	X		X			

A.3.6.1 Downsize at Kansas City Plant

KCP provides most of the nonnuclear components for the current nuclear weapons stockpile. KCP can effectively support the future stockpile management missions of the nuclear weapons program through a major downsizing of the physical plant and the functions required to support the production mission. The plant was designed, sized, and organized around the mission and workload of the Cold War era, and thus is not appropriately structured to efficiently accomplish the reduced workload of the future. The consolidation of the physical plant would allow a much more efficient organizational approach to be implemented to provide required direct and indirect support functions. The downsized plant would be referred to as KCP II.

The proposed KCP II consists of changing the existing plant and operational approach in four major aspects: (1) physically reducing the size of the facility, (2) changing the approach to manufacturing from product-based to process-based, (3) reducing the support infrastructure appropriate for the right-sized operation, and (4) changing the basic organizational structure to focus directly on the core manufacturing mission.

The proposed KCP II concept was developed to accommodate current and future active stockpile needs. The KCP II facility is to provide, with a 3-year notice, any conceivable combination of components for 150 factory retrofits as well as 150 field retrofits per year on a single-shift basis. These requirements are in addition to limited-life component exchanges, the stockpile evaluation program, and the stockpile surveillance program (joint test assemblies and warhead rebuild) currently scheduled.

Currently KCP consists of approximately 297,000 m *2* (3.2 million ft *2*) of space contained in three connected buildings: the Main Building, the Manufacturing Support Building, and the Technology Transfer Center (figure A.3.6.1-1). Much of this floor space is underutilized and very costly to maintain. Many of the production departments are staffed with only a few people because of the low workload in some production technologies. The KCP II proposal and earlier independent space consolidation initiatives would reduce the size of the plant to approximately 167,000 m *2* (1.8 million ft *2*) for DP activities. The Technology Transfer Center and Manufacturing Support Building facilities would be vacated of DP activities. All operations and support functions required for stockpile management would be accomplished within reduced floor space of the main buildings.

The KCP II proposal is based on the consolidation of similar processes in three separate production areas (the electronic, mechanical, and engineered materials factories) and several product-based departments.

Electronics Factory. The products described in this section consist of electronic systems and electrical subsystems that function within weapon systems. There are three process modules: microelectronics, interconnects, and final assembly. Table A.3.6.1-1 shows the major processes within each of the electronics modules and the product types produced by these procedures. Total production floor space requirement would be approximately 12,454 m^2 (134,000 ft^2).

Microelectronics . A significant portion of the microelectronics fabrication would be performed in an existing hybrid microcircuit production facility. This 2,970-m^2 (32,000-ft^2) facility is divided into a number of sub-areas. Some of these areas have unique cleanliness capabilities from Class 100 to Class 10,000. The facility is also designed to provide differing temperature and humidity controls, as required, for the various areas. The balance of the microelectronics fabrication would be performed 1,282 m^2 (13,800 ft^2) of the Electronics Factory Mezzanine.

Interconnects. The area for this work would occupy 2,304 m^2 (24,800 ft^2) of the Electronics Factory Mezzanine. It would include an environmentally controlled photo-imaging area and an etching area to support flat flex cables for detonator assemblies. The remaining areas would be temperature and humidity-controlled, consistent with traditional electronics manufacturing requirements.

Table A.3.6.1-1.-- Kansas City Plant II Electronics Factory Processes and Products

Process Module	Major Processes	Product Types
Microelectronics	Vacuum deposition	Leadless chip carriers
	Plating	Thick film networks
	Screen printing	Thin film networks
	Photo lithography	Multichip modules
	Beam lead bonding	Hybrid microcircuits
	Fine wire bonding	
	Soldering	
	Component placement	
	Hermetic sealing	
	Cleaning	

Interconnects	Manual soldering	Printed wiring assemblies
	Wave and drag soldering	
	Auto component placement	
	Component insertion	
	Robotic tinning and preforming	
	Cleaning	
	Electrical testing	
	Photo imaging	Flat flex cables
	Etching	Detonator cables and assemblies
	Laminating	
	Lead titanate processing	Lightning arrestor connectors
	Manual assembly	
Final assembly	Manual assembly	Nose assemblies
	Hand soldering	Radars
	Welding	Firesets
	Encapsulation	Arming, fusing, and firing assemblies
	Bonding	ECA's
	Cleaning	Programmers
	Electrical testing	Timers
		Controllers
		Trajectory sensing signal generators
		Code activated processes
KC ASI 1995a.		

Final Assembly. The area for this work would occupy 3,019 m 2 (32,500 ft 2) and, with one exception, would also reside on the Electronics Factory Mezzanine. The one exception would be for nose assemblies, which would be built on the factory floor near the new microelectronics facility. The welding and encapsulation area would support all of the weapon electronics products, as well as some joint test assemblies, special electronic assemblies, and mechanical product requirements. Temperature and humidity controls for traditional electronics manufacturing would also be provided. Products currently fabricated in-house, but to be purchased as a result of KCP II consolidation are printed wiring boards, junction boxes, antennas, voltage regulators, interconnect cables (round coaxial wire, high voltage), ready-safe switches, filter packs, and option select switches.

Joint Test Assembly/Special Electronic Assembly Factory. Security, production, and quality requirements of the joint test assembly and special electronic assembly product lines are not conducive to integration with other factory areas. Products built within the joint test assembly and special electronic assembly are primarily electronics operations and use similar or identical processes. These are bonding, cleaning, coating, encapsulation, mechanical assembly, soldering, swaging, and electrical verification.

Since the joint test assembly mission supports weapons throughout their life in the stockpile, the product lines within the joint test assembly area are somewhat insensitive to changes in weapon production requirements. As a result, reductions in the joint test assembly area would not be as dramatic as in other factory estimates. For future capacity requirements, the joint test assembly operation would be sized to produce assemblies at a rate that would support stockpile evaluation schedules currently in planning for the enduring stockpile.

The current joint test assembly production area would shrink by 33 percent to 1,644 m ^{2} (17,699 ft ^{2}) (excluding stores and storage). The special electronics assembly manufacturing area would be reduced by 55 percent to 1,352 m ^{2} (14,550 ft ^{2}). The joint test assembly area would be relocated to the Electronics Factory Mezzanine, while the special electronics assembly operation would be downsized in place. The estimated reduction in floorspace would primarily result from the elimination of capital equipment, testers, and tooling that are unnecessary to support the baseline workload. No special environments or highly hazardous operations would be required as a part of the production processes.

The joint test assembly operation is a job shop environment which makes use of a very limited amount of highly automated assembly, cleaning, and soldering processes. Prior to the relocation of the area, the newer products requiring automated processes would be built. At the end of that period, related test equipment and capital equipment would be moved and requalified over an 8-month period. In the interim, the labor force would be directed to build those assemblies requiring only manual soldering and cleaning techniques. Phasing production by program and process would result in a negligible increase in cost. Based on past precedent, a requalification of each product would be unnecessary since most production processes are manual and the quality of joint test assembly products is controlled primarily by the operator.

The planned special electronic assembly operation rearrangement would keep critical manufacturing equipment in place. Process requalifications would be unnecessary.

Mechanical Factory. The proposed Mechanical Factory would maintain most of the capabilities presently available with significantly reduced capacity. The factory is based on projected production rates for reservoirs, transportation safeguards division products, and a small quantity of other unscheduled production requirements. This workload exercises key factory capabilities and maintains the ability to support currently unscheduled stockpile replacement product. Total productive floor space requirement would be 20,900 m ^{2} (225,000 ft ^{2}).

Table A.3.6.1-2.-- Kansas City Plant II Alternative Mechanical Factory Products

Area	Products
Transportation safeguards products	Safe secure trailer/safeguards transport roadworthy refurbishment
	Safe secure trailer/safeguards transport retrofit/upgrades
	Safe secure trailer decommissioning
	Escort vehicle production
	Miscellaneous trailer production/repair
Metal machining	*Metal parts to support:*
	Mechanical assembly
	Electrical assembly
	Joint test assembly
	Cases and structural parts (limited)
Sheet metal and support processes	*Sheet metal parts to support:*
	Mechanical assembly
	Electrical assembly
	Liners and housings
	Support processes:
	Plating
	Painting
	Heat treatment
Mechanical welding	Support of mechanical assembly and sheet metal
Model shop/tool support	Tool repair and emergency fabrication
	Capability for prototype and evaluation hardware

KC ASI 1995a.

The workload mandates the consolidation of several previously separate manufacturing departments. The rearrangement consolidates all general machining processes in a common area. These consolidations allow for enhanced utilization of floor space, equipment, and personnel. Table A.3.6.1-2 lists mechanical factory products.

Engineered Materials Factory. The Engineered Materials Factory is designed to accommodate the minimum manufacturing capabilities required to support current and anticipated weapon program needs for all nonmetallic products. Basic processing capabilities have been retained to produce the following product families: polyurethane foam supports, syntactic foams, cushions, filled polymers, secure container assemblies, desiccants and getters, nonmetallic machining, and the polymer pilot plant. The minimum complement of manufacturing equipment to produce these products was determined and each production area sized appropriately.

Current manufacturing floor space of 11,241 m ^{2} (121,000 ft ^{2}) within the main building would be reduced by more than 34 percent to 7,350 m ^{2} (79,150 ft ^{2}). The polymer plant, a stand-alone facility used to produce unique materials not available from commercial suppliers, would not be reduced. Individual modules are described below:

- Compounding-164 m ^{2} (1,767 ft ^{2}): This area supports the compounding of polymeric materials for urea-filled cellular silicone cushion material and metal-filled polymers for fabrication.
- Foam molding-492 m ^{2} (5,300 ft ^{2}): Specially formulated polyurethane materials are mixed, poured, and cured to form structural parts for component packaging.
- Pressing--2,075 m ^{2} (22,335 ft ^{2}): This facility molds-to-size all cushion and filled polymer products. Press capacity ranges from 9 to 1,814 t (10 to 2,000 tons).
- Machining--823 m ^{2} (8,864 ft ^{2}): This environmentally controlled temperature and humidity area provides the capability to machine all nonmetallic products to their final configuration. Fabrication of syntactic foam products is also accomplished in this area.
- Assembly--2,404 m ^{2} (25,881 ft ^{2}): This area supports lay-up, wrapping, and impregnating capabilities to manufacture secure container assemblies. Desiccant and hydrogen getter materials are blended, formed, and assembled in this facility.
- Polymer production--1,394 m ^{2} (15,000 ft ^{2}): This external facility provides the polymer reactor capability to blend polyurethane materials that are unavailable from commercial suppliers. This facility has the capability to repackage bulk material into smaller unit quantities for production use.

Special environmental requirements were defined for machining, foam molding, and secure container assemblies, and appropriate areas were sized within the capability footprint of each module. Special security classification needs of secure container assemblies, cushion, and filled polymers have been considered and sufficient isolation provisions have been incorporated into the new factory concept.

Outsourcing Kansas City Plant-Made Products. A key tactic of the KCP II alternative is to aggressively pursue the outsourcing of products currently manufactured within KCP. KCP currently maintains most of the manufacturing technologies required to support weapons production. Anticipated reductions in production schedules and funding will no longer support maintaining all of these technologies in-house. Outsourcing is the preferred alternative as product designs become more compatible with commercial industry capabilities. Products to be outsourced are antennas, interconnect cables, retrofit kits, filter packs, molded plastic parts, trainer hardware, voltage regulators, parachute assemblies, piezoelectric motors, junction boxes, handling equipment, TC firing sets, ready-safe switches, test gear, printed wiring boards, option select switches, trainer kits, lasers/ electro-optics, and actuator assemblies.

Facilities modification to establish the KCP II configuration would take approximately 4 years. The following list describes the facility modification required to accomplish the proposed plant consolidation:

- Design and construction of standard manufacturing facilities
- Installation of modular clean rooms
- Design and construction of a fire-rated wall separating DOE from other site occupants
- Installation of heating, ventilation, and air conditioning systems and controls
- Extension of existing utility systems for chilled water, steam, sanitary, and industrial drains, and other mechanical and electrical services
- Site preparation, modification, and installation of walls and partitions, floor and ceiling finishes, security and fire protection features, and material handling equipment
- Rearrangement of existing operations and relocation of production equipment

Materials/resources consumed during KCP II construction are listed in table A.3.6.1-3. Emissions during construction/plant reduction would be negligible. The numbers of KCP II alternative construction workers required for construction/plant reduction can be found in table A.3.6.1-4.

Table A.3.6.1-3.-- Kansas City Plant II Construction/Plant Reduction Materials/ Resources Requirements

Material/Resource	Total Consumption	Peak Demand
Electricity	Negligible	Negligible
Concrete (m ^{3})	286	
Structural steel (t)	220	
Water	*Negligible*	
KC ASI 1995a; KCP 1995a:2.		

Table A.3.6.1-4.-- Kansas City Plant II Construction/Plant Reduction Construction Workers

Employees	1998 Year 1	1999 Year 2	2000 Year 3	2001 Year 4	Total
Total craftworkers	87	162	104	40	393
Construction management and support staff	15	25	18	8	46
Total Employment	102	187	122	48	459
KC ASI 1995a.					

KCP is completing an extensive renovation and upgrade of the plants major utility systems through the facilities capabilities assurance program. KCP has upgraded the high voltage electrical distribution systems including the replacement of approximately 50 substations and switchgear and 13,800 volt cables. In addition, the majority of the roof mounted air-handling units, dehumidification units, controls and duct work, chillers and cooling towers at the west boilerhouse have been replaced. Sprinklers and fire main systems have also been upgraded to provide continued reliable fire protection for KCP. KCP manages two boiler and chiller sites on a 7-day-per-week, 24-hour-per-day basis. These locations provide chilled water, steam, and compressed air for KCP and the other Federal agencies occupying the site.

Taking the renovation and upgrade activities into account, downsizing and reconfiguring the plant for KCP II would have no impact on the utility system capacities. KCP II alternative surge operation utility requirements are shown in table A.3.6.1-5.

Table A.3.6.1-5.-- Kansas City Plant II Nonnuclear Fabrication Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand 2
Electricity	225,000 MWh	30 MWe
Liquid fuel (L)	0	
Natural gas 3 (m 3)	18,900,000	
Raw water (dry site) (L)	1,340,000,000	

KCP II alternative operation annual chemical requirements are listed in table A.3.6.1-6, and KCP II alternative surge operation emissions are listed in table A.3.6.1-7.

Table A.3.6.1-6.-- Kansas City Plant II Nonnuclear Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity
Nitrogen	
Gas (m *3)*	3,270
Liquid (L)	14,900,000

Argon	
Gas (m *3*)	4,830
Liquid (L)	236,000
Carbon Dioxide	
Gas (m *3)*	322
Liquid (L)	122,000
Hydrogen	
Gas (m *3)*	0.1
Helium	
Gas (m *3)*	883

Liquid (L)	1,650
KC ASI 1995a.	

Table A.3.6.1-7.-- Kansas City Plant II Nonnuclear Fabrication Surge Operation Annual Emissions

Pollutant	**Quantity (t)**
Acetone	0.32
Carbon monoxide	13.17
Chromium	<0.01
Cyanide	<0.01
Ethyl benzene	0.054
Formaldehyde	<0.01

Hydrochloric acid	0.018
Isopropyl alcohol	4.44
Methanol	0.009
Methyl ethyl ketone	0.14
Methyl isobutyl ketone	0.027
Particulate matter	1.03
Perc	0.29
Sulfur dioxide	0.35
Toluene	0.59
Toluene diisocyanate	<0.01

1,1,1-Trichloroethane	0.036
Trichloroethylene	3.82
Volatile organic compounds	13.05
Xylene	0.25
KC ASI 1995a; KCP 1995a:3.	

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor. Sanitary wastewater would be processed in the sanitary wastewater system. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

Table A.3.6.1-8.-- Kansas City Plant II Nonnuclear Fabrication Facility Waste Volumes

Category	**Annual Average Volume Generated from Construction (m^3)**	**Annual Volume Generated from Surge Operations (m^3)**	**Annual Volume Effluent from Surge Operations (m^3)**
Low-Level [4]			
Liquid	None	None	None

Solid	None	None	None
*Mixed Low-Level*4			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	60	60
Solid	786	61	61
Nonhazardous (Sanitary)			
Liquid	None	570,000	570,000
Solid	745	310	310
Nonhazardous (Other)			
Liquid	None	223,900	223,900
Solid	None	11,500	11,500

The project design considers and incorporates waste minimization and pollution prevention. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.6.1-8 presents the estimated annual waste volumes from the nonnuclear fabrication plant at Kansas City during construction and surge operations. Solid and liquid wastestreams are routed to the waste management system. Solid wastes would be characterized and segregated into hazardous or nonhazardous wastes, then treated to a form suitable for offsite disposal. Liquid wastes would be treated onsite to reduce hazardous/toxic elements before discharge or transport. All fire sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Transuranic Waste. The Nonnuclear Fabrication Facility at KCP would not generate any TRU waste.

Low-Level Waste. The Nonnuclear Fabrication Facility at KCP would not routinely generate any LLW.

Mixed Low-Level Waste. The Nonnuclear Fabrication Facility at KCP would not routinely generate any mixed LLW.

Hazardous Waste. Hazardous wastes generated by the Nonnuclear Fabrication Facility at KCP would consist of acidic and alkaline liquids, solvents, and oils and coolants. Processes such as plating, etching, electronic assembly, metals and plastics machining and forming, and wastewater treatment are the principal generators. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging, characterization, and packaging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Nonhazardous waste generated at the Nonnuclear Fabrication Facility at KCP primarily consists of liquid sanitary, nonrecyclable, nonhazardous solid sanitary, and industrial wastes. Liquid sanitary wastes would be collected by sewer pipe systems from most of the support buildings and discharged directly to the Kansas City municipal sanitary sewer system. Process wastewater is sent to holding tanks for treatment and recycled, where appropriate. Process rinsewater waste streams are routed to the industrial wastewater pretreatment facility for treatment and then discharged to the Kansas City municipal sanitary sewer system.

Nonhazardous (Other) Waste. One-pass cooling water, fire sprinkler water, water from air dryers and vacuum pumps, as well as stormwater from areas of KCP would be discharged through the Blue River and Indian Creek NPDES outfalls.

A.3.6.2 Relocate to Los Alamos National Laboratory

Historically, LANL has designed nuclear weapons and has fabricated the development hardware to support the nuclear weapon design process. LANL has made a clear distinction between fabrication for production and fabrication for design agency requirements. At LANL production agency responsibilities would be separately managed. The LANL alternative would rely primarily on in-house production of nonnuclear components and services. Table A.3.6-1 shows the list of nonnuclear products and make-buy decisions. The following sections describe the nonnuclear fabrication products and processes that would be carried out at LANL.

Plastics, Detonators, and Pilot Plant Operations. Technologies currently in place at LANL, with the exception of parylene coating, large scale polymer pilot operations, cellular silicone compounding, and certain filled polymer molding, can support production of all components under consideration.

Generic descriptions of the products or processes to be transferred include inert components for high energy main charge detonators, inert components for high energy neutron generator detonators, blown and cellular silicone foams, polyurethane foams, silicone elastomer molding, composite molding, commodity material molding, filled silicone molding, and pilot scale synthesis of polymeric materials.

Due to the small scale and specialty nature of weapons components, most would be made internally. Materials that would most likely be procured include commodity molded materials. Polyurethane resin currently fabricated at the polymer pilot plant is made in relatively large lots, and, as such, may be procurable from outside vendors. In all cases, internal capability would be maintained to fabricate all materials and components. If internal capability to fabricate specialty items were lost, the technical risk of meeting scheduled or unscheduled production deadlines would be significantly increased. Additional processing capability would be required in the areas of polyurethane foam dispensing, intensive mixing, extruding and leaching of cellular silicone, flame spraying, and parylene coating. For pilot plant operations, additional processing capability would be required for large scale processing of up to 380 L (100 gal). All detonator flat cable processing capability is currently available; however, upgraded equipment would be required to better meet production requirements. High energy detonator fabrication capabilities would need to be installed.

Reservoirs and Valves. LANL has the capability for small scale fabrication for valves and reservoirs in support of R&D of new boost systems, NTS operations, and local hydrodynamic or other experimental testing. Generic descriptions of the products or processes to be transferred include the procurement, certification, and storage of all nuclear-grade materials needed by production. These materials include different alloys of stainless steel, beryllium, copper, aluminum, weld filler materials, and other specialty materials unique to boost system applications. These materials may take the form of raw billets, forging, partially machined parts, finished machine parts, subassemblies, and finished assemblies. Also included in this parts list are vendor purchased parts such as elastomer seals, metal seals, screws, and filters. Fabrication of boost systems includes the procurement of material stock, machining operations, mechanical and radiographic inspection, cleaning, welding, assembly, proof pressure testing, leak testing, volume measurement, packaging, storage, and shipment. As part of the product certification, shelf life storage units would be manufactured to represent the product and monitored throughout the stockpile life.

Facility Description. LANL occupies an area of 111,000 ha (274,000 acres) with 30 active TAs (figure A.3.6.2-1). Figures A.3.6.2-2 through A.3.6.2-5 show the detailed facility layout for project TAs. [figure A.3.6.2-3] [figure A.3.6.2-4]

The following facilities, with the specified installations/upgrades, would be used for nonnuclear production activities at LANL:

- *Plastics production.* TAs-16-302, -303, -304, -305, -306, and -307: New or transferred equipment would be installed in these facilities. Electrical system upgrades would be required in some of these facilities.
- *Reservoir and valve production.* TA-3-SM-39: Removal of existing machine tools and replacement with new or transferred machine tools would be required. No other upgrades would be necessary.
- *Detonator component manufacture.* TA-22-91: New or transferred equipment would be installed at this facility. Electrical systems upgrades would be required.
- *Large scale pilot plant polymer synthesis.* TA-16-340: New or transferred equipment would be installed at this facility. Electrical systems upgrades would be required.
- *Small scale pilot plant polymer synthesis operations.* TA-35-213; no additional installations or upgrades required.
- *Mold storage.* TA-16-332: no installations or upgrades required.

Table A.3.6.2-1 presents facility data for the nonnuclear fabrication missions at LANL.

Technical Areas-16-302, -303, -304, -305, -306, and -307. These buildings would contain the plastics production activities associated with the proposed production activities. Buildings 302, 304, and 306 are single story with equipment room basements. Buildings 303, 305, and 307 are single story. The buildings are each concrete-walled, roofed structures that currently house plastics-related production, fabrication, and storage functions. Each of the buildings is served by 480-volt power and each has existing process steam, vacuum, air, and ventilation systems required for plastics fabrication and manufacture. The proposed production activities would require that several types of new or transferred equipment (mixers, extruders, roll mills, presses, coaters, screeners, testing equipment, and quality assurance equipment) be installed in Buildings 303 through 307. Building 302 would be used for raw material storage and bonded material/product storage. Although the existing electrical power would accommodate the added equipment, power distribution panels and associated wiring would have to be upgraded in some facilities. The steam, ventilation, air, and vacuum systems would not require upgrades.

Technical Area-3-SM-39. This facility would contain the metal machining, inspection, packaging, and storage functions required for reservoir and valve production. The facility is a two-story (second floor is mezzanine), concrete-walled, roofed structure with steel beam construction. The facility was originally designed as and is currently used as a machine shop, with air ventilation systems required for metal machining. The proposed production activities would require that several types of new or transferred machine tools (lathes, mills, drills, grinders, welders, inspection/testing equipment) be installed. Although the existing electrical power would accommodate the added equipment, power distribution panels and associated wiring would have to be installed for the specific machines. Besides rearranging equipment and storage locations, no other upgrades would be required.

Technical Area-22-91. This facility would contain the inert detonator manufacture and assembly operations. The facility is a single-story, block and concrete structure with joist/concrete roof that was originally designed for detonator fabrication and assembly. The proposed production activities would require that several types of new or transferred equipment be installed. Although the existing electrical power would accommodate the added equipment, power distribution panels and associated wiring would have to be installed for the specific equipment. No other upgrades would be required.

Table A.3.6.2-1.-- Los Alamos National Laboratory Nonnuclear Facilities

Facility	**Number of Stories**	**Total Space (m ^{2})**	**Utilized Space [5] (m ^{2})**	**Construction Type**
TA-3-SM-39	2	10,405 [6]	2,323	Concrete with steel beam
TA-16-302	1	566	566	Concrete walls/roof
TA-16-304	1	566	566	Concrete walls/roof
TA-16-306	1	566	566	Concrete walls/roof
TA-16-303	1	273	273	Concrete walls/roof

TA-16-305	1	273	273	Concrete walls/roof
TA-16-307	1	273	273	Concrete walls/roof
TA-16-332	1	929	929	Steel joist/metal sheet
TA-16-340	2	2,111 [6]	149	Concrete walls/roof
TA-22-91	1	2,002	2,002	Concrete walls/roof
TA-35-213	3	7,880	1,125	Concrete walls/roof

Technical Area-16-340. Bays 109 and 110 of this facility would contain the large scale pilot plant polymer synthesis. The building is a two-story (second floor is equipment room) concrete-walled, roofed structure with blowout walls originally designed for explosive synthesis operations. The proposed production activities would require that a reactor vessel, mixer heater, pulverizer, solvent recovery equipment, and storage area be located in the bays. New electrical service to the equipment would have to be installed. No other upgrades would be required.

Technical Area-35-213. This facility would contain the small scale plant polymer synthesis. The building is a three-story formed concrete structure with a joist/concrete roof. The proposed production activities would not require any modification or installations as all of the required equipment currently exists.

Technical Area-16-332. This facility would be used as a storage area for raw materials and/or components associated with the proposed production activities. The building is a single-story, steel-framed metal building. No upgrades or installations would be required.

Table A.3.6.2-2 presents a schedule for implementation of nonnuclear fabrication activities at LANL. Construction would consist of new or transferred equipment in existing facilities and upgrades to electrical systems within the proposed facilities. The proposed installations and modifications would occur over a 2-year period. The resources and raw materials would consist of only what would be required to install 50 pieces of equipment and to upgrade electrical systems. Materials/resources consumed during the entire construction phase are presented in table A.3.6.2-3.

Table A.3.6.2-2.-- Los Alamos National Laboratory Schedule of Activities for Nonnuclear Fabrication

Activity	**Start**	**End**
Research and development duration	1/96	1/97
Hazard/risk assessment, NEPA determination	1/96	1/98
Engineering design (conceptual, final)	1/97	1/00
Modifications/equipment installations	1/00	1/01
Mission transfer/qualification/ proof of operation	1/99	12/02
Steady-state operations	12/02	
Decontamination/decom-missioning or conversion	1/30	
LANL 1995c.		

Table A.3.6.2-3.-- Los Alamos National Laboratory Nonnuclear Fabrication Construction/Upgrade Materials/Resources Requirements

Material/Resource	**Total Consumption**	**Peak Demand**
Electricity	105 kWh	3.8kWe
Electrical wiring (m)	762	

Conduit (m)	3,050	
Water (L)	9,500	
LANL 1995c.		

Because the construction activities associated with the proposed activities would consist only of installation of equipment and upgrade of electrical systems, there would be no aerial emissions of criteria or other pollutants.

Only small quantities of nonhazardous solid and liquid wastes would be generated as a result of the equipment installation and electrical upgrade work required for the proposed activities. Table A.3.6.2-4 lists the total number of personnel that would be required to perform the installation/modification work. This includes only those actually involved with the work and does not include process development or design work. The number of employees listed are spread out over a 1-year period, and more than the listed quantity could be present at any time during the year (1.5 workers per year may consist of 3 workers for a 6-month period).

Table A.3.6.2-4.-- Los Alamos National Laboratory Nonnuclear Fabrication Construction Workers

Employees	**2000**	**2001**	**Total**
Total craftworkers	3.0	3.0	6
Construction (installation) management/support staff	0.25	0.25	0.5
Technical support personnel	2.0	2.0	4

Project support personnel	1.0	1.0	2
Total Employment	6.25	6.25	12.5
LANL 1995c.			

Table A.3.6.2-5 provides estimates of the electrical, steam, and water usage that would be added to facility surge operations due to the proposed action. Because all of the activities would occur in existing buildings, space heating loads and electrical loads from normal occupancy (lighting and ventilation) are not included. Raw water consumption includes added sanitary usage from increased personnel that would occupy the facilities due to the proposed activities.

It is noted that all of the facilities associated with the proposed activities are heated either by steam or by central gas heating systems. At the TA-16 facilities, steam is also used as a process heating method and for process washdown/cleaning activities.

Table A.3.6.2-5.-- Los Alamos National Laboratory Nonnuclear Fabrication Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand 7
Electricity	525 MWh	0.23 MWe
Liquid fuel	None	
Natural gas	340	

Steam (m *3)*	95	
Raw water (L)	48,300,000	

Table A.3.6.2-6 lists the annual chemicals consumed during surge operation.

Table A.3.6.2-6.-- Los Alamos National Laboratory Nonnuclear Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity
Raw materials/chemicals used for plastics formulation	38,600
Metals for valve/reservoir/detonator production (kg)	3,020
Machine tool cutting fluids/lube oils (kg)	511
Cleaning/developing fluids for detonator assembly (kg)	2,270
LANL 1995c.	

Emissions. None of the proposed activities would require discharge to existing NPDES-permitted outfalls. Although there would be a slight increase in once-through cooling water discharged from the steam plant to an NPDES outfall resulting from the slight increase in process steam usage, this is not considered to be a pollutant. Aerial emissions of combustion by-products from the slight increase in process steam usage are listed as annual surge operation emissions in table A.3.6.2-7.

Table A.3.6.2-7.-- Los Alamos National Laboratory Nonnuclear Fabrication Surge Operation Annual Emissions

Pollutant	Quantity (t)
Carbon monoxide	0.0002
Nitrogen oxides	0.0002
Particulate matter	0.00007
Sulfur oxides	0.000003
Volatile organic compounds	0.282
LANL 1995c.	

Waste Management. Small amounts of nonhazardous liquid and solid wastes would be generated as a result of the installation of equipment and upgrade of the electrical systems. No radioactive waste or hazardous waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.6.2-8 presents the estimated annual waste volumes from the Nonnuclear Fabrication

Facility at LANL during modification activities and surge operations. Solid and liquid waste streams are routed to the waste management system. Solid wastes would be characterized and segregated into hazardous and nonhazardous wastes, then treated to a form suitable for offsite disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic characteristics before discharge or transport.

Transuranic Waste. The Nonnuclear Fabrication Facility at LANL would not generate any TRU waste.

Low-Level Waste. The Nonnuclear Fabrication Facility at LANL would not generate any LLW.

Table A.3.6.2-8.-- Los Alamos National Laboratory Nonnuclear Fabrication Waste Volumes

Category	**Annual Average Volume Generated from Construction (m ^{3})**	**Annual Volume Generated from Surge Operations [8] (m ^{3})**	**Annual Volume Effluent from Surge Operations (m ^{3})**
Hazardous			
Liquid	None	11	11
Solid	None	0.11	0.11
Nonhazardous (Sanitary)			
Liquid	None	568	566 [9]
Solid	None	10	6 [10]

Nonhazardous (Other)			
Liquid	5 11	25 12	None
Solid	0.04	3 13	None

Mixed Low-Level Waste. The Nonnuclear Fabrication Facility at LANL would not generate any mixed LLW.

Hazardous Waste. Some hazardous wastes would be generated as a result of the Nonnuclear Fabrication Facility at LANL; however, no new hazardous waste streams would be generated. These wastes consist of liquid solvent wastes and solid beryllium wastes from machining operations. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters. The solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging, characterization, and packaging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Nonhazardous process wastes generated at the Nonnuclear Fabrication Facility at LANL consist of washdown and cleaning water containing soaps and other cleaning agents. These wastes would be discharged to the sanitary waste systems. Solid nonhazardous plastics waste and wastewater sewage sludge is disposed of in offsite industrial and sanitary landfills.

Nonhazardous (Other) Waste. Liquid nonhazardous wastes such as spent machine tool cutting fluids and spent lubricating oils will either be recycled or disposed of onsite or offsite by the LANL Waste Management Group. Solid nonhazardous wastes such as excess electrical wire, resins, and molds would also be generated. This waste would be salvaged, recycled, or disposed of offsite.

A.3.6.3 Relocate to Lawrence Livermore National Laboratory

Nonnuclear fabrication at LLNL would include production or procurement of all plastic components, polymers, and composite parts. Nearly all processes are currently, or have been, in operation at LLNL on the same scale as needed for the nonnuclear fabrication mission. The nonnuclear fabrication mission would be accomplished within 15 departments listed in table A.3.6.3-1.

Table A.3.6.3-1.-- Lawrence Livermore National Laboratory Existing Nonnuclear Fabrication Departments

Department Number	Function
1	Compression molding
2	Transfer molding
3A	Cellular silicone foam
3B	Brown silicone foam
4	Injection molding
5	Polyurethane foam molding
6	Casting and encapsulation
7	Machining
8	Composite fabrication
9	Repackaging
10	Polymer synthesis
11	Receiving
12	Packaging/shipping
13	Document control
14	Quality control
15	In-process material handling
LLNL 1995f.	

Nonnuclear fabrication would take place at the Livermore Site as shown in figure A.3.6.3-1. The fabrication, including polymer synthesis, would be confined to a consolidated area consisting of five adjacent buildings as shown in figure A.3.6.3-2.

Departments 1, 2, 3B, 4, 6, 7, 8, and 9 currently exist in dedicated facilities within the B231 complex at LLNL. Equipment for Department 5 is available but would be relocated to B131 in an existing low-relative-humidity operations area. Relative-humidity-sensitive and precision machining operations would also be located in this area. Department 3A would most likely be a scaled down version of the existing process and would be located in area B231. Department 10 would be an entirely new process which would be located in B232. Large scale storage of incoming and finished product would be accomplished in B131 adjacent to the Department 5 facility. Receiving inspections would be accomplished in B223. Finished product packaging and short-term storage would be in B227. In-process storage would be in the high bay area on B231. Support offices and in-process quality control would also be located in B231.

The process/products included in the LLNL nonnuclear fabrication alternative are transfer molded parts, compression molded parts, injection molded parts, machined plastic parts, silicone cushion (all types), syntactic components, filled polymers, and polymer synthesis.

This alternative covers processes for fabrication of nearly all plastic nonnuclear components needed to meet nonnuclear fabrication requirements. There are a few components that can be obtained more cost effectively through procurement. Some very specialized plastic film and tubing parts for certain assemblies may more effectively be produced or procured by the agency producing the assembly. Synthesis of basic polymers is included to provide raw materials that are not commercially available.

Compression Molding. The compression molding process would be used to produce filled and unfilled, elastomeric or rigid, thermosetting components.

Existing roll mill capacity would be sufficient for all products except cellular silicone. Currently ceramic rolls are used for high purity instead of beryllium oxide rolls utilized at KCP. The beryllium oxide rolls would have to be transferred or a modification made to the process specifications to allow for other materials. An intermediate size roll mill and Banbury mixer for use with cellular silicone are included in capital equipment. Scales, preform cutting, and in-process storage are available.

The facility is capable of utilizing integrally heated or platen heated tools. Thus, existing tooling should be sufficient in all cases. Tooling would be stored in the B231 complex in the 1300 Wing.

There is very little transfer molding involved in this alternative. Diallyl phthalate electronic components would be procured by the agency needing the components. However, the capability would exist within the production facility.

Preforming would be done on existing compression or transfer presses located in Department 2. The dielectric heater would be transferred from the production agency or purchased new. Post cure can be accomplished in the current oven capacity at the facility. In-process trim and inspection would be accomplished in the same area used for compression molded parts. Overflow inspection capability would exist in room 1240.

Cellular Silicone Compounding. The current production process for cellular silicone compounding could either be scaled down to a more appropriate size or the equipment could be transferred from the current production agency. The most economical approach would be to scale this process down to a much smaller batch size. Similar parts were made 10 years ago in the existing equipment at LLNL. This equipment includes the Banbury mixer, compounding roll mills, and sheeting roll mills. Production levels dictate an equipment size in-between those at LLNL and KCP. The current proposal allows for scaling down the process; however, there is an area set aside in the B231 high bay for installation of KCP equipment. Another option would be to transfer the production agency equipment to LLNL. In that case, the compounding operations would be installed in the high bay of B231 in place of existing temporary structures.

The urea screening operation either would be transferred from the production agency or a new system of smaller capacity would be installed at LLNL. This equipment would be scheduled for B231, in a dedicated area in either case. Washing and drying operations would be located in B231 in a newly enclosed area in Wing 1200. Two washers would be transferred from KCP. A reverse osmosis water system would be installed in B232 and piped to the 1200 Wing of B231. A new drying oven would be purchased. Molding operations would be conducted in the compression molding department.

Blown Silicone Foam Molding. The current operation for blown silicone foam molding in department 3B utilizes equipment in the compression molding department. There is some ancillary equipment in place that is functionally identical to that used at KCP.

Injection Molding. The installed injection molding (Department 4) capacity at LLNL includes machines of up to 260-g (9-ounce) and 100-t (110-ton) capacity. The capability at KCP includes machines of this size and also 400, 740, 790, and 2,270 g (14, 26, 28, and 80 ounces). The need for this larger equipment would be evaluated as the requirement warranted. The machines at LLNL are in excellent condition. The 100-t (110-ton) machine at LLNL utilizes dedicated computer control. This feature is very useful in a production environment when a variety of products are involved because of the rapid, error free setting of machine variables from stored programs. Large polymethylpentene blanks are currently made at KCP using the 2,270-g (80-ounce) injection molding machine in a specialized process that is somewhat similar to compression injection but on a very large scale. This process could be sent to an outside vendor if a change in grade of material could be approved. This would be the option of choice. However, there are two other options: install the 2,270-g (80-ounce) machine in the B231 high bay adjacent to existing injection molding facilities or qualify the process currently in use at LLNL for the production of large polymethylpentene castings.

Polyurethane Foam Molding. LLNL currently operates three machines in Department 5 that can be utilized for the polyurethane foam molding process. One is a resin transfer molding unit that can be modified for foam. This machine is extremely versatile and would be the machine of choice for most production.

This process would be located in Wings 1300 and 1400 of B131, less than 100 m (*328* ft) from the Central Process Area in B231. This is the location of preference since 10 percent relative humidity control is installed and operational. Foam and other relative humidity sensitive and precision machining operations would be collocated in the same wing. Much of that machining capacity is already installed. Existing tooling could be used in all cases. Tooling storage would be in an adjacent storage area.

Casting and encapsulation. Casting and encapsulation is a routine operation in the current Department 6 facility, and no significant changes are anticipated. Vacuum/pressure encapsulators are available. Existing tooling should be adequate in all cases. Tooling storage would be similar to that for compression molding.

Machining. Machining operations would be conducted in Department 7 in the B231 Machine Facility in Wing 1500. Composite machining would occur in Room 1019, B231. This room is currently dedicated to this type of machining and has the proper tooling, including diamond tools, and the proper high speed machining heads. HEPA filtration and high velocity dust extraction is built into this facility.

Low relative humidity and precision machining would occur in B131. The current facility can be humidity controlled to less than 10 percent relative humidity and has substantial matching and inspection capability in place. Certain specific machines may have to be relocated from other onsite locations or, if necessary, from KCP.

Composite Fabrication. There is only a small amount of composite fabrication needed for this alternative. These few parts can readily be fabricated in the current facilities, located in Department 8. The most sophisticated component is a carbon/phenolic part. The existing 318-t (350-ton) press has highly flexible bump cycle programming which can be utilized for fabricating this part.

Repackaging. Repackaging is a routine operation within the existing Department 9 facility. No additional changes would be required for this alternative.

Polymer synthesis. Polymer synthesis would be a new Department 10 operation at LLNL. Reactors of 190- and 380-L (50- and 100-gal) capacity and associated support equipment would be located in B232. Reactors, complete with a dedicated hot oil heating system, are included in capital equipment. The units would be installed in the south portion of B232. This is an abandoned high pressure facility and is ideal for this operation. Items such as product dryers and precipitators would be transferred from KCP.

A list of materials and resources consumed during modification activities can be found in table A.3.6.3-2. A list of emissions produced during modification activities can be found in table A.3.6.3-3. A list of construction workers needed during the modification phase can be found in table A.3.6.3-4. A list of utilities consumed during surge operation can be found in table A.3.6.3-5. A list of the annual chemicals consumed during surge operation can be found in table A.3.6.3-6. A list of emissions produced during surge operations can be found in table A.3.6.3-7.

Table A.3.6.3-2.-- Lawrence Livermore National Laboratory Nonnuclear Fabrication Construction/Modification Materials/Resources Requirements

Material/Resource	Total Consumption	Peak Demand 14
Electricity	21 MWh	50 kWe
Fuel (L)	19,900	
Water (L)	79,500	
Concrete (m *3*)	7.6	
Steel (t)	7.3	
Industrial gases (m *3*)	7.5	

Table A.3.6.3-3.-- Lawrence Livermore National Laboratory Nonnuclear Fabrication Construction/Modification Emissions

Pollutant	Quantity (t/yr)
Carbon monoxide	3.08
Nitrogen oxides	1.09
Particulate matter	0.36
Sulfur dioxide	0.09
Volatile organic compounds	0.54
LLNL 1995f.	

Table A.3.6.3-4.-- Lawrence Livermore National Laboratory Nonnuclear Fabrication Construction/Modification Construction Workers

Employees	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Architectural design	0.14	0.35	0.43	0.35	0.14	1.4
Plant design	0.09	0.22	0.26	0.22	0.09	0.9
Project manager	0.09	0.22	0.26	0.22	0.09	0.9
Construction manager	0.13	0.31	0.38	0.31	0.13	1.3
Inspectors	0.13	0.31	0.38	0.31	0.13	1.3
Document clerk	0.01	0.03	0.04	0.03	0.01	0.1
Craftworkers	1.27	3.20	3.80	3.20	1.27	12.7
Total Employment	1.9	4.6	5.5	4.6	1.9	18.6
LLNL 1995f; LLNL 1995i:2.						

Table A.3.6.3-5.-- Lawrence Livermore National Laboratory Nonnuclear Fabrication Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand 15
Electricity	108 MWh	0.095 MWe
Natural gases (m *3*)	28,900	
Liquid fuel (L)	0	
Water (L)	3,790,000	

Table A.3.6.3-6.-- Lawrence Livermore National Laboratory Nonnuclear Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity
Nitrogen	
Gas (m^3)	37.8
Liquid (L)	278,000
Argon	
Gas (m^3)	39.2
Liquid (L)	3,420
Carbon dioxide	
Gas (m^3)	2.35
Liquid (L)	1,760
Hydrogen	

Gas (m 3)	0.04
Liquid (L)	0
Helium	
Gas (m 3)	71.64
Liquid (L)	22.7
LLNL 1995f; LLNL 1995i:2.	

Table A.3.6.3-7.-- Lawrence Livermore National Laboratory Nonnuclear Fabrication Surge Operation Annual Emissions

Chemical	**Quantity (t)**
Acetone	0.066
Isopropanol	0.13
Methyl ethyl ketone	0.006

Toluene	0.006
LLNL 1995f.	

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling.

Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped off site to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.6.3-8 presents the estimated annual waste volumes from the Nonnuclear Fabrication Facility at LLNL during modification activities and surge operations. Solid and liquid waste streams are routed to the waste management system. Solid wastes would be characterized and segregated into nonhazardous or hazardous wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic elements before discharge or transport. All fire sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Transuranic Waste . The Nonnuclear Fabrication Facility at LLNL would not generate any TRU waste.

Low-Level Waste. The Nonnuclear Fabrication Facility at LLNL would not generate any LLW.

Mixed Low-Level Waste. The Nonnuclear Fabrication Facility at LLNL would not generate any mixed LLW.

Hazardous Waste. Hazardous wastes generated by the Nonnuclear Fabrication Facility at LLNL would consist of acetone, toluene/methanol mixture, toluene, and dimethyl formamide in aqueous solution. The toluene/methanol waste stream has been evaluated as a strong candidate for recycling by distillation to recover the high value solvent components. The distillation of this waste stream would result in the generation of distillation bottoms, which would be removed periodically and managed as a solid hazardous waste. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging, characterization, and packaging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Nonhazardous waste generated by the Nonnuclear Fabrication Facility at LLNL primarily consists of process water and incidental water usage, and nonrecyclable, nonhazardous solid sanitary and industrial wastes. Liquid sanitary wastes would be collected by sewer pipe systems from most of the support buildings and discharged directly to the city of Livermore municipal sanitary sewer system. One of the projected waste streams, an aqueous solution of urea, will be sampled to establish a baseline of waste stream constituents, and directed to the sanitary sewer system. Process wastewater is sent to holding tanks for treatment and recycled where appropriate. Process rinsewater waste streams are pretreated and then discharged to the sanitary sewer system according to permit requirements and the city of Livermore Public Services Ordinance.

Table A.3.6.3-8.-- Lawrence Livermore National Laboratory Nonnuclear Fabrication Waste Volumes

Category	**Annual Average Volume Generated from Construction (m^3)**	**Annual Volume Generated from Surge Operations [16] (m^3)**	**Annual Volume Effluent from Surge Operations (m^3)**
Hazardous			
Liquid	0.08	7 [17]	3 [18]

Solid	0.15	None	0.2
Nonhazardous (Sanitary)			
Liquid	36	5,770 19	5,770 20
Solid	0.9	127 21	64 22
Nonhazardous (Other)			
Liquid	76	Included in sanitary	Included in sanitary
Solid	10	Included in sanitary	Included in sanitary

Nonhazardous (Other) Waste. The bulk of waste would be thermoplastic and cured thermoset materials and various fillers or reinforcements. LLNL is conditionally permitted in California to treat any unused thermosetting waste in order to make the waste nonhazardous. Stormwater from areas of LLNL is allowed to go in natural drainage channels.

A.3.6.4 Relocate to Sandia National Laboratories

Most products and services currently obtained from KCP would be obtained by SNL, which is located in New Mexico, through procurement from the commercial sector or through capabilities that would be developed internal to SNL. Procurement of products and services from the private sector would be the preferred alternative. Key nonnuclear product and process descriptions for items to be purchased are described in the following section.

System Level Products (Made up of more than one component to form a kit or system.)

Retrofit Kits . Retrofit kits would be assembled, stored, packaged, and shipped to various locations for repairing problems in weapons or upgrading weapon capabilities. Retrofit kits would be maintained in a bonded storage area, and when complete would be specially packaged and shipped to where they are needed. Sometimes specialty packaging would be done at the fabrication point within the plant.

Trainer Kits . Trainer kits are a package that may contain a variety of weapon components that may be hazardous or operationally irreversible in their realistic form but are functional in helping to teach the customer how to test, operate, or install a real component prior to actually doing so. Alternately, the kit may be used to teach the customer how to perform a weapon retrofit. The trainer kit may also contain tools, test devices, bolt packs, or similar hardware packs to perform tests or component replacement training. Trainer kits would be made in-house for components that are made in-house.

SECOM Relay Station. DOE currently maintains five high frequency relay station facilities around the country in support of its redundant secure communications network. KCP has maintained the high frequency relay station physically located south of KCP for nearly 20 years. Current responsibilities include upkeep of the grounds including security fencing, mowing, building repair, generator repair, and maintenance of the computers, transmitters, receivers, and antenna field.

Electrical Components

Hybrid Microcircuit Substrates . Ceramic substrates with conductor patterns are needed to support assembly of circuits for radar units. These substrates would be purchased to meet the circuit layout specifications.

High Energy Density Capacitors and Passives: Ceramic Capacitors, Resistors, and Filters. This group of components includes high energy density capacitors and all passive electrical components such as capacitors, resistors, and filters.

Integrated Circuits and Semiconductor Components. These components include the full range of all the semiconductor products including diodes, transistors, and large-scale integrated circuits used in war reserve assemblies.

Joint Test Assembly Components. These are telemetry components used on joint test assemblies that are all procured from outside suppliers. They include pulse code modulators, voltage controlled oscillators, a mixer amplifier, a crystal oscillator, transmitters, and transponders.

Printed Wiring Products . This group of products consists of a wide variety of items processed in the printed wiring facility at KCP. These products range from rigid multilayer boards, multilayer flex, and special material boards to polyimide quartz boards, detonator cables, and chem-milled products used to fabricate rolamites.

Interconnects Cable Fabrication. Cable fabrication includes round wire, flat flex, and radio frequency types of cables.

Junction Boxes . Junction boxes are used to electrically connect internal weapons components to each other and the weapon control panel. The junction box has many lines and some components internally wired to several connectors at the junction box surface. The various weapon components are then attached with cables to the junction box connectors as the weapon is being assembled.

Mechanical Components

Transducers. Transducer components consist of pressure transducers, accelerometers, rate gyro assemblies, and temperature piezoelectric transduces.

Radio Frequency and Multicontact Connectors. The radio frequency multicontact connector product category includes all electrical connectors used on all weapons programs. The primary next-assemblies for the radio frequency and coaxial connectors are radars, antenna systems, and system-level coaxial cable assemblies. The multipin connectors are used throughout systems on firesets, radars, and programmers, in addition to being used for system-connect cables.

Handling Gear. Weapon systems require specially designed equipment for handling, lifting, and transportation called handling gear. There are two distinct types of handling gear: team gear and ultimate user package gear. Team gear is designed by SNL and is purchased by DOD. Ultimate user package gear is typically designed by SNL for DOE; thus, DOE owns and maintains it. Ultimate user package gear normally consists of shipping and storage containers and bomb hand trucks.

Piezoelectric Motors . Miniature piezoelectric motors are currently being developed to replace solenoids in some applications.

Molded Plastic Parts . There are 550 to 650 molded plastic parts in weapon systems. Approximately 60 percent of the parts contain inserts that are molded in place. Most of the parts are transfer-molded, with some compression-molded and some injection-molded.

Major Mechanical Parts . Major mechanical parts are nonfunctional structural components. Most of these parts will be machined metal components, but they could also be components fabricated from plastics, ceramics, or sheet metal.

O-rings, Cushion, and Gaskets . O-rings are used extensively in maintaining environmental and functional seals in most nuclear weapons systems. There are many types of materials available to compensate for the effects of temperature changes and materials compatibility within the weapon system.

Honeycomb Parts . Honeycomb components are used for structural purposes and shock mitigation in some nuclear weapons systems.

Parachute Assemblies . Parachute assemblies consist of four major components: the parachute tube and end, the parachute, the reefing line cutter, and the explosive deployment component. The parachute tube is a machined component. In some systems, a pilot parachute and ejection plate are used in place of a tube.

Commercial Hardware . Commercial hardware encompasses all the small hardware items used to support weapon builds, limited-life component exchanges, and stockpile maintenance. This includes screws, bolts, nuts, and other fasteners, as well as other commercially available parts.

Precision Machining . Precision machining is a service required for numerous products currently manufactured at KCP. Various machining processes are already available at SNL that could be utilized in support of war reserve production activities. The local and national vendor base with precision machining capability has been well categorized in the past, and good relations with sufficient case histories are present to aid the transition from make in-house to buy outside.

Gas Transfer Systems-Buy Items . Because SNL plans to do only final assembly, testing, and acceptance of reservoirs, there would be significant procurement of piece parts and subassemblies. All electro-explosive valves and interconnect tubing and fittings would be procured from commercial suppliers. Similarly, all machined reservoir components from hemispheres, caps, stems, sleeves, and forgings would be machined by private industry. Currently, buy items such as nuts, bolts, washers, protective caps, and raw material for forgings will continue to be procured commercially.

Materials/Explosives/Other

Detonator Cables . Detonator cables (nonprimary) consist of a header that contains the electrical wire leads and the bridge wire. Header material may vary from plastic to a metal/ceramic combination. The electric connection may be hookup wire leads, coaxial, or multipin assembly.

Military Base Spare . Military base spares are kits that DOE is required to provide to the military to maintain nuclear weapons. Currently, about 140 different kits are supplied with approximately 50 percent of the items consisting of off-the-shelf hardware and 50 percent being limited-shelf-life chemicals.

Nuclear-Grade Materials . Nuclear-grade materials comprise special controlled chemistry wrought product (bar and plate stock) used for critical and noncritical applications. This encompasses special specification materials for gas transfer systems as well as commercial grade materials for structural and nonstructural applications.

The only products to be assembled or manufactured at SNL would be those that have exceptional security requirements or that employ technologies unavailable in the commercial sector. The principal activity at SNL would be the assembly of piece parts and subassemblies procured from the commercial sector, and manufacture and assembly of those components with special security requirements. Key nonnuclear product and program descriptions for items to be manufactured in-house are described in the following sections.

System Level

Arming, Fuzing, and Firing Assembly. This process is the final assembly of the arming, fuzing, and firing subsystems. This major hardware assembly is composed of printed wiring boards, battery pack, various electronic components, connectors, wiring harness, other materials, and outer containers. All are assembled in a precise step-by-step process to meet rigid final assembly requirements. The arming, fuzing, and firing assembly is a complex process involving many different activities, supporting equipment, and personnel skill sets to achieve product realization. It is not expected that the SNL assembly process would be markedly different from that employed at KCP.

Nose Assemblies . Nose assembly includes both new-build and refurbishment assemblies. The nose assembly process is straightforward and involves several different activities, supporting equipment, and personnel skill sets.

Joint Test Assemblies . Joint test assemblies consist mainly of internal power supplies, signal conditioning, circuitry, neutron and/or x-ray detectors, and analog and digital circuitry to process data during DOE test flights. This data is transmitted to ground stations or stored in an internal data recorder for recovery after the flight.

Safeguards Transporter . The safeguards transporter new-build activity integrates both new and proven security and safety technologies into a modern transport design that will ultimately replace the safe secure trailer. The safeguards transporter project includes developing a manufacturing capability and producing safeguards transporters. Approximately 20 percent of the production work would be done at SNL and 80 percent would be procured commercially.

Electrical Components

Lightning Arrester Connectors . Lightning arrester connectors are multicontact circular hermetic connectors that must reliably function as a connector in normal environments and must divert current from a direct lightning strike, or any other high voltage source, from the connector contacts to the connector shell. A lightning arrester connector is made from commercially manufactured connector shell and piece parts, combined with specially formulated granules. The special granules give the lightning arrester connector its lightning protection capability.

Firesets Capacitor Discharge Unit Firing Systems. The primary purpose of a capacitor discharge unit firing system is to provide the timing and initiation power for the weapon electrical system. The firing systems also provide the packaging for other weapon components depending on the specific requirements. Hence, firing systems use low and high voltage circuits, power and voltage switches, stronglinks, regulators, and related circuitry. The processes currently in use at KCP would continue much the same at SNL except that more parts would be commercially procured.

Radars . The following list briefly outlines the required processes:

- Radio frequency and printed wiring assembly: kitting of parts, circuit board population, belt/ hand soldering, cleaning, laser marking, final visual/electrical inspection
- Channel assembly: install logic/converter and radio frequency assemblies, attach flex, cables, clean, first visual/electrical inspection, temperature cycle, encapsulate, final visual/electrical inspection
- Radar assembly: select two channels, first electrical, install desiccant and compression pad, laser weld channels, first leak test, purge and backfill, weld evacuated tubes, final leak test, laser mark, final visual/electrical inspection
- E-test/D-test: short/medium term vibration, shock, temperature cycling, electrical test, dissection

Antennas . The process of antenna manufacturing consists of machining, welding, and plating a housing. Feed network component parts are assembled into the housing and welded together. A dielectric is sealed into the housing, and the assembly is leak tested. The completed assembly then undergoes an environmental preconditioning (temperature cycling). The antenna is then radio frequency tested on a ground plane in an anechoic chamber. Samples are pulled periodically and undergo test environments to ensure product and process reliability.

Use Control Hardware . All use control hardware would be manufactured in-house. In some cases, commercial parts would be used. All repair of use control hardware would also be performed in-house.

Mechanical Components

Gas Transfer Systems . Gas transfer systems include high pressure reservoirs for containing either boost or inert working gases, explosive valves to open the reservoirs, and tubulations and connectors to transfer the contained gases to required locations within the weapon. Electro-explosive valves are used to accomplish several functions including opening and closing gas flow paths and/or diverting gas flow. SNL currently possesses reservoir production capability but without sufficient capacity. The fabrication process begins with commercial vendor-supplied metal forgings made from certified controlled chemistry bar stock material procured by SNL. Piece parts and subassemblies would be qualified and certified at the vendor by SNL personnel. Final reservoir assembly, primarily welding, would be conducted at SNL along with final inspection and testing. The only machining done at SNL would be post-welding dressing to achieve final contours in the welded areas. Final certification, including volume measurement and proof testing, packaging, and shipping, would be an SNL responsibility.

Desiccants and Getters. Desiccants are made of molded materials that combine epoxies, curatives, and zeolite desiccant material. Getters are organic compounds that are mixed with a catalyst and binder. Getters and desiccants are used to control environments in weapon systems. SNL would use the current KCP processes.

Process Support Systems. Process support systems include capabilities and facilities that are used to support production activities across a wide variety of product lines. These range from general, commonly used services such as materials characterization, and analysis, and environmental and nondestructive testing, to more specialized support such as failure analysis and reliability physics for semiconductor devices, and metrology. While the general activity transfer philosophy is to purchase goods and services from commercial sources wherever possible, the approach with the services and support systems described here is to meet requirements by building upon SNL's existing capabilities. In almost all cases, these capabilities must be maintained in order to meet SNL traditional missions. In addition, particularly for analytical and testing services, the wide spectrum of required tests coupled with the large capital expenditure for testing instrumentation makes commercial availability of these services uncommon.

The alternative for siting nonnuclear production facilities in New Mexico at SNL calls for providing a new stand-alone production site. New production facilities would be provided near an existing Technical Area. Figure A.3.6.4-1 indicates location of technical areas at SNL. The new site (figure A.3.6.4-2) would be independent of the existing technical areas, but would be connected to the area's utility network. The new construction would total approximately 58,060 m^2 (625,000 ft^2) which would be located on 9 ha (22 acres) of available land. In addition to major renovation projects, some existing buildings would undergo minor modifications to accept the new workload. These minor modifications would yield an additional 5,110 m^2 (55,000 ft^2) of work space. Table A.3.6.4-1 lists key facilities. A description of the key nonnuclear fabrication facilities is discussed in the following section.

Office and Distribution Center. Standard open-bay office setup with modular furniture, break areas, files and reproduction areas, conference rooms, secure storage, and executive offices. This space would also include a visitor entry way, an equipment room, and a communications room.

Distribution Center Facility. This would be a standard environmentally controlled warehouse with an administrative office section. Space would include an equipment and communications room.

Electronic Assembly Facility. This facility would include electronic assembly, clean room, and heavy lab capability. Its modules would contain clean rooms, screen room, conductive flooring, special temperature and humidity areas, and assembly areas. The space would include a chemical and materials handling and distribution area, an equipment room, and communications room.

Mechanical Assembly Facility. This facility would include a high bay, heavy lab, mechanical assembly, clean room, and some offices. It would also contain a precision machine shop with forges, presses, ovens, and other metal-forming and metal-treating equipment, mechanical assembly areas, and clean room areas. Space would include an equipment room and a communications room.

Table A.3.6.4-1.-- Sandia National Laboratories Nonnuclear Fabrication Facility Data

Facility	**Floor Space (m *2*)**
Office facility	10,219
Distribution center facility	12,277
Electronics assembly facility	16,537
Mechanical assembly facility	6,225
Special production facility	5,574
Central utility building	929
Existing building modifications	5,110
Additional contingency space	4,645
Total	*61,316*
SNL 1995e.	

Special Products Facility. The space would include a high bay, heavy lab, electrical assembly, mechanical assembly, clean room, equipment and communications room. This facility would also have a vault-type security system for controlled areas.

Central Utility Building . In addition to the central chiller and other utilities, this facility would serve as the maintenance headquarters for the site. It would contain offices, records storage, and an emergency management center.

Construction activities would consume electrical power, potable and construction water, and fuel for heavy construction equipment. Emissions generated during construction would include vehicle exhausts and fugitive dust from land clearing and other construction operations. Wastes generated during construction would consist of wash water, construction debris, scrap materials, and hazardous materials such as lead paint and asbestos collected during renovation of older buildings. A list of materials and resources consumed during construction can be found in table A.3.6.4-2.

The number of construction personnel can be found in table A.3.6.4-3.

Table A.3.6.4-2.-- Sandia National Laboratories Nonnuclear Fabrication Construction Materials/Resources Requirements

Material/Resource	Total Consumption	Peak Demand
Electricity	46.8 MWh	2.5 MWe
Fuel (L)	2,600,000	
Water (L)	2,200,000	
Concrete (m^3)	12,800	
Steel (t)	5,440	
Industrial Gases	NA	

NA - not applicable.

SNL 1995b:5; SNL 1995e.

Table A.3.6.4-3.-- Sandia National Laboratories Nonnuclear Fabrication Construction Workers

	Personnel Required			
Employees	**Year 1**	**Year 2**	**Year 3**	**Total**
All crafts and laborers	120	320	200	640
Supervisors and foremen	10	23	16	49
Office and support	20	26	20	66
Inspectors	8	10	8	26
Total Employment	158	379	244	781
SNL 1995e.				

Utilities consumed during operation would include electric power; natural gas-fired and/or central-plant steam heat, potable, fire protection, irrigation, and process hot/chilled water; clean dry air; and sanitary sewer. The central steam plant is fired by commercially purchased natural gas. Electric power is purchased from the local utility, who generates it from coal-fired plants augmented by a natural-gas fired peak-power plant. Water is pumped electrically from wells. The other utilities are produced through the use of electrical power. The actual consumables used by SNL directly, therefore, are electricity, natural gas, and water. The surge operation utilities usages are listed in table A.3.6.4-4. A list of annual chemical use during operation can be found in table A.3.6.4-5.

Emissions from the complex during operations would include exhaust from vehicles and small quantities of aromatic hydrocarbon solvents, alcohols, and related chemistry. Usage quantities of these chemicals preclude any possibility of emissions greater than the *9.1* t (10 tons) per year threshold for *Clean Air Act* 1990 amendments. A list of these emissions can be found in table A.3.6.4-6.

Table A.3.6.4-4.-- Sandia National Laboratories Nonnuclear Fabrication Surge Operation Annual Utility Requirements

Utility	Consumption	Peak Demand 23
Electricity	39,700 MWh	6.2 MWe
Liquid fuel	0	
Natural gas 24 (m3)	*3,270,000*	

Raw water (L)	893,000,000	

Table A.3.6.4-5.-- Sandia National Laboratories Nonnuclear Fabrication Surge Operation Annual Chemical Requirements

Chemical	Quantity
Nitrogen	
Gas (m *3)*	3,270
Liquid (L)	14,900,000
Argon	
Gas (m *3*)	4,830
Liquid (L)	236,000
Carbon dioxide	
Gas (m *3)*	322

Liquid (L)	121,000
Hydrogen	
Gas (m 3)	0.1
Helium	
Gas (m 3)	883
Liquid (L)	1,650
SNL 1995b:4.	

Table A.3.6.4-6.-- Sandia National Laboratories Nonnuclear Fabrication Surge Operation Annual Emissions

Pollutant	**Quantity (t)**
Acetone	0.44
Carbon monoxide	13.17

Chromium	<0.01
Cyanide	0.01
Ethyl benzene	0.05
Formaldehyde	<0.01
Hydrochloric acid	0.03
Isopropyl alcohol	1.62
Methanol	0.01
Methyl ethyl ketone	0.16
Methyl isobutyl ketone	0.03
Particulate matter	1.03

Perc	0.29
Sulfur dioxide	0.35
Toluene	0.50
Toluene diisocyanate	<0.01
1,1,1-Trichloroethane	0.04
Trichloroethylene	2.60
Volatile organic compound	1.9
Xylene	0.26
SNL 1995b:4.	

Waste Management. The solid and liquid nonhazardous wastes generated during construction would consist of the collection and ponding of wash water, landfilling of construction debris and scrap materials (especially from the renovation of existing buildings), and collection and disposal of hazardous materials (primarily asbestos and lead paint) during renovation of older buildings. The nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.6.4-7 presents the estimated annual waste volumes from the Nonnuclear Fabrication Facility at SNL during construction and surge operations. Solid and liquid wastestreams are routed to the waste management system. Solid wastes would be characterized and segregated into hazardous or nonhazardous wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic elements before discharge or transport. All fire sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

No new wastestreams would be generated. Wastes from the complex would include metal and dielectric material machining chips and turnings, solder scrap, acids and other eychants, curing compounds for various electrical encapsulants, test and analytical reagents, hydraulic fluid and other machine servicing compounds, reverse-osmosis backflush water, silicon slurries and other wastes generated as part of integrated circuit manufacture, sanitary sewer flows, and related materials.

Transuranic Waste. The Nonnuclear Fabrication Facility at SNL would not generate any TRU waste.

Low-Level Waste. The Nonnuclear Fabrication Facility at SNL would not generate any LLW.

Mixed Low-Level Waste. The Nonnuclear Fabrication Facility at SNL would not routinely generate any mixed LLW.

Hazardous Waste. Hazardous wastes generated by the Nonnuclear Fabrication Facility at SNL would consist of acids and other etchants, curing compounds, solvents, test and analytical reagents, and other wastes generated as part of integrated circuit manufacture. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging, characterization, and packaging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Nonhazardous liquid waste generated at the Nonnuclear Fabrication Facility primarily consists of reverse-osmosis backflush water, and sanitary sewer flows. Nonrecyclable, nonhazardous solid sanitary and industrial wastes would be compacted and disposed of in local commercial facilities. Liquid sanitary wastes would be collected by independent underground septic tanks at nonnuclear fabrication buildings and by sewer pipe systems from most of the support buildings and routed to municipal treatment facilities. Excess water is discharged to a natural drainage channel. Process wastewater is sent to holding tanks for pretreatment and screening prior to discharge to the publicly owned treatment works. The sewage wastewater would be routinely monitored for radioactive contaminants.

Nonhazardous (Other) Waste. Stormwater from areas of SNL is allowed to go in natural drainage channels.

Table A.3.6.4-7.-- Sandia National Laboratories Nonnuclear Fabrication Waste Volumes

Category	**Annual Average Volume Generated from Construction (m^3)**	**Annual Volume Generated from Surge Operations [25] (m^3)**	**Annual Volume Effluent from Surge Operations (m^3)**
Low-Level [26]			
Liquid	None	None	None
Solid	None	None	None
Mixed Low-Level[26]			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	0.11	15	15

Solid	23	17	17
Nonhazardous (Sanitary)			
Liquid	6,160 27	291,470	291,470 28
Solid	236	7,880	3,940 29
Nonhazardous (Other)			
Liquid	383 30	Included in sanitary	Included in sanitary
Solid	5	Included in sanitary	Included in sanitary

1

LLNL is an alternative site for production of nonnuclear plastic components.

KC ASI 1995a; LANL 1995c; LLNL 1995f; SNL 1995e.

2

Peak demand is the maximum rate expected during any hour.

3

Cubic meters measured at standard temperature and pressure.

Source: *KC ASI 1995a; KCP 1995a:2; KCP 1995a:3.*

4

LLW or mixed LLW would not be routinely generated during normal operations. However, upset conditions may result in the generation of minimal quantities of LLW or mixed LLW.

KC ASI 1995a; KCP 1995a:2; KCP 1995a:3.

5

Space in existing facility that will be used for the proposed production activity.

6

Includes mezzanines.

LANL 1995c.

7

Peak demand is the maximum rate expected at any hour.

LANL 1995b:3; LANL 1995c.

8

Data for multiple shift were not provided. Single-shift values were multiplied by 3.

9

Assumes a 350:1 wastewater to sludge ratio in the treatment of liquid sanitary wastes.

10

Assumes that 2/3 of the solid waste is compactible by a factor of 4:1.

11

2,500 gal of cleanup/washdown water, converted to cubic meters and divided by 2 for the 2-year construction period.

12

Industrial liquid wastes which include cleaners, cutting liquids, lube oils, and developers are recycled.

13

Metal machining wastes, wire, scrap, and molds are recycled.

LANL 1995c.

14

Peak demand is the maximum expected during any hour.

LLNL 1995f.

15

Peak demand is the maximum rates expected at any hour.

LLNL 1995f; LLNL 1995i:2

16

With the exception of sanitary wastes, the data for a multiple shift were determined by multiplying the single-shift values by 2.5.

17

Data were provided as 2,500 lb of acetone, 3,500 lb of toluene/methanol, 250 lb of toluene, and 270 lb of dimethyl formamide. Assuming a density of 1,000 kg/cubic meter, these were converted to cubic meters.

18

Assumes toluene/methanol wastestream would be recycled by a distillation process. Five percent of the toluene/methanol volume is assumed for the distillation bottoms which appear as a solid waste effluent.

19

No data provided for liquid sanitary wastes such as sewage. Assumed 50 gal per day per person, 250 days per year operation. Number of employees used is 47.5. The urea waste stream was multiplied by 2.5. The rest of the sanitary waste was multiplied by 2.4 for three shifts.

20

LLNL does not treat sanitary wastewater as it goes to the municipal sanitary sewer system; thus the effluent is the same as generated.

21

No data provided for solid sanitary wastes such as housekeeping trash. Assumed 0.3 ft3 per day per person, 250 days per year operation. Number of employees used is 47.5, which was multiplied by 2.4 to get three shifts.

22

Assumes that 2/3 of the solid waste is compactible by a factor of 4:1.

LLNL 1995f; LLNL 1995i:2.

23

Peak demand is the maximum rate expected during any hour.

24

Cubic meters measured at standard temperature and pressure.

SNL 1995b:4; SNL 1995b:5; SNL 1995e.

25

The data for a multiple shift were determined by multiplying single-shift data by 2.

26

LLW or mixed LLW would not be generated during normal operations. However, upset conditions may result in the generation of minimal quantities of LLW or mixed LLW.

27

No data provided. Assumes 25 gallons per day per construction worker for 250 days per year and 260 construction workers. Construction toilets are trucked off site for servicing.

28

SNL sanitary wastewater goes to the city of Albuquerque sanitary sewer system; thus the effluent is the same as generated.

29

Assumes that 2/3 of the solid waste is compactible by a factor of 4:1.

30

Includes washing from flushing mechanical systems, dust control water, and blockwork, cementitious coatings.

SNL 1995b:5; SNL 1995e.

APPENDIX B: AIR QUALITY

B.1 Introduction

This appendix provides detailed data that support impact assessments for air quality addressed in sections 4.X.2.3, Affected Environment--Air Quality and 4.X.3.3, Environmental Impacts--Air Quality. The data presented include emission inventories from site-related activities and facility emissions for various alternatives. Section B.2 presents the methodology and models used in the air quality assessment. Section B.3 presents supporting data applicable to each site. The tables included in sections B.3.2 through B.3.9 contain site-specific information applicable to the air quality assessments at each site including figures containing wind rose data specific to each site.

B.2 Methodology and Models

The assessment of potential impacts to air quality is based upon comparisons of proposed project effects with applicable standards and guidelines. The Industrial Source Complex Short-Term model, version 2, is used to estimate concentrations of pollutants from emission sources at each site.

The air quality modeling analysis performed for the alternative sites is considered a "screening level" analysis incorporating conservative assumptions applied to each of the sites such that the impacts associated with the respective alternatives could be compared among the sites. The assumptions are as follows: major source criteria pollutant emissions were modeled using actual source locations and stack parameters to determine No Action criteria pollutant concentrations; toxic/hazardous pollutant emissions were modeled from a single source centrally located within the complex of facilities on each site assuming a 10-meter (m) (32.8-foot [ft]) stack height, a stack diameter of 0.3 m (1 ft), stack exit temperature equal to ambient temperature, and a stack exit velocity equal to 0.03 m/second (s) (0.1 ft/s), unless otherwise specified.

These assumptions will tend to overestimate pollutant concentrations since no credit is given to spacial and temporal variations of emission sources.

Emission sources for the facilities for each alternative were located at the same location as the existing toxic/hazardous pollutant emission sources and assumed the modeling parameters used for these emissions.

B.3 Supporting Data

B.3.1 Overview

This section presents supporting information for each of the eight existing Department of Energy (DOE) sites considered under various alternatives. Table B.3.1-1 presents the air quality standards applicable to each site. Subsequent sections present supporting information used in the air quality analysis at Oak Ridge Reservation (ORR), Savannah River Site (SRS), Kansas City Plant (KCP), Pantex Plant (Pantex), Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL) (which includes the Livermore Site and Site 300), Sandia National Laboratories (SNL), and Nevada Test Site (NTS).

Table B.3.1-1.-- Ambient Air Quality Standards Applicable to the Candidate Sites

Pollutant	Averaging Time	Primary NAAQS mg/m^3	Secondary NAAQS mg/m^3	California (Livermore Site and Site 300) mg/m^3	Nevada (NTS) mg/m^3	Kansas (KCP) mg/m^3	Texas (Pantex) mg/m^3	Tennessee (ORR) mg/m^3	Georgia and South Carolina (SRS) mg/m^3	New Mexico (LANL/SNL) mg/m^3
Criteria Pollutant										
	Annual	2	2	2	2	2	2	2	2	b/4,600

Carbon monoxide	8-hour	10,000	2	10,000	10,000	10,000	10,000	10,000	10,000	7,689/10,000
	1-hour	40,000	2	23,000	40,000	40,000	40,000	40,000	40,000	11,578/15,000
Lead	Calendar quarter	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5/1.5
	30-day	2	2	1.5	2	2	2	2	2	b/3
Nitrogen dioxide	Annual	100	100	100	100	100	100	100	100	73/94
	24-hour	2	2	2	2	2	2	2	2	145/117
	1-hour	2	2	470	2	2	2	2	2	b/ 2
Ozone	1-hour	235	235	180	235	235	235	235	235	235/235
Particulate matter	Annual	50	50	30	50	50	50	50	50	50/50
	24-hour	150	150	50	150	150	150	150	150	150/150
Sulfur dioxide	Annual	80	2	80	80	80	80	80	80	40/11
	24-hour	365	2	105	365	365	365	365	365	202/92
	3-hour	2	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300/1,300
	1-hour	2	2	655	2	2	2	2	2	b/ 2
	30-minute	2	2	2	2	2	1,045	2	2	b/ 2
State and County Mandated Pollutants										
Arsenic, Copper & Zinc	30-day	2	2	2	2	2	2	2	2	b/10
Beryllium	30-day	2	2	0.01	2	2	2	2	2	b/ *0.01*
	24-hour	2	2	2	2	2	0.01	2	2	b/ 2
Hydrocarbons (non-methane)	3-hour	2	2	2	2	2	2	2	2	b/100
Hydrogen	30-day	2	2	2	2	2	0.8	1.2	0.8	b/ 2
fluoride	7-day	2	2	2	2	2	1.6	1.6	1.6	b/ 2
	24-hour	2	2	2	2	2	2.9	2.9	2.9	b/ 2
	12-hour	2	2	2	2	2	3.7	3.7	3.7	b/ 2

State and County Mandated Pollutants (Continued)										
Hydrogen sulfide	1-hour	2	2	42	112	2	2	2	2	11/4
30-minute	2	2	2	2	42	2	2	2	*b/*2	
Photochemical oxidants	1-hour	2	2	2	2	2	2	2	2	b/20
Sulfate	24-hour	2	2	25	2	2	2	2	2	*b/*2
Sulfuric acid	24-hour	2	2	2	2	10	2	2	2	*b/*2
	1-hour	2	2	2	2	30	2	2	2	*b/*2
Total reduced sulfur	1-hour	2	2	2	2	2	2	2	2	3/4
Total	Annual	2	2	2	2	2	2	2	75	60/60
suspended	30-day	2	2	2	2	2	2	2	2	90/90
particulates	7-day	2	2	2	2	2	2	2	2	110/110
	24-hour	2	2	2	2	2	2	150	2	150/150
Vinyl chloride	24-hour	2	2	26	2	2	2	2	2	*b/*2

B.3.2 Oak Ridge Reservation

This section provides information on meteorology and climatology, emission rates, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.2-1) at ORR. Table B.3.2-1 presents emission source inventories for criteria and toxic/hazardous pollutants at ORR. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. The wind direction above the ridge tops and within the valley at ORR tends to follow the orientation of the valley. On an annual basis, the prevailing winds at the National Weather Service station in the city of Oak Ridge are either up-valley, from west to southwest, or down valley, from east to northeast. Figure B.3.2-1 shows mean wind speeds and direction frequencies for 1990 measured at the 30-m (100-ft) level of the ORR meteorology tower. The prevailing wind directions are from the southwest and northeast quadrants. Annual mean wind speeds measured in the region are relatively low averaging 2 m/s (4.5 miles per hour [mph]) at the Oak Ridge National Weather Service station at the 14-m (46-ft) level and 2.1 m/s (4.7 mph) at the ORR Bethel Valley monitoring station at the 10-m (32.8-ft) level. The average annual temperature at ORR is 13.7 degrees Celsius (°C) (56.6 degrees Fahrenheit [°F]); temperatures vary from an average daily minimum of -3.8 °C (25.1 °F) in January to an average daily maximum of 30.4 °C (86.7 °F) in July. Relative humidity readings taken 4 times per day range from 51 percent in April to 92 percent in August and September (NOAA 1994c:3).

The average annual precipitation measured at ORR in Bethel Valley is 131 centimeters (cm) (56.1 inches [in]), while the average annual precipitation for the Oak Ridge National Weather Service station is 136.4 cm (53.77 in). The maximum monthly precipitation recorded at the Oak Ridge National Weather Service station was 48.9 cm (19.27 in) in July 1967, while the maximum rainfall in a 24-hour period observed was recorded in August 1960 at 19 cm (7.48 in). The average annual snowfall as measured at the Oak Ridge National Weather Service station is 24.9 cm (9.8 in) (NOAA 1994c:3).

Damaging winds are uncommon in the region. Peak gusts recorded in the area range from 26.8 to 30.8 m/s (60 to 69 mph) for the months of January through July; from 21.9 to 26.8 m/s (49 to 60 mph) for August, September, and December; and 16.1 to 20.1 m/s (36 to 45 mph) in October and November (ORNL 1982a:2-72). The fastest mile wind speed (the 1 mile [mi] [1.6 kilometer {km}]) passage of wind with the highest speed for the day) recorded at the Oak Ridge National Weather Service station for the period of record 1958 through 1979 was 26.4 m/s (59.1 mph) in January 1959 (NOAA 1994c:3).

The extreme mile wind speed at a height of 9.1 m (30 ft) that is predicted to occur near ORR once in 100 years is approximately 39.8 m/s (89 mph). The approximate values for occurrence intervals of 10, 25, and 50 years are 28.6, 32.6, and 34.0 m/s (64, 73, and 76 mph), respectively (ORNL 1981a:3.3-7).

Between 1916 and 1972, there were 25 tornadoes reported in the counties of Tennessee having borders within about 64.4 km (40 mi) of ORR. The probability of a tornado striking a particular point in the vicinity of ORR is estimated to be 3.6×10^{-4} per year (ORNL 1982a:2-125).

On February 21, 1993, a tornado passed through the northeastern edge of ORR and caused considerable damage to a number of structures in the nearby Union Valley Industrial Park. Damage from this tornado to ORR was relatively light. The wind speeds associated with this tornado ranged from 17.9 m/s (40.0 mph) to those approaching 58.1 m/s (130 mph) (OR DOE 1993c:iii).

Emission Rates. ORR exceeds the applicable 250-ton-per-year emissions criterion for nitrogen dioxide and sulfur dioxide and is therefore classified as an existing major source for these pollutants. The classification of ORR as a major source may require further prevention of significant deterioration review than sites not classified as a major source. Table B.3.2-1 presents the emission rates for criteria and toxic/hazardous pollutants at ORR. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the ORR site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the Y-12 Plant (Y-12) complex at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1.0 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Table B.3.2-1.-- Emission Rates for Proposed Management Alternatives at Oak Ridge Reservation

Pollutant	2005 No Action (kg/yr)	Downsize Secondary and Case Fabrication (kg/yr) [3]	Phaseout of Secondary and Case Fabrication (kg/yr)
Criteria Pollutant			
Carbon monoxide	95,000	89,500	(12,900)
Nitrogen dioxide	870,000	708,000	(357,000)
Particulate matter	8,300	7,930	(870)
Sulfur dioxide	972,000	904,000	(148,000)
Total suspended particulates	1,125,000	1,025,000	(110,000)
Hazardous and Other Toxic Compounds			
Acetic acid	1	1	(1)

Chlorine	1,750	1,740	(160)
Hydrogen chloride	6,420	5,480	(5,740)
Hydrogen fluoride	70	70	(70)
Hydrogen sulfide	[4]	[4]	[4]
Methyl alcohol	26,400	16,600	(23,800)
Nitric acid	9,500	8,100	(8,500)
Sulfuric acid	2,500	2,120	(2,180)
1, 1, 1-Trichloroethane	220	220	(200)

Atmospheric Dispersion Characteristics. Data collected at the ORR meteorological monitoring station (Y-12 east tower) for calendar year 1990 indicate that unstable conditions occur approximately 23 percent of the time, neutral conditions approximately 31 percent of the time, and stable conditions approximately 46 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. ORR meteorological data for annual mean wind speed and direction for 1990 is presented in figure B.3.2-1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the east-northeast with a secondary maximum from the northeast. The mean wind speed from the east-northeast is 1.7 m/s (3.8 mph); from the northeast is 2.3 m/s (5.1 mph); while the maximum mean wind speed is 3.3 m/s (7.4 mph) from the southwest.

B.3.3 Savannah River Site

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.3-1) at SRS. Table B.3.3-1 presents emission source inventories for criteria and toxic/hazardous pollutants at SRS. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.3-1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 60-m (200-ft) level of the SRS H-Area weather station. The wind data from the site indicate that there is no prevailing wind direction at SRS. The highest directional frequency is from the northeast. The average annual wind speed measured is 3.8 m/s (8.4 mph) (WSRC 1992h).

Table B.3.3-1.-- Emission Rates for Proposed Management Alternatives at Savannah River Site

Pollutant	2005 No Action (kg/yr)	Pit Fabrication (kg/yr)
Criteria Pollutant		
Carbon monoxide	404,449	685

Hydrogen fluoride	16,690		7
Nitrogen dioxide	4,278,380		15,666
Particulate matter	1,963,180		968
Sulfur dioxide	9,454,199		32,552
Total suspended particulates	4,430,890		5
Hazardous and Other Toxic Compounds	Point and Volume Source (kg/yr)	Area Source (kg/yr/m2)	
Acrolein	5	1.94x10 -*3*	5
Benzene	129,772.3	0.21	5
Bis (chloromethyl) ether	211.0	5	5
Cadium oxide	243.0	5	5
Chlorine	21,146.7	10.11	5
Chloroform	1,035,006	13.6	5
Cobalt	5,970.2	4.58x10 -*4*	5
3, 3-Dichlorobenzidine	211.0	5	5
Formic acid	46,949.5	5	5
Manganese	27,882.1	2.61	5
Mercury	917.5	1.15x10 -*3*	5
Nickel	23,022.5	6.02	5
Nitric acid	1,150,525.8	5	5
Parathion	6	6	5

Phosphoric acid	14,859.8	5	5

The average annual temperature at SRS is 17.3 °C (63.2 °F); temperatures vary from an average daily minimum of 0.0 °C (32 °F) in January to an average daily maximum of 33.2 °C (91.7 °F) in July. Relative humidity readings taken 4 times per day range from 45 percent in April to 92 percent in August and September (NOAA 1994c:3).

The average annual precipitation at SRS is 113.4 cm (44.66 in). Precipitation is distributed fairly evenly throughout the year, with the highest precipitation in summer, 32.7 cm (12.87 in) and the lowest in autumn, 21.2 cm (8.34 in). Although snow can fall from November through April, the average annual snowfall is only 2.8 cm (1.1 in); large snowfalls are rare (NOAA 1994c:3).

Winter storms in the SRS area occasionally bring strong and gusty surface winds with speeds as high as 22.8 m/s (51 mph). Thunderstorms can generate winds with speeds as high as 21.5 m/s (48.1 mph) and even stronger gusts. The fastest 1-minute wind speed recorded at Augusta between 1952 and 1993 was 27.7 m/s (62 mph) (NOAA 1994c:3).

The average number of thunderstorm days per year at SRS is 56. From 1954 to 1983, 37 tornadoes were reported for a 1-degree square of latitude and longitude that includes SRS. This frequency of occurrence amounts to an average of about one tornado per year. The estimated probability of a tornado striking a point at SRS is 7.1x10 -5 per year. Since operations began at SRS in 1953, nine tornadoes have been confirmed on or near SRS. Nothing more than light damage was reported in any of these storms, with the exception of a tornado in October 1989. That tornado caused considerable damage to timber resources in an undeveloped wooded area of SRS (WSRC 1990b:1).

From 1899 to 1980, 13 hurricanes occurred in Georgia and South Carolina, for an average frequency of about 1 hurricane every 6 years. Three hurricanes were classified as major. Because SRS is about 160 km (99.4 mi) inland, the winds associated with hurricanes have usually diminished below hurricane force (greater than or equal to a sustained speed of 33.5 m/s (75 mph) before reaching the site (DOE 1992e:4-115).

Emission Rates. SRS exceeds the applicable 250-ton-per-year emissions criterion for carbon monoxide, nitrogen dioxide, PM10, and sulfur dioxide and is therefore classified as an existing major source for these pollutants. The classification of SRS as a major source may require further prevention of significant deterioration review than sites not classified as a major source. Table B.3.3-1 presents the emission rates for criteria and toxic/hazardous pollutants at SRS. The toxic/hazardous pollutant emissions presented in the table represent those pollutants with estimated concentrations at or beyond the SRS boundary that exceed 1 percent of the state air quality standards. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Emission rates for criteria and toxic/hazardous pollutants were based upon site actual emissions data for the year 1990. Additional model input used to estimate maximum criteria and toxic/hazardous pollutant concentrations at or beyond the SRS site boundary include pollutant emissions modeled from actual stack heights, actual effective stack diameters, actual exit velocity, and actual exit temperature.

Atmospheric Dispersion Characteristics. Data collected at the SRS meteorological monitoring station for 1991 indicate that unstable conditions occur approximately 38 percent of the time, neutral conditions approximately 43 percent of the time, and stable conditions approximately 19 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The SRS meteorological data for annual mean wind speed and direction for 1991 is presented in figure B.3.3-1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the northeast with a secondary maximum from the east-northeast. The mean wind speed from the northeast is 3.8 m/s (8.5 mph); from the east-northeast, 3.8 m/s (8.5 mph); while the maximum mean wind speed is 4.1 m/s (9.2 mph) from the west-northwest.

B.3.4 Kansas City Plant

This section provides information on meteorology and climatology, emission rates, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.4-1) at KCP. Table B.3.4-1 presents emission source inventories for criteria and toxic/hazardous pollutants at KCP. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.4-1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 10-m (32.8-ft) level of the Kansas City, Missouri National Weather Service station. The wind data from the Kansas City National Weather Service station indicate that the predominant wind direction frequency is from the south. The average annual wind speed measured is 4.8 m/s (10.8 mph). Average monthly wind speeds range from 5.6 m/s (12.6 mph) in March, to 4.1 m/s (9.1 mph) in August.

The average annual temperature at KCP is 12.0 °C (53.6 °F); temperatures vary from an average daily minimum of -8.5 °C (16.7 °F) in January to a daily mean maximum of 31.5 °C (88.7 °F) in July. Relative humidity readings taken four times per day range from 53 percent in April to 86 percent in August and September (NOAA 1994a:3).

The average annual precipitation at KCP is 95.6 cm (37.62 in). The highest precipitation occurs in the summer months, May through September, and the lowest in winter. Snow can fall from November through April, with the average annual snowfall being 51.1 cm (20.1 in) (NOAA 1994a:3).

Winter storms in the KCP area occasionally bring strong and gusty surface winds with speeds as high as 25.9 m/s (58 mph). Thunderstorms can generate winds with speeds as high as 33.5 m/s (75 mph) and even stronger gusts. The fastest 1-minute wind speed recorded at Kansas City National Weather Service station was 21.5 m/s (48 mph) (NOAA 1994a:3).

The average number of thunderstorm days per year at KCP is 51.8. The estimated probability of a tornado striking a point at KCP is 7.5×10^{-4} per year (NRC 1986a:32).

Emission Rates. Table B.3.4-1 presents the emission rates for criteria and toxic/hazardous pollutants at the KCP. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the KCP site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the KCP complex at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1.0 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Table B.3.4-1.-- Emission Rates for Proposed Management Alternatives at Kansas City Plant

Pollutant	2005 No Action (kg/yr)	Downsize Nonnuclear Fabrication (kg/yr)	Phaseout of Nonnuclear Fabrication (kg/yr)
Criteria Pollutant			
Carbon monoxide	11,948	11,948	(11,948)
Nitrogen dioxide	42,574	42,574	(42,574)
Particulate matter	934	934	(934)
Sulfur dioxide	318	318	(318)
Total suspended particulates	934	934	(934)

Hazardous and Other Toxic Compounds			
Acetone	399	416	(399)
Chromium	<9	<9	(<9)
Cyanide	10.21	5.22	(10.21)
Ethyl benzene	45.4	45.4	(45.4)
Formaldehyde	<9	<9	(<9)
Hydrogen chloride	27.2	14.5	(27.2)
Isopropyl alcohol	1,470	2,538	(1,470)
Methanol	9	9	(9)
Methyl ethyl ketone	145	123.6	(145)
Methyl isobutyl ketone	27.2	27.2	(27.2)
Perchloroethylene	263	263	(363)
Toluene	454	506	(454)
Toluene-2,4-Diisocyanate	<9	<9	(<9)
Trichloroethane	36.3	36.3	(36.3)
Trichloroethylene	2,359	3,201	(2,359)
Xylene	235.9	235.9	(235.9)

Parentheses indicate a net reduction in emissions.

KC ASI 1995a.

Atmospheric Dispersion Characteristics. Data collected at the Kansas City National Weather Service station for calendar year 1991 indicate that unstable conditions occur approximately 15 percent of the time, neutral conditions approximately 61 percent of the time, and stable conditions approximately 24 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The Kansas City National Weather Service meteorological data for annual mean wind speed and direction for 1991 is presented in figure B.3.4-1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the south with a secondary maximum from the south-southwest. The mean wind speed from the south is 6.1 m/s (13.6 mph); while the maximum mean wind speed is 6.3 m/s (14.1 mph) from the south-southwest.

B.3.5 Pantex Plant

This section provides information on climatology and meteorology, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.5-1) at Pantex. Table B.3.5-1 presents emission source inventories for criteria and toxic/hazardous pollutants at Pantex. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.5-1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 6.6-m (21.6-ft) level of the Amarillo National Weather Service station. Prevailing wind directions are from the south to southwest. The average annual wind speed measured is 6 m/s (13.5 mph).

The average annual temperature at Pantex is 13.8 °C (56.9 °F); average daily temperatures vary from a daily mean minimum of -5.7 °C (21.8 °F) in January to a daily mean maximum of 32.8 °C (91.1 °F) in July and August. Relative humidity readings taken four times per day range from 31 percent in April to 80 percent in September (NOAA 1994c:3).

The average annual precipitation at Pantex is 49.7 cm (19.56 in). Most of the annual precipitation falls during the months of April through October and usually occurs from thunderstorm activity and the intrusion of warm, moist tropical air from the Gulf of Mexico. Snowfall averages nearly 43 cm (16.9 in). Snowfall can occur from October through April. The maximum 24-hour rainfall with a 100-year recurrence interval is approximately 16.5 cm (6.5 in). On average, the area can expect thunderstorms about 50 days per year, hail 4 days per year, and freezing rain 8 days per year (NOAA 1994c:3). During the 30-year period between 1954 and 1983, a total of 108 tornadoes were reported within a 1-degree latitude and longitude square area which includes Pantex. On average, less than four tornadoes per year occur in an area of 10,096 km^2 (3,898 mi^2) surrounding Pantex. The estimated probability of a tornado striking a point at Pantex is $2.3x10^{-4}$ per year (NRC 1986a:32).

Emission Rates. Table B.3.5-1 presents the emission rates for criteria and toxic/hazardous pollutants at Pantex. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Table B.3.5-1.-- Emission Rates for Proposed Management Alternatives at Pantex Plant

Pollutant	2005 No Action (kg/yr)	Downsize Assembly/ Disassembly and High Explosives (kg/yr)	Downsize Assembly/ Disassembly (kg/yr)	Phaseout of Assembly/ Disassembly and High Explosives (kg/yr)
Criteria Pollutant				
Carbon monoxide	22,493	5,856	5,443	(22,493)
Hydrogen fluoride	1,176.06	4.5	[7]	(1,176.06)
Lead	185	[7]	[7]	(185)
Nitrogen dioxide	54,056	22,879	21,319	(54,056)
Particulate matter	8,439	884	816	(8,439)
Sulfur dioxide	0.1	0.03	0.02	(0.1)

Hazardous and Other Toxic Compounds				
Acetonitrile	*7*	2.8	2.3	*7*
Alcohols	1,184	*7*	*7*	(1,184)
Aldehydes	*7*	6.5	4.5	*7*
Ammonia	*<0.45*	*<0.45*	*<0.45*	*(<0.45)*
Benzene	91.38	3.0	*7*	(91.38)
Carbon disulfide	27.05	*7*	*7*	(27.05)
Carbon tetrachloride	15.59	*7*	*7*	(15.59)
Chlorobenzene	1.79	*7*	*7*	(1.79)
1,1,1-Chloroethane	22.74	*7*	*7*	(22.74)
Chromium	2.14	*7*	*7*	(2.14)
Cyclohexane	*7*	2.2	0.45	*7*
Cresol	0.05	*7*	*7*	(0.05)
Cresylic acid	0.05	*7*	*7*	(0.05)
Dibensofuran	0.07	*7*	*7*	(0.07)
Dibutyl phthalate	*7*	5.4	5.4	*7*
Ester glycol ethers	0.86	*7*	*7*	(0.86)
Ethyl benzene	1.51	*7*	*7*	(1.51)
Ethylene dichloride	1.33	*7*	*7*	(1.33)
Formaldehyde	57.89	*7*	*7*	(57.89)
Hydrogen chloride	1,106.11	27.7	24.5	(1,106.11)
Hydrogen sulfide	*0*	21.3	21.3	*(0)*

Ketones	0.28	7	7	(0.28)
Mercury	*<0.45*	*<0.45*	*<0.45*	*(<0.45)*
Methanol	1,095.57	11.8	9.1	(1,095.57)
Methyl ethyl ketone	7,067.62	666.8	317.5	(7,067.62)
Methyl isobutyl ketone	0.62	7	7	(0.62)
Methylene chloride	182.07	7	7	(182.07)
Naphthalene	0.41	7	7	(0.41)
Nickel	0.16	7	7	(0.16)
Nitrobenzene	0.05	7	7	(0.05)
2-Nitropropane	1.71	7	7	(1.71)
Phenol	2.23	7	7	(2.23)
Propylglycol methyl ether	7	7.3	7.3	7
Hazardous and Other Toxic Compounds (Continued)				
Tetrachloroethylene	6.44	7	7	(6.44)
Toluene	465.29	14.0	4.5	(465.29)
1,1,1-Trichloroethane	7	45.0	44.5	7
1,1,2-Trichloroethane	3.78	7	7	(3.78)
Trichloroethene	1.56	7	7	(1.56)
Trichloroethylene	19.50	5.0	4.5	(19.50)
Triethylamine	0	7	7	(0)
Xylene	222.15	166.5	158.8	(222.15)

Atmospheric Dispersion Characteristics. Data collected at the Amarillo National Weather Service station for 1991 indicate that unstable conditions occur approximately 14 percent of the time, neutral conditions approximately 64 percent of the time, and stable conditions approximately 22 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The Amarillo meteorological data for annual mean wind speed and direction for 1991 are presented in figure B.3.5-1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the south with a secondary maximum from the south-southwest. The mean wind speed from the south is 6.3 m/s (14.1 mph); from the south-southwest is 6.3 m/s (14.1 mph); while the maximum mean wind speed is 6.6 m/s (14.8 mph) from the west.

B.3.6 Los Alamos National Laboratory

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.6-1) at LANL. Table B.3.6-1 presents emission source inventories for criteria and toxic/hazardous pollutants at LANL. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.6-1 shows annual mean wind speed and wind direction frequencies for 1991 measured at the 11.5-m (37-ft) level of the Technical Area (TA)-6 meteorological tower. Prevailing wind directions are from the south through northwest. The average annual wind speed measured is 2.8 m/s (6.3 mph) (LANL 1995s:II-11).

The average annual temperature at LANL is 8.8 °C (47.8 °F). In July, the average daily high temperature is 27.2 °C (81 °F), and the average nighttime low temperature is 12.8 °C (55 °F). The highest recorded temperature is 35 °C (95 °F). The average daily January high is 4.4 °C (40 °F), and the average nighttime low is -8.3 °C (17 °F). The lowest recorded temperature is -27.8 °C (-18 °F). The average monthly values of the dew point temperature range from -9.4 °C (15.0 °F) in January to 8.9 °C (48 °F) in August, when moist subtropical air invades the region. Fog is rare in Los Alamos, occurring on fewer than 5 days per year (LANL 1995s:II-11).

The average annual precipitation at LANL is 47.6 cm (18.7 in). Most of the annual precipitation falls during the months of July and August and usually occurs from convective storms. Snowfall averages nearly 150 cm (59 in). The maximum 24-hour rainfall is approximately 8.8 cm (3.5 in) (LANL 1995s:II-11).

The average annual temperature at the National Weather Service station at Albuquerque, NM, is 13.4 °C (56.2 °F); temperatures vary from an average daily minimum of -5.7 °C (21.7 °F) in January to an average daily maximum of 33.6 °C (92.5 °F) in July. Relative humidity readings taken four times per day range from 19 percent in April and May to 71 percent in January (NOAA 1994c:3).

The average annual precipitation is 22.6 cm (8.88 in). The maximum monthly precipitation recorded was 8.5 cm (3.33 in) in July 1968, while the maximum rainfall in a 24-hour period observed was recorded in September 1955 at 4.9 cm (1.92 in). The average annual snowfall is 28.2 cm (11.1 in); all measurements are from the Albuquerque National Weather Service station (NOAA 1994c:3). The average number of thunderstorm days per year is 58, with most occurring during the summer. The estimated probability of a tornado striking a point at LANL is 2x10 *-5* per year (NRC 1986a:32). Historically, no tornadoes have been reported to have touched down in Los Alamos County (LANL 1993b:II-9).

Emission Rates. Table B.3.6-1 presents the emission rates for criteria and toxic/hazardous pollutants at LANL. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the LANL site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the LANL facility at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Table B.3.6-1.-- Emission Rates for Proposed Stewardship and Management Alternatives at Los Alamos National Laboratory

Pollutant	**2005 No Action (kg/yr)**	**Pit Fabrication (kg/yr)**	**Secondary and Case Fabrication (kg/yr)**	**High Explosives Fabrication (kg/yr)**	**Nonnuclear Fabrication (kg/yr)**	**Atlas Facility (kg/yr)**	**National Ignition Facility (kg/yr)**
Criteria Pollutant							
Carbon monoxide	21,583	*7*	4,500	4,536	8	*7*	460
Lead	26	*7*	100	*7*	*7*	*<0.1*	*7*
Nitrogen dioxide	55,314	*7*	117,000	22,680	*7*	*7*	1,910
Particulate matter	2,983	*7*	300	227	*7*	*7*	180
Sulfur dioxide	704.6	*7*	48,000	*7*	*7*	*7*	30
Total suspended particulates 9	2,983	*7*	300	227	*7*	*7*	180
Hazardous and Other Toxic Compounds							
Acetic acid	537	*7*	*7*	*7*	*7*	*7*	*7*
Ammonia	799	*7*	*7*	454	*7*	*7*	*7*
2-Butoxyethanol	123	*7*	*7*	*7*	*7*	*7*	*7*
Chlorine	13	340	*7*	*7*	*7*	*7*	*7*
Chloroform	533	*7*	*7*	*7*	*7*	*7*	*7*
Ethyl acetate	89	*7*	*7*	*7*	*7*	*7*	*7*
Ethylene glycol	72	*7*	*7*	*7*	*7*	*7*	*7*
Formaldehyde	49	*7*	*7*	*7*	*7*	*7*	*7*
Heavy metals	114	*7*	*7*	*7*	*7*	*7*	*7*
Heptane (n-heptane)	1,849	*7*	*7*	*7*	*7*	*7*	*7*
Hexane (n-hexane)	77	*7*	*7*	*7*	*7*	*7*	*7*

Hydrogen chloride	638	11	7	113	7	7	7
Hydrogen fluoride (as F)	242	7	7	45.4	7	7	7
Isopropyl alcohol	539	7	7	7	7	<0.1	7
Kerosene	260	7	7	7	7	7	7
Methyl alcohol	589	7	7	7	7	7	7
Methyl ethyl ketone	1,864	7	7	22.7	7	7	7
Methylene chloride	1,104	a	7	7	7	7	7
Nickel	55	7	7	7	7	7	7
Nitric acid	661	7	7	7	7	7	7
Nitrogen oxide	428	7	7	7	7	7	7
Nonmethane hydrocarbons	2,893	7	7	7	7	7	7
Propane sultone	205	7	7	7	7	7	7
Stoddard solvent	264	7	7	7	7	7	7
Toluene	2,483	7	7	22.7	7	7	7
1, 1, 2-Trichloroethane	927	7	7	7	7	<0.1	7
Hazardous and Other Toxic Compounds (Continued)							
Trichloroethylene	210	7	7	7	7	<0.1	7
Tungsten (as W) (insoluble)	109	7	7	7	7	7	7
VM&P naptha	613	7	7	7	7	7	7
Welding fumes	511	7	7	7	7	7	7

Xylene (o-, m-, p-isomers)	1,762	7	7	7	7	7	7

Atmospheric Dispersion Characteristics. Data collected at the TA-6 meteorological tower for 1991 indicate that unstable conditions occur approximately 45 percent of the time, neutral conditions approximately 21 percent of the time, and stable conditions approximately 34 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The TA-6 meteorological data for wind speed and direction for 1991 is presented in figure B.3.6-1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the west-northwest with a secondary maximum from the west. The mean wind speed from the west-northwest is 3.2 m/s (7.2 mph), which is also the maximum mean wind speed. The mean wind speed from the west is 3 m/s (6.7 mph).

B.3.7 Lawrence Livermore National Laboratory

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (figures B.3.7-1 and B.3.7-2) at the Livermore Site and Site 300. Table B.3.7-1 presents emission source inventories for criteria and toxic/hazardous pollutants at the Livermore Site and Site 300. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figures B.3.7-1 and B.3.7-2 show annual mean wind speed and wind direction frequencies for 1991 measured at the 10-m (32.8-ft) level of the Livermore Site and Site 300 meteorological monitoring sites. Prevailing wind directions at the Livermore Site are from the south-southwest through west while at Site 300 the prevailing wind direction is from the west-southwest. The average annual wind speed measured at the Livermore Site is 2.5 m/s (5.7 mph) while at Site 300 the average annual wind speed is 5.9 m/s (13.1 mph).

The annual mean temperature at the Livermore Site is 12.5 °C (54.5 °F); temperatures range from a minimum of 0 °C (32 °F) in the winter to 38 °C (100.4 °F) in summer (LLNL 1993b:1-2).

The average annual precipitation at the Stockton, CA National Weather Service station is 35.4 cm (13.95 in). Most of the annual precipitation falls from October through April. Snowfall is rare in the Livermore Site area. The maximum 24-hour rainfall is approximately 7.65 cm (3.01 in). On the average, the area can expect thunderstorms about 3.1 days per year (NOAA 1994d:3).

The climate at Site 300, while generally similar to the Livermore Site, is modified by higher elevation and more pronounced relief. The temperature range is somewhat more extreme than the Livermore Site, and topography significantly influences surface wind patterns (LLNL 1993b:1-3).

Emission Rates. Table B.3.7-1 presents the emission rates for criteria and toxic/hazardous pollutants at the Livermore Site and Site 300. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the facility at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1.0 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Table B.3.7-1.-- Emission Rates for Proposed Stewardship and Management Alternatives at the Livermore Site and Site 300

	2005 No Action		

Pollutant	**Livermore Site (kg/yr)**	**Site 300 (kg/yr)**	**Secondary and Case Fabrication (kg/yr)**	**High Explosives Fabrication (kg/yr)**	**NonnuclearFabrication (kg/yr)**	**Contained Firing Facility (kg/yr) [10]**	**National Ignition Facility (kg/yr)**
Criteria Pollutant							
Beryllium	0.002	0.279	*12*	*12*	11	-	*12*
Carbon monoxide	5,629	1,854	1000	113.4	*11*	-	430
Lead	0.0068	0.059	*12*	*12*	*11/EM>*	-	12
Nitrogen dioxide	32,450	8,576	1,900	249.5	11	-	1,790
Particulate matter [13]	4,636	993	100	22.7	11	-	160
Sulfur dioxide	430	99	20	*13.6*	11	-	30
Total suspended particulates	4,636	993	3,200	*22.7*	11	-	160
Hazardous and Other Toxic Compounds							
Acetone	818.7	45.4	12	12	11	-	12
Benzene	100.2	0.082	12	12	11	-	12
2-Butoxyethanol	153.8	12	12	12	11	-	12
Carbon tetrachloride	204.6	12	12	12	11	-	12
Chlorine	12	12	50	12	11	-	12
Chlorofluorocarbons	8,705.3	163.7	12	12	11	-	12
Chloroform	188.7	0.054	12	12	11	-	12
Ethanol	322.1	<0.45	12	12	11	-	12
Formaldehyde	53.52	1.91	12	12	11	-	12
Gasoline	12	367.1	12	12	11	-	12

Glycol ethers (other)	2.99	53.1	12	12	11	-	12
Hexane	59.4		12	12	11	-	12
Hydrogen chloride	64.4	60.2	1,600	*45.4*	11	-	12
Hydrogen fluoride	12	12	12	90.7	11	-	12
Hydrogen sulfide	12	12	12	12	11	-	12
Isopropyl alcohol	729.4	0.14	12	12	11	-	12
Methanol	949.37	12	4,500	12	11	-	12
Methyl ethyl ketone	338.4	0.27	12	6.8	11	-	12
Methylene chloride	133.81	1.72	12	12	11	-	12
Nephthalene	73.48	12	12	12	11	-	12
Nitric acid	12	12	2,300	12	11	-	12
Styrene	1,270.1	12	12	12	11	-	12
Sulfuric acid	12	12	600	12	11	-	12
Tetrohydrofuran	61.23	12	12	12	11	-	12
Toluene	384.65	18.44	12	12	11	-	12
1, 1, 1-Trichloroethane	981.6	12	12	12	11	-	12
Trichloroethylene	175.99	3.63	12	12	11	-	12
Xylene	222.26	4.99	12	2.7	11	-	12

Atmospheric Dispersion Characteristics. Data collected at the Livermore Site and Site 300 for 1991 indicate that unstable conditions occur approximately 32/37 percent of the time, neutral conditions approximately 35/34 percent of the time, and stable conditions approximately 33/29 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The 1991 meteorological data for wind speed and direction for the Livermore Site and Site 300 are presented in figures B.3.7-1 and B.3.7-2 as wind roses. As shown in the figures, the maximum wind direction frequency at the Livermore Site and Site 300 is from the southwest/west-southwest with a secondary maximum from the west-southwest/north-northwest. The mean wind speed from the southwest/west-southwest is 3.4/8.9 m/s (7.7/19.9 mph) and from the west-southwest/north-northwest is 3.0/6.3 m/s (6.7/14.1 mph).

B.3.8 Sandia National Laboratories

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (figure B.3.8-1) at SNL. Table B.3.8-1 presents emission source inventories for criteria and toxic/hazardous pollutants at SNL. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.8-1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 10-m (32.8-ft) level of the Albuquerque National Weather Service station. Prevailing wind directions are from the north. The average annual wind speed measured is 4 m/s (9 mph).

The average annual temperature at SNL is 13.4 °C (56.2 °F); average daily temperatures vary from a minimum of -5.7 °C (21.7 °F) in January to a maximum of 33.6 °C (92.5 °F) in July (NOAA 1994c:3).

The average annual precipitation at SNL is 22.6 cm (8.88 in). Most of the annual precipitation falls during the months of July through October and usually occurs from thunderstorm activity and the intrusion of warm, moist tropical air from the Gulf of Mexico. Snowfall averages nearly 28.2 cm (11.1 in). Snowfall has occurred from October through April. The maximum 24-hour rainfall was 4.9 cm (1.92 in) occurring in September 1955. On the average, the area can expect thunderstorms about 41 days per year (NOAA 1994c:3). The estimated probability of a tornado striking a point at SNL is 2.0x10^{-5} per year (NRC 1986a:32).

Emission Rates. Table B.3.8-1 presents the emission rates for criteria and toxic/hazardous pollutants at SNL. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the SNL site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the SNL facility at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Table B.3.8-1.-- Emission Rates for Proposed Stewardship and Management Alternatives at Sandia National Laboratories

Pollutant	2005 No Action (kg/yr)	Nonnuclear Fabrication (kg/yr)	National Ignition Facility (kg/yr)
Criteria Pollutant			
Carbon monoxide	230[14]	[15]	520
Nitrogen dioxide	1,070 [14]	[15]	2,150
Particulate matter	3,760 [14]	[15]	200
Sulfur dioxide	70 [14]	[15]	40
Total suspended particulates	[15]	[15]	[15]

Hazardous and Other Toxic Compounds			
Acetone	247	15	15
Benzene	1.1	15	15
Carbon tetrachloride	2.7	15	15
Hydrogen chloride	3,227	15	15
Isopropyl alcohol	106	15	15
Methanol	108	15	15
Methyl chloroform	703	15	15
Methylene chloride	40	15	15
Toluene	546	15	15
Trichloroethylene	103	15	15
Trichlorotrifluoroethane	151	15	15
Xylene	580	15	15

Atmospheric Dispersion Characteristics. Data collected at the Albuquerque National Weather Service station for 1991 indicate that unstable conditions occur approximately 28 percent of the time, neutral conditions approximately 38 percent of the time, and stable conditions approximately 34 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The Albuquerque National Weather Service meteorological data for annual mean wind speed and direction for 1991 are presented in figure B.3.8-1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the north with a secondary maximum from the east and south. The mean wind speed from the north is 4.1 m/s (9.2 mph); from the south is 4.8 m/s (10.7 mph); while the maximum mean wind speed is 6.4 m/s (14.3 mph) from the east.

B.3.9 Nevada Test Site

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (figure B.3.9-1) at NTS. Table B.3.9-1 presents emission source inventories for criteria and toxic/hazardous pollutants at NTS. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.9-1 shows annual mean wind speed and wind direction frequencies for 1991 measured at the 10-m (32.8-ft) level of the Desert Rock, Nevada National Weather Service station. Prevailing winds are southerly during summer and northerly during winter. The general downward slope in the terrain from north to south results in an intermediate scenario that is reflected in the characteristic diurnal wind reversal from southerly winds during the day to northerly winds at night. This north-to-south reversal is strongest in the summer and, on occasion, becomes intense enough to override the wind regime associated with large-scale pressure systems.

Average annual wind speeds and direction vary with location. At higher elevations on Pahute Mesa, the average annual wind speed is 4.7 m/s (10.5 mph). The prevailing wind direction during winter months is north-northeasterly, and during summer months, is southerly. In Yucca Flat the average annual wind speed is 3.1 m/s (6.9 mph). The prevailing wind direction during winter months is north-northwesterly and during summer months is south-southwesterly. At Mercury, NV, the average annual wind speed is 3.6 m/s (8.1 mph), with northwesterly prevailing winds during the winter months and southwesterly winds during the summer months (NT DOE 1994b:2-16).

Elevation influences temperatures on NTS. At an elevation of 2,000 m (6,560 ft) above mean sea level on Pahute Mesa, the average daily maximum/minimum temperatures are 4.4/-2.2 °C (40/28 °F) in January and 26.7/16.7 °C (80/62 °F) in July. In Yucca Flat, 1,195 m (3,920 ft) above mean sea level, the average daily maximum/minimum temperatures are 10.6/-6.1 °C (51/21 °F) in January and 35.6 /13.9 °C (96/57 °F) in July. The extreme temperatures at Mercury are 20.6/-11.1 °C (69/12 °F) in January and 42.8/15 °C (109/59 °F) in July (NT DOE 1993e:2-17,2-19).

The average annual temperature at the Las Vegas National Weather Service station is 19.5 °C (67.1 °F); average daily temperature varies from a minimum of 0.9 °C (33.6 °F) in January to a maximum of 41.1 °C (105.9 °F) in July. The average annual precipitation at the Las Vegas National Weather Service station is 10.5 cm (4.13 in) (NOAA 1994d:3). Annual precipitation in southern Nevada is very light and depends largely upon elevation. On NTS, the mesas receive an average annual precipitation of 23 cm (9 in), which includes winter snow accumulations. The lower elevations receive approximately 15 cm (6 in) of precipitation annually, with occasional snow accumulations lasting only a few days (NT DOE 1993e:2-17,2-19).

Precipitation usually falls in isolated showers with large variations in precipitation amounts within a shower area. Summer precipitation occurs mainly in July and August when intense heating of the ground below moist air masses triggers thunderstorm development. On rare occasions, a tropical storm will move northeastward from the west coast of Mexico, bringing heavy precipitation during September and/or October.

Wind speeds in excess of 27 m/s (60 mph), with gusts up to 48 m/s (107 mph), may be expected to occur on a 100-year return period. Other than temperature extremes, severe weather in the region includes occasional thunderstorms, lightning, tornadoes, and sandstorms. Severe thunderstorms may produce high precipitation with durations of approximately 1 hour, and may create a potential for flash flooding (NT DOE 1983a:26). Tornadoes have been observed in the region but are infrequent. The estimated probability of a tornado striking a point at NTS is $3.0x10^{-7}$ per year (NRC 1986a:32).

Emission Rates. Table B.3.9-1 presents the emission rates for criteria and toxic/hazardous pollutants at NTS. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the NTS site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the NTS facility at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Table B.3.9-1.-- Emission Rates for Proposed Stewardship and Management Alternatives at Nevada Test Site

Pollutant	2005 No Action [16] (kg/yr)	Assembly/ Disassembly (kg/yr)	National Ignition Facility (kg/yr)
Criteria Pollutant			

Carbon monoxide	17	454	370
Hydrogen sulfide	17	17	17
Nitrogen dioxide	17	6,350	2,010
Particulate matter	86,820	136	80
Sulfur dioxide	71,125	6,804	4
Total suspended particulates	18	18	18
Hazardous and Other Toxic Compounds	17	17	17

Atmospheric Dispersion Characteristics. Data collected at the NTS meteorological monitoring station for 1991 indicate that unstable conditions occur approximately 26 percent of the time, neutral conditions approximately 37 percent of the time, and stable conditions approximately 37 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The NTS meteorological data for annual mean wind speed and direction for 1991 are presented in figure B.3.9-1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the northeast with a secondary maximum from the north-northeast. The mean wind speed from the northeast is 4.2 m/s (9.4 mph); from the north-northeast is 4.7 m/s (10.5 mph); while the maximum mean wind speed is 6.3 m/s (14.1 mph) from the south-southwest.

1

The NAAQS (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on average annuals, are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per year with maximum hourly average concentrations above the standard is less than or equal to one. The 24-hour particulate matter standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to one. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The calendar quarter lead standard is not to be exceeded.

2

There is no standard.

NAAQS - National Ambient Air Quality Standard.

40 CFR 50; CA EPA 1993a; MO DNR 1994a; NM EIB 1996a; NV DCNR 1995a; SC DHEC 1992b; TN DEC 1994a; TX ACB 1987a; TX ACB 1993a; TX NRCC 1992a.

3

Based upon reduction of No Action emissions.

4

No sources indicated.

Parentheses indicate a net reduction in emissions.

OR DOE 1993a; OR DOE 1995g.

5

No sources indicated.

6

Data not available.

SRS 1993a:4; SRS 1995a:10; WSRC 1995c.

7

No sources indicated.

Parentheses indicate a net reduction in emissions.

PX 1996e:1, PX DOE 1996b; PX MH 1995a; PX MH 1995b.

8

No sources indicated.

9

It is assumed that PM *10* emissions are total suspended particulates emissions.

LANL 1995c; LANL 1995d; LANL 1995e; LANL 1995g; appendix I; appendix K.

10

Contained Firing Facility air emissions are addressed in appendix J.

11

No increase over No Action.

12

No sources indicated.

13

It is conservatively assumed that *particulate matter* emissions are total suspended particulates emissions.

LLNL 1995e; LLNL 1995f; LLNL 1995i:5; LLNL 1995j; appendix I; appendix J.

14

Based on steam plant and stand-by steam plant emissions.

15

No sources indicated.

SNL 1991b:1; SNL 1995e; appendix I.

16

Based on permitted sources.

17

No sources indicated.

18

No data available.

NT DOE 1995b; NV DCNR 1992a; appendix I.

APPENDIX C: THREATENED, ENDANGERED, AND SPECIAL STATUS SPECIES

This appendix contains tables C-1 through C-7 that present flora and fauna identified by the U.S. Fish and Wildlife Service (USFWS) and state governments as threatened, endangered, or other special status. Special status species include Federal candidate species and state classifications such as species of concern or species in need of management. The threatened, endangered, and special status lists include all such species which could potentially occur in a site area regardless of their residence status (i.e., breeding, year round, summer, winter, or migratory) or likelihood of being affected by project actions.

Table C-1.-- Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Oak Ridge Reservation

Common Name	Scientific Name	Status 1	
		Federal	State
Mammals			
Alleghany woodrat	*Neotoma magister*	NL	D
Eastern cougar 2	*Felis concolor couguar*	E	E
Eastern small-footed bat	*Myotis leibii*	NL	D
Gray bat 2	*Myotis grisescens*	E	E
Indiana bat 2	*Myotis sodalis*	E	E
Rafinesque's big-eared bat	*Plecotus rafinesquii*	NL	D
River otter	*Lutra canadensis*	NL	T
Smoky shrew	*Sorex fumeus*	NL	D
Southeastern shrew	*Sorex longirostris*	NL	D
Birds			
American peregrine falcon 2	*Falco peregrinus anatum*	E	E
Appalachian Bewick's wren	*Thryomanes bewickii altus*	NL	T
Arctic peregrine falcon	*Falco peregrinus tundrius*	E(S/A)	E
Bachman's sparrow	*Aimophila aestivalis*	NL	E
Bald eagle 2, 3	*Haliaeetus leucocephalus*	T	T

Barn owl 4	*Tyto alba*	NL	D
Cooper's hawk 4,5	*Accipiter cooperii*	NL	D
Grasshopper sparrow	*Ammodramus savannarum*	NL	D
Northern harrier	*Circus cyaneus*	NL	D
Osprey 4	*Pandion haliaetus*	NL	T
Red-cockaded woodpecker	*Picoides borealis*	E	E
Sharp-shinned hawk 4, 5	*Accipiter striatus*	NL	D
Swainson's warbler	Limnothlypis swainsonii	NL	D
Reptiles			
Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*	NL	D
Northern pine snake	*Pituophis melanoleucus melanoleucus*	NL	T
Amphibians			
Hellbender 4,5	*Cryptobranchus alleganiensis*	NL	D
Tennessee cave salamander 6	*Gyrinophilus palleucus*	NL	T
Fish			
Alabama shad	*Alosa alabamae*	NL	D
Amber darter 2	*Percina antesella*	E	E
Blue sucker	*Cycleptus elongatus*	NL	T
Flame chub	*Hemitremia flammea*	NL	D
Frecklebelly madtom	*Noturus munitus*	NL	T
Highfin carpsucker	*Carpiodes velifer*	NL	D
Spotfin chub 2	*Cyprinella monacha*	T	E
Tennessee dace 4,5	*Phoxinus tennesseensis*	NL	D
Yellowfin madtom 2	*Noturus flavipinnis*	T	E
Invertebrates			
Alabama lampmussel 2	*Lampsilis virescens*	E	E
Appalachian monkeyface pearlymussel 2	*Quadrula sparsa*	E	E
Birdwing pearlymussel 2	*Conradilla caelata*	E	E
Cumberland bean pearlymussel 2	*Villosa trabalis*	E	E
Cumberland monkeyface pearlymussel 2	*Quadrula intermedia*	E	E

Dromedary pearlymussel 2	*Dromus dromas*	E	E
Fine-rayed pigtoe 2	*Fusconaia cuneolus*	E	E
Green-blossom pearlymussel 2	*Epioblasma torulosa gubernaculum*	E	E
Orange-footed pearlymussel 2	*Plethobasus cooperianus*	E	E
Painted snake coiled forest snail	*Anguispira picta*	T	E
Pale lilliput pearlymussel 2	*Toxolasma cylindrellus*	E	E
Pink mucket pearlymussel 2	*Lampsilis abrupta*	E	E
Rough pigtoe 2	*Pleurobema plenum*	E	E
Shiny pigtoe 2	*Fusconaia cor*	E	E
Tan riffle shell 2	*Epioblasma walkeri*	E	E
Tubercled-blossom pearlymussel 2	*Epioblasma torulosa torulosa*	E	E
Turgid-blossom pearlymussel 2	*Epioblasma turgidula*	E	E
White wartyback pearlymussel 2	*Plethobasus cicatricosus*	E	E
Yellow-blossom pearlymussel 2	*Epioblasma florentina florentina*	E	E
Plants			
American barberry	*Berberis canadensis*	NL	S
American ginseng 4,5	*Panax quinquefolius*	NL	T
Appalachian bugbane 4	*Cimicifuga rubifolia*	NL	T
Auriculate false-foxglove	*Tomanthera auriculata*	NL	E
Branching whitlowgrass	*Draba ramosissima*	NL	S
Butternut 4	*Juglans cinerea*	NL	T
Canada (wild yellow) lily 4,5	*Lilium canadense*	NL	T
Carey's saxifrage 4	*Saxifraga careyana*	NL	S
Fen orchid 4,5	*Liparis loeselii*	NL	E
Golden seal 4,5	*Hydrastis canadensis*	NL	T
Gravid sedge 4,5	*Carex gravida*	NL	S
Plants (Continued)			
Heartleaf meehania	*Meehania cordata*	NL	T
Heller's catfoot	*Gnaphalium helleri*	NL	S
Lesser ladies' tresses 4	*Spiranthes ovalis*	NL	S
Michigan lily 4,5	*Lilium michiganense*	NL	T

Mountain honeysuckle	Lonicera dioica	NL	S
Mountain witch alder 4	*Fothergilla major*	NL	T
Northern bush honeysuckle 4	*Diervilla lonicera*	NL	T
Nuttall waterweed 4	*Elodea nuttallii*	NL	S
Pink lady's-slipper 4,5	*Cypripedium acaule*	NL	E
Prairie goldenrod	Solidago ptarmicoides	NL	E
Purple fringeless orchid 4,5	*Platanthera peramoena*	NL	T
Slender blazing star	Liatris cylindracea	NL	E
Spreading false foxglove 4	*Aureolaria patula*	NL	T
Swamp lousewort	Pedicularis lanceolata	NL	T
Tall larkspur 4	*Delphinium exaltatum*	NL	E
Tennessee purple coneflower 2	*Echinacea tennesseenis*	E	E
Tubercled rein-orchid 4,5	*Platanthera flava var. herbiola*	NL	T
Virginia spiraea	*Spiraea virginiana*	T	E
Whorled mountainmint	Pycnanthemum verticillatum	NL	E-P

Table C-2.-- Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Savannah River Site

Common Name	**Scientific Name**	**Status 7**	
		Federal	**State**
Mammals			
Meadow vole	Microtus pennsylvanicus	NL	SC
Rafinesque's big-eared bat 8	*Plecotus rafinesquii*	NL	SE
Southern Appalachian eastern woodrat 8	*Neotoma floridana haematoreia*	NL	SC
Spotted skunk 8	Spilogale putorius	NL	SC
Star-nosed mole 8	*Condylura cristata parva*	NL	SC
Swamp rabbit	*Sylvilagus aquaticus*	NL	SC

Birds			
American peregrine falcon8 , 9	*Falco peregrinus anatum*	E	SE
American swallow-tailed kite	*Elanoides forficatus*	NL	SE
Appalachian Bewick's wren 8	*Thryomanes bewickii altus*	NL	ST
Arctic peregrine falcon 8	*Falco peregrinus tundrius*	E (S/A)	ST
Bald eagle 9A	*Haliaeetus leucocephalus*	T	SE
Barn owl 8	Tyto alba	NL	SC
Common ground dove 8	*Columbina passerina*	NL	ST
Cooper's hawk 8	*Accipiter cooperii*	NL	SC
Kirtland's warbler 8	*Dendroica kirtlandii*	E	SE
Mississippi kite 8	*Ictinia mississippiensis*	NL	SC
Red-cockaded woodpecker 8,9A	*Picoides borealis*	E	SE
Red-headed woodpecker 8	*Melanerpes erythrocephalus*	NL	SC
Swainson's warbler 8	Limnothlypis swainsonii	NL	SC
Wood stork 8,10	*Mycteria americana*	E	SE
Reptiles			
American alligator 8	*Alligator mississippiensis*	T (S/A)	NL
Carolina swamp snake 8	*Seminatrix pygaea*	NL	SC
Eastern coral snake 8	*Micrurus fulvius fulvius*	NL	SC
Green water snake 8	Nerodia cyclopion	NL	SC
Spotted turtle 8	*Clemmys guttata*	NL	SC
Amphibians			
Carolina crawfish frog 8	*Rana areolata capito*	NL	SC
Eastern bird-voiced treefrog 8	*Hyla avivoca ogechiensis*	NL	SC
Eastern tiger salamander 8,10	*Ambystoma tigrinum tigrinum*	NL	SC
Northern cricket frog 8	Acris crepitans crepitans	NL	SC
Pickerel frog 8,10	*Rana palustris*	NL	SC
Upland chorus frog 8	*Pseudacris triseriata feriarum*	NL	SC
Fish			
Shortnose sturgeon 8,9A,10	*Acipenser brevirostrum*	E	SE

Invertebrates			
Brother spike mussel	*Elliptio fraterna*	NL	SE
Plants			
Beak-rush 8,10	*Rhynchospora inundata*	NL	SC
Bog spice bush 8	*Lindera subcoriacea*	NL	RC
Cypress stump sedge 8,10	*Carex decomposita*	NL	SC
Durand's white oak8	Quercus durandii	NL	SC
Dwarf bladderwort 8	*Utricularia olivacea*	NL	SC
Dwarf burhead8	Echinodorus parvulus	NL	SC
Elliott's croton 8	*Croton elliottii*	NL	SC
Few-fruited sedge 8	*Carex oligocarpa*	NL	SC
Florida bladderwort 8	*Utricularia floridana*	NL	SC
Florida false loosestrife 8	*Ludwigia spathulata*	NL	SC
Gaura 8	*Gaura biennis*	NL	SC
Green-fringed orchid 8,10	*Platanthera lacera*	NL	SC
Leafy pondweed 8	*Potamogeton foliosus*	NL	SC
Loose water-milfoil 8	*Myriophyllum laxum*	NL	RC
Milk-pea 8	*Astragalus villosus*	NL	SC
Nailwort 8,10	*Paronychia americana*	NL	SC
Nestronia 8	Nestronia umbellula	NL	SC
Nutmeg hickory 8	*Carya myristiciformis*	NL	RC
Oconee azalea 8	*Rhododendron flammeum*	NL	SC
Pink tickseed 8	*Coreopsis rosea*	NL	RC
Quill-leaved swamp potato 8	*Sagittaria isoetiformis*	NL	SC
Sandhill lily 8	*Nolina georgiana*	NL	SC
Smooth coneflower 8	*Echinacea laevigata*	E	-- *e*
Trepocarpus 8	*Trepocarpus aethusae*	NL	SC
Wild water-celery 8	*Vallisneria americana*	NL	SC
Yellow cress 8	*Rorippa sessiliflora*	NL	SC
Yellow wild indigo 8	*Baptisia lanceolata*	NL	SC

Table C-3.-- Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Pantex Plant

		Status [10]	
Common Name	**Scientific Name**	**Federal**	**State**
Mammals			
Swift fox[11]	*Vulpes velox*	C	NL
Birds			
American peregrine falcon [12]	*Falco peregrinus anatum*	E	E
Arctic peregrine falcon	*Falco peregrinus tundrius*	E (S/A)	T
Bald eagle [11], [12]	*Haliaeetus leucocephalus*	T	E
Interior least tern [12]	*Sterna antillarum athalassos*	E	E
Mountain plover	*Charadrius montanus*	C	NL
White-faced ibis [11]	*Plegadis chihi*	NL	T
Whooping crane [11],[12]	*Grus americana*	E	E
Reptiles			
Smooth green snake	*Opheodrys vernalis*	NL	E
Texas horned lizard [11]	*Phrynosoma cornutum*	NL	T

Table C-4.-- Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Los Alamos National Laboratory

Common Name	**Scientific Name**	Status [13]	
		Federal	**State**
Mammals			

New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	NL	T
Spotted bat	*Euderma maculatum*	NL	T
Birds			
Baird's sparrow	Ammodvamus bairdii	NL	T
Bald eagle [14], [15]	*Haliaeetus leucocephalus*	T	T
Broad-billed hummingbird	*Cynanthus latirostris*	NL	T
Common black-hawk	*Beuteogallus anthracinus*	NL	T
Gray vireo	*Vireo vicinior*	NL	T
Mexican spotted owl [15]	*Strix occidentalis lucida*	T	NL
Peregrine falcon [14,15]	*Falcon peregrinus*	E (S/A)	E
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	T
Whooping crane [14]	*Grus americana*	E	E
Amphibians			
Jemez Mountain salamander [15]	*Plethodon neomexicanus*	NL	T
Fish			
Rio Grande silvery minnow	*Hybognathus amarus*	E	T
Invertebrates			
Say's pond snail	*Lymnaea caperata*	NL	E
Plants			
Checker lily	Fritillaria atropurpurea	NL	R
Giant helleborine orchid	*Epipactis gigantea*	NL	RS
Golden lady's slipper	Cypripedium pubesceas	NL	E
Sandia alumroot	*Heuchera pulchella*	NL	RS
Santa Fe cholla	*Opuntia viridiflora*	NL	E
Wood lily	*Lilium philadelphicum var. andinum*	NL	E

Table C-5.-- Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of the Livermore Site and Site 300

Common Name	Scientific Name	Status [16]

		Federal	State
Mammals			
American badger 17	*Taxidea taxus*	NL	SC
Greater western mastiff-bat	*Eumops perotis californicus*	NL	SC
Pacific Townsend's big-eared bat	*Plecotus townsendii townsendii*	NL	SC
Riparian brush rabbit	Sylvilagus bachmani riparius	C	E
San Francisco dusky-footed woodrat	Neotoma fuscipes annectens	NL	SC
San Joaquin kit fox 20	*Vulpes macrotis mutica*	E	T
San Joaquin pocket mouse 17	*Perognathus inoratus inoratus*	NL	SC
San Joaquin Valley woodrat	*Neotoma fuscipes riparia*	C	SC
Birds			
American peregrine falcon 17,20	*Falco peregrinus anatum*	E	E
Bald eagle *c,d*	*Haliaeetus leucocephalus*	T	E
Bell's sage sparrow	Amphispiza belli belli	NL	SC
California horned lark 17	Eremophila alpestris actia	NL	SC
Coopers hawk 17,*d*	*Accipiter cooperii*	NL	SC
Double-crested cormorant *d*	Phalacrocorax auritus	NL	SC
Ferruginous hawk 17,*d*	Buteo regalis	NL	SC
Golden eagle 17,*d*	*Aquila chrysaetos*	NL	SC
Long-eared owl 17	Asio otus	NL	SC
Merlin 17,*d*	Falco columbarius	NL	SC
Mountain plover	Charadrius montanus	C	NL
Northern harrier 17,*d*	*Circus cyaneus*	NL	SC
Prairie falcon 17,*d*	*Falco mexicanus*	NL	SC
Sharp-shinned hawk *d*	*Accipiter striatus*	NL	SC
Short-eared owl	*Asio flammeus*	NL	SC
Swainson's hawk 17	*Buteo swainsoni*	NL	T
Tricolored blackbird 17	*Agelaius tricolor*	NL	SC
Western burrowing owl 17,*d*	*Athene cunicularia hypugea*	NL	SC
Reptiles			

Alameda whipsnake 17	*Masticophis lateralis euryxanthus*	PE	T
California horned lizard 17	*Phrynosoma coronatum frontale*	NL	SC
Giant garter snake	Thamnophis gigas	T	T
Northwestern pond turtle	Clemmys marmorata marmorata	NL	SC
San Joaquin whipsnake 17	Masticophis flagellum ruddocki	NL	SC
Silvery legless lizard	Anniella pulchra pulchra	NL	SC
Southwestern pond turtle	Clemmys marmorata pallida	NL	SC
Amphibians			
California red-legged frog 17	*Rana aurora draytoni*	PE	SC
California tiger salamander 17	*Ambystoma californiense*	C	SC
Western spadefoot toad 17	Scaphiopus hammondii	NL	SC
Invertebrates			
Longhorn fairy shrimp	*Branchinecta longiantenna*	E	NL
Valley elderberry longhorn beetle 17	*Desmocerus californicus dimorphus*	T	SC
Vernal pool fairy shrimp	Branchinecta lynchi	T	NL
Vernal pool tadpole shrimp *e*	Lepidurus packardi	E	NL
Plants			
Alkali milkvetch	Astragalus tener tener	NL	SC
Big scale balsamroot	Balsamorhiza macrolepis var. macrolepis	NL	SC
Congdon's tarplant	Hemizonia parryi congdonii	NL	SC
Large-flowered fiddleneck 17	*Amsinckia grandiflora*	E	E
Palmate-bracted bird's beak	*Cordylanthus palmatus*	E	E
Showy Indian clover	*Trifolium amoenum*	PE	NL
Stinkbells	Fritillaria agrestis	NL	SC

Table C-6.-- Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Sandia National Laboratories

Common Name	Scientific Name	Status 18

		Federal	State
Mammals			
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	NL	T
Spotted bat	*Euderma maculatum*	NL	T
Birds			
Bald eagle [19]	*Haliaeetus leucocephalus*	T	T
Baird's sparrow	Ammodramus bairdii	NL	T
Bell's vireo	Vireo bellii	NL	T
Common black hawk	Beuteogallus anthracinus	NL	T
Gray vireo [20]	Vireo vicinior	NL	T
Mexican spotted owl	Strix occidentalis lucida	T	NL
Mountain plover	*Charadrius montanus*	C	NL
Northern beardless-tyrannulet	Camptostoma imperbe	NL	E
Peregrine falcon [19]	Falco peregrinus	E (S/A)	E
Southwestern willow flycatcher	Empidonax traillii extimus	E	T
Whooping crane [19]	Grus americana	E	E
Fish			
Rio Grande silvery minnow	Hybognathus amarus	E	T
Plants			
Great Plains lady tresses	Spiranthes magnicamporum	NL	E
Plank's catchfly	Silene plankii	NL	RS
Santa Fe milkvetch	Astragalus feensis	NL	RS
Strong prickly pear	Opuntia valida	NL	R

Table C-7.-- Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Nevada Test Site

Common Name	Scientific Name	Status [21]	
		Federal	State

Mammals			
Spotted bat 22	*Euderma maculatum*	NL	T
Birds			
American peregrine falcon 23 , 24	*Falco peregrinus anatum*	E	E
Arctic peregrine falcon 23	*Falco peregrinus tundrius*	E (S/A)	E
Bald eagle 22,24	*Haliaeetus leucocephalus*	T	T
Mountain plover 22	*Charadrius montanus*	C	NL
Reptiles			
Desert tortoise 22, 25	*Gopherus agassizii*	T	T
Fish			
Devils Hole pupfish 24, 26	*Cyprinodon diabolis*	E	E
Plants			
Beatley milkvetch 22	*Astragalus beatleyae*	NL	CE
Mojave fishhook cactus 22	*Sclerocactus polyancistrus*	NL	CY

1

Status codes: D - deemed in need of management; E - endangered; NL - not listed; P - possibly extirpated; S - species of special concern; S/A - protected under the similarity of appearances provision of the *Endangered Species Act* ; T - threatened.

2

USFWS Recovery Plan exists for this species.

3

Observed near Oak Ridge Reservation (ORR) on Melton Hill and Watts Bar Lakes.

4

Recent record of species occurrence on ORR.

5

Species known to occur on or near proposed project site.

6

Species collected on ORR in 1964.

50 CFR 17.11; 50 CFR 17.12; DOE 1995w; OR DOE 1990a; OR FWS 1992b; OR NERP 1993a; ORNL 1981a;
ORNL 1984b; ORNL 1988c; TN DEC 1995a; TN DEC 1995b; TN DEC 1995c; TN DEC 1995d; TN WRC 1991a;
TN WRC 1991b.

7

Status codes: E - endangered; NL - not listed; RC - regional of concern (unofficial plants only); S/A - protected under the similarity of appearance provision of the Endangered Species Act; SC - state of concern; SE - state endangered (official state-listed animals only); ST - state threatened (official state-list animals only); and T - threatened.

8

Species occurrence recorded on Savannah River Site (SRS).

9

USFWS Recovery Plan exists for this species.

9A

Species known to occur on Upper Three Runs Creek downstream from the proposed project site or in areas affected by the project.

9B

There is no official state threatened or endangered status for plants; defer to Federal status.

50 CFR 17.11; 50 CFR 17.12; DOE 1992e; SC WD 1995a; SR NERP 1990b; WSRC 1989e; WSRC 1993b.

10

Status codes: C - Federal candidate; E - endangered; NL - not listed; S/A - protected under the similarity of appearances provision of the *Endangered Species Act* ; T - threatened.

11

Species observed on Pantex Plant.

12

USFWS Recovery Plan exists for this species.

**50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; PX DOE 1996b; PX MH 1994c; TX PWD 1993a; TX PWD 1995a;
TX PWD 1995b.**

13

Status codes: E - endangered; NL - not listed; R - state rare plant review list; RS - state rare and sensitive plant species; S/A - protected under the similarity of appearances provision of the Endangered Species Act; T - threatened.

14

USFWS Recovery Plan exists for this species.

15

Species recorded on Los Alamos National Laboratory (LANL).

50 CFR 17.11; 50 CFR17.12; DOE 1995hh; LANL 1996e:2; NM DGF 1990b; NM DGF 1995a; NM FRCD 1995a.

16

Status codes: C - Federal candidate; E - endangered species; NL - not listed; PE - proposed endangered; SC - state species of special concern; T - threatened.

17

Species considered only for Site 300.

50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; CA DFG 1994a; CA DFG 1995a; CA DFG 1995b; CA DFG 1995c;
LL DOE 1992c; LLNL 1996i:3.

18

Status codes: C - Federal candidate; E - endangered; NL - not listed; R - state rare plant review list; RS - state rare and sensitive plant species; S/A - protected under the similarity of appearance provision of the *Endangered Species Act* ; T - threatened.

19

USFWS Recovery Plan exists for this species.

20

Species observed on Sandia National Laboratory (SNL).

50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; NM DGF 1990b; NM DGF 1995a; NM FRCD 1995a; SNL 1990a; SNL 1992c; SNL 1995h; appendix I.

21

Status codes: C - Federal candidate; CE - critically endangered by authority of NRS 527.270 (State Division of Forestry); CY - protected by authority of NRS 522.60-.120 (Nevada Cacti and Yucca Law); E - endangered; NL - not listed; S/A - protected under the similarity of appearances provision of the *Endangered Species Act* ; T - threatened.

22

Species recorded on Nevada Test Site (NTS).

23

Peregrine falcon seen on NTS; however not identified to subspecies level.

24

USFWS Recovery Plan exists for this species.

25

Species known to occur on the proposed project site.

26

Only known location of this species is outside NTS approximately 55 km (34 mi) southwest of the proposed project site. This species is included here due to offsite groundwater concerns.

50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; DOE 1995w; NT DOE 1995j; NT DOE 1996c; NT DOI 1995a; NT ERDA 1976a; NV FWS 1989a; NV NHP 1995a.

APPENDIX D: SOCIOECONOMICS

D.1 Introduction

This appendix includes the methodologies, models, assumptions, and supporting data used to assess potential impacts in the socioeconomics sections of this programmatic environmental impact statement. Section D.2 presents the methods and assumptions used to evaluate the potential socioeconomic effects of the proposed alternatives of the Stockpile Stewardship and Management Program. The socioeconomic analysis involved two major steps: (1) characterizing and projecting existing social, economic, and infrastructure conditions surrounding each of the candidate sites (i.e., the affected environment); and (2) evaluating potential changes in socioeconomic conditions that could result from operating the proposed alternatives in the regions addressed (i.e., the environmental consequences).

For each site, socioeconomic impacts were estimated using two geographic areas. First, a region of influence (ROI) was identified based on the distribution of residences for current Department of Energy (DOE) and contractor employees. The ROI is defined as those counties where approximately 90 percent of the workforce lives. This residential distribution reflects existing commuting patterns and attractiveness of area communities for people employed at each site, and was used to estimate the future distribution of direct workers associated with the proposed alternatives.

As an example, table D.1-1 displays the residential distribution by city and county for approximately 90 percent of all personnel employed at Oak Ridge Reservation (ORR). Data on residential locations of a large portion of facility employees were obtained from ORR personnel offices. Similar data were provided by the other locations and are given in tables D.1-2 through D.1-8.

Table D.1-1.-- Distribution of Employees by Place of Residence in the Oak Ridge Reservation Region of Influence, 1991

County/City	Number of Employees	Total Site Employment (percent)
Anderson County	5,053	33.1
Clinton	1,035	6.8
Oak Ridge	3,292	21.6
Knox County	5,490	36.0
Knoxville	4,835	31.7
Loudon County	848	5.6
Lenoir City	638	4.2
Roane County	2,537	16.6
Harriman	802	5.3
Kingston	1,033	6.8
Total ROI	13,928	91.3
City values are included within county totals. **ORR 1991a:4.**		

Table D.1-2.-- Distribution of Employees by Place of Residence in the Savannah River Site Region of Influence, 1991

County/City	Number of Employees	Total Site Employment (percent)
Aiken County	9,978	51.9
Aiken	4,928	25.7
North Augusta	2,666	13.9
Barnwell County	1,401	7.3
Columbia County	2,036	10.6
Richmond County	3,358	17.5
Augusta	2,780	14.5
Total ROI	16,773	87.3

City values are included within county totals.

SRS 1991a:3.

Table D.1-3.-- Distribution of Employees by Place of Residence in the Kansas City Plant Region of Influence, 1991

County/City	Number of Employees	Total Site Employment (percent)
Cass County	761	14.0
Belton	237	4.4
Harrisonville	150	2.8
Jackson County	3,246	59.8
Kansas City	1,499	27.6
Lee's Summit	609	11.2
Johnson County	915	16.9
Overland Park	376	6.9
Wyandotte County	135	2.3
Total ROI	5,057	93.2

City values are included within county totals.

KCP 1993a:1.

Table D.1-4.-- Distribution of Employees by Place of Residence in the Pantex Plant Region of Influence, 1994

County/City	Number of Employees	Total Site Employment (percent)
Armstrong County	46	1.3
Carson County	380	10.7
Potter County	1,217	34.2
Amarillo	196	5.5
Randall County	1,783	50.2
Total ROI	3,426	96.4
City values are included within county totals. **PX 1994a:2.**		

Table D.1-5.-- Distribution of Employees by Place of Residence in the Los Alamos National Laboratory Region of Influence, 1991

County/City	Number of Employees	Total Site Employment (percent)
Los Alamos County	4,697	48.3
Rio Arriba County	2,027	20.8
Espanõla	944	9.7
Santa Fe County	1,851	19.0
Santa Fe	1,548	15.9
Total ROI	8,575	88.1
City values are included within county totals. **LANL 1991b:6.**		

Table D.1-6.-- Distribution of Employees by Place of Residence in the Lawrence Livermore National Laboratory Region of Influence, 1995

County/City	Number of Employees	Total Site Employment (percent)

Alameda County	4,746	57.1
Livermore	3,215	38.7
Pleasanton	642	7.7
Contra Costa County	1,098	13.2
San Joaquin County	1,327	16.0
Manteca	372	4.5
Tracy	656	7.9
Total ROI	7,171	86.3
City values are included within county totals. **LLNL 1995i:1.**		

Table D.1-7.-- Distribution of Employees by Place of Residence in the Sandia National Laboratories Region of Influence, 1994

County/City	Number of Employees	Total Site Employment (percent)
Bernalillo County	6,463	88.0
Albuquerque	6,030	82.1
Sandoval County	333	4.5
Valencia County	334	4.5
Total ROI	7,130	97.0
City values are included within county totals. **SNL 1995b:1.**		

Table D.1-8.-- Distribution of Employees by Place of Residence in the Nevada Test Site Region of Influence, 1991

County/City	Number of Employees	Total Site Employment (percent)
Clark County	6,270	81.7
Henderson	357	4.7
Las Vegas	5,352	69.7

North Las Vegas	505	6.6
Nye County	1,173	15.3
Total ROI	7,443	97.0
City values are included within county totals. **NTS 1991a:1.**		

A second geographical area, referred to as a regional economic area, was also identified for estimating socioeconomic impacts. The regional economic area encompasses a broad market that involves trade among regional industrial and service sectors and is characterized by strong economic links between the communities located in the region. These links determine the nature and magnitude of multiplier effects of economic activity at each candidate site. Regional economic areas, as defined by the U.S. Bureau of Economic Analysis, consist of an economic node that serves as the center of economic activity, and surrounding counties that are economically related and include the places of work and residence of its labor force. The regional economic area is used to analyze the primary economic impacts on employment, spending, earnings, and personal income. Table D.1-9 displays the counties found in each site's regional economic area.

Data for the year 1992 or later were obtained from sources such as the U.S. Bureau of Census, the U.S. Bureau of Economic Analysis (BEA), state and local government publications, and telephone interviews with state and local government officials and planners.

Table D.1-9.-- Candidate Sites' Regional Economic Areas

ORR	**SRS**	**KCP**			**Pantex**		**LANL**	**LLNL**		**SNL**	**NTS**
Tennessee	Georgia	Kansas	Missouri (Con't)	Missouri (Con't)	New Mexico	Texas (Con't)	New Mexico	California	California (Con't)	Arizona	Arizona
Anderson	Burke	Anderson	Caldwell	Livingston	Curry	Gray	Guadalupe	Alameda	Stanislaus	Apache	Mohave
Blount	Columbia	Atchison	Carroll	Macon	Debaca	Hall	Los Alamos	Calaveras	Trinity		
Campbell	Glascock	Bourbon	Cass	Mercer	Harding	Hansford	Mora	Contra Costa	Tuolumne		
Cocke	Jefferson	Doniphan	Cedar	Nodaway	Quay	Hartley	Rio Arriba	Humboldt		New Mexico	Nevada
Grainger	Jenkins	Douglas	Chariton	Pettis	Roosevelt	Hemphill	San Miguel	Lake		Bernalillo	Clark
Hamblen	Lincoln	Franklin	Clay	Platte	Union	Hutchinson	Santa Fe	Marin		Catron	Esmeralda
Hancock	McDuffie	Johnson	Clinton	Putnam		Lipscomb	Taos	Mariposa		Cibola	Lincoln
Jefferson	Richmond	Leavenworth	Davies	Ray		Moore		Mendocino		McKinley	Mineral
Knox	Warren	Linn	De Kalb	Saline	Texas	Ochiltree		Merced		Sandoval	Nye
Loudon	Wilkes	Miami	Gentry	Schuyler	Armstrong	Oldham		Monterey		Socorro	
Morgan		Wyandotte	Grundy	St. Clair	Bailey	Parmer		Napa		Torrance	
Roane			Harrison	Sullivan	Carson	Potter		San Benito		Valencia	Utah
Scott	South Carolina		Henry	Vernon	Castro	Randall		San Francisco			Beaver
Sevier	Aiken	Missouri	Holt	Worth	Childress	Roberts		San Joaquin			Garfield
Union	Allendale	Adair	Jackson		Collingsworth	Sherman		San Mateo			Iron
	Bamberg	Andrew	Johnson		Cottle	Wheeler		Santa Clara			Piute
	Barnwell	Bates	Knox		Dallam			Santa Cruz			Washington
	Edgefield	Benton	Lafayette		Deaf Smith			Solano			
		Buchanan	Linn		Donley			Sonoma			
DOC 1995a.											

D.2 Methodologies and Models

D.2.1 Employment and Population

The description of socioeconomic conditions includes indicators, such as population, civilian labor force, employment, unemployment rate, and income. These indicators provide a basis for comparing baseline projections of the affected regions to estimates of project-induced impacts. These baseline projections depict the No Action alternative. The baseline projections are derived from forecasts for the project period developed with data from BEA.

An analysis of the existing labor availability was performed to determine the number of workers that would be needed to come from outside the region. In addition to jobs created directly by the proposed project alternatives, other jobs and opportunities are created indirectly within the region. These indirect jobs and resulting income are measured by employing the most recent version of the Regional Input-Output Modeling System developed by BEA. For this analysis, direct effect multipliers were used to determine project-related additional indirect workers and earnings increases. Final demand multipliers were not used because there were not sufficient data on purchases. Population increases due to the in-migration of new workers and their families are estimated by the number of new workers and the national average household size because this new population would come from unknown places outside the region.

Total employment and local economic data for all the sites are given in tables D.2.1-1 through D.2.1-8. Population data for all the sites are given in tables D.2.1-9 through D.2.1-16.

Table D.2.1-1.-- Employment and Local Economy for the Oak Ridge Reservation Regional Economic Area, No Action Alternative, 1995-2030

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	486,400	513,600	535,800	555,300	594,000	601,300
Total employment	462,900	488,700	509,800	528,400	565,200	572,100

Unemployment rate (percentage)	4.9	4.9	4.9	4.9	4.9	4.9
Total personal income (thousand dollars)	16,498,303	18,391,177	20,017,623	21,498,098	24,601,119	25,206,968
Per capita income (dollars per person)	18,198	19,214	20,046	20,774	22,223	22,494
Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; OR LMES 1996i; ORR 1995a:1.						

Table D.2.1-2.-- Employment and Local Economy for the Savannah River Site Regional Economic Area, No Action Alternative, 1995-2030

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	261,400	278,100	292,300	306,100	335,600	338,500
Total employment	243,800	259,400	272,700	285,500	313,000	315,800
Unemployment rate (percentage)	6.7	6.7	6.7	6.7	6.7	6.7
Total personal income (thousand dollars)	10,608,794	12,013,250	13,269,987	14,550,516	17,487,856	17,798,751
Per capita income (dollars per person)	17,789	18,930	19,895	20,833	22,839	23,041

Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOE 1995p; DOL 1991a; DOL 1995a; SR DOE 1995b; SRS 1995a:1.

Table D.2.1-3.-- Employment and Local Economy for the Kansas City Plant Regional Economic Area, No Action Alternative, 1995-2030

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	1,215,800	1,255,900	1,296,200	1,338,900	1,428,200	1,444,000
Total employment	1,156,200	1,194,400	1,232,700	1,273,400	1,358,300	1,373,300
Unemployment rate (percentage)	4.9	4.9	4.9	4.9	4.9	4.9
Total personal income (thousand dollars)	46,020,762	49,151,226	52,309,800	55,815,538	63,506,729	64,919,757
Per capita income (dollars per person)	20,004	20,683	21,327	22,030	23,499	23,759
Census 1993a; Census 1993q; Census 1993t; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; KCP 1995a:1.						

Table D.2.1-4.-- Employment and Local Economy for the Pantex Plant Regional Economic Area, No Action Alternative, 1995-2030

Regional Economic Area	1995	2000	2005	2010	2020	2030

Civilian labor force	234,700	247,800	261,100	274,800	302,300	302,000
Total employment	223,300	235,800	248,400	261,500	287,700	287,400
Unemployment rate (percentage)	4.8	4.8	4.8	4.8	4.8	4.8
Total personal income (thousand dollars)	9,622,309	10,728,135	11,908,766	13,190,906	15,965,800	15,933,429
Per capita income (dollars per person)	19,987	21,104	22,235	23,401	25,745	25,719
Census 1993a; Census 1993m; Census 1993w; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; PX 1995a:2.						

Table D.2.1-5.-- Employment and Local Economy for the Los Alamos National Laboratory Regional Economic Area, No Action Alternative, 1995-2030

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	119,700	130,800	140,900	150,400	169,400	175,200
Total employment	112,300	122,700	132,200	141,100	158,900	164,400
Unemployment rate (percentage)	6.2	6.2	6.2	6.2	6.2	6.2

Total personal income (thousand dollars)	4,218,781	5,034,646	5,845,041	6,655,720	8,440,189	9,034,538
Per capita income (dollars per person)	18,314	20,007	21,557	23,003	25,904	26,801
Census 1993a; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; LANL 1995b:1.						

Table D.2.1-6.-- Employment and Local Economy for the Lawrence Livermore National Laboratory Regional Economic Area, No Action Alternative, 1995-2030

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	4,556,000	5,004,100	5,448,100	5,917,500	6,992,100	7,097,200
Total employment	4,208,100	4,621,900	5,032,000	5,465,600	6,458,200	6,555,300
Unemployment rate (percentage)	7.6	7.6	7.6	7.6	7.6	7.6
Total personal income (thousand dollars)	236,627,513	285,131,842	337,968,862	398,727,427	556,687,763	573,557,669
Per capita income (dollars per person)	26,716	29,310	31,910	34,660	40,954	41,570
Census 1993a; Census 1993x; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; LLNL 1995i:1.						

Table D.2.1-7.-- Employment and Local Economy for the Sandia National Laboratories Regional Economic Area, No Action Alternative, 1995-2030

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	408,300	446,100	480,600	512,900	577,500	597,500
Total employment	385,200	420,900	453,500	483,900	544,900	563,800
Unemployment rate (percentage)	5.7	5.7	5.7	5.7	5.7	5.7
Total personal income (thousand dollars)	14,923,362	17,809,373	20,676,034	23,543,700	29,856,016	31,958,442
Per capita income (dollars per person)	17,676	19,310	20,806	22,202	25,002	25,867
Census 1993a; Census 1993f; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; SNL 1995b:1.						

Table D.2.1-8.-- Employment and Local Economy for the Nevada Test Site Regional Economic Area, No Action Alternative, 1995-2030

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	648,600	747,100	814,100	861,900	959,500	993,200

Total employment	608,900	701,400	764,300	809,100	900,800	932,400
Unemployment rate (percentage)	6.1	6.1	6.1	6.1	6.1	6.1
Total personal income (thousand dollars)	27,397,938	36,357,995	43,164,854	48,380,917	59,961,996	64,253,190
Per capita income (dollars per person)	22,083	25,438	27,718	29,345	32,669	33,817
Census 1993a; Census 1993f; Census 1993y; Census 1993z; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; NTS 1995a:1.						

Table D.2.1-9.-- Population for the Oak Ridge Reservation Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Anderson County	73,300	77,400	80,800	83,700	89,500	90,600
Clinton	9,900	10,400	10,900	11,300	12,000	12,200
Oak Ridge	26,300	27,800	29,000	30,000	32,100	32,500
Knox County	361,400	381,500	398,100	412,500	441,300	446,700

Knoxville	173,900	183,600	191,600	198,500	212,400	215,000
Loudon County	34,600	36,500	38,100	39,500	42,200	42,700
Lenoir City	7,100	7,500	7,800	8,100	8,600	8,700
Roane County	50,000	52,800	55,100	57,100	61,100	61,800
Harriman	7,400	7,900	8,200	8,500	9,100	9,200
Kingston	4,800	5,100	5,300	5,500	5,900	6,000
Total ROI	519,300	548,200	572,100	592,800	634,100	641,800

City values are included in county totals.

Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.

Table D.2.1-10.--Population for the Savannah River Site Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Aiken County	135,300	144,000	151,300	158,500	173,700	175,300

Aiken	23,600	25,100	26,400	27,600	30,300	30,600
North Augusta	17,200	18,300	19,300	20,200	22,100	22,300
Barnwell County	22,200	23,600	24,800	26,000	28,500	28,700
Columbia County	76,800	81,800	85,900	90,000	98,600	99,500
Richmond County	213,000	226,700	238,300	249,500	273,400	275,900
Augusta	46,800	49,800	52,300	54,800	60,100	60,600
Total ROI	447,300	476,100	500,300	524,000	574,200	579,400

City values are included in county totals.

Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j.

Table D.2.1-11.--Population for the Kansas City Plant Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Cass County	68,700	70,900	73,200	75,600	80,700	81,600

Belton	19,800	20,400	21,100	21,800	23,200	23,500
Harrisonville	8,200	8,500	8,800	9,100	9,700	9,800
Jackson County	645,400	666,700	688,100	710,800	758,200	766,600
Kansas City	439,300	453,800	468,400	483,800	516,000	521,800
Lee's Summit	52,200	54,000	55,700	57,500	61,400	62,100
Johnson County	381,900	394,500	407,100	420,600	448,600	453,600
Overland Park	121,400	125,400	129,400	133,700	142,600	144,200
Wyandott County	161,600	166,900	172,200	177,900	189,800	191,900
Total ROI	1,257,600	1,299,000	1,340,600	1,384,900	1,477,300	1,493,700

City values are included in county totals.

Census 1993a; Census 1993q; Census 1993t; DOC 1990c; DOC 1990d; DOC 1994j.

Table D.2.1-12.-- Population for the Pantex Plant Region of Influence, No Action

Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Armstrong County	2,100	2,200	2,300	2,500	2,700	2,700
Carson County	6,800	7,200	7,600	8,000	8,800	8,800
Potter County	105,000	110,900	116,800	122,900	135,200	135,100
Amarillo	169,500	179,000	188,600	198,500	218,400	218,100
Randall County	96,700	102,100	107,600	113,200	124,500	124,400
Total ROI	210,600	222,400	234,300	246,600	271,200	271,000
Amarillo is divided across Potter and Randall Counties. The population shown for Amarillo is for the whole city. Potter and Randall County totals represent their share of Amarillo. Census 1993a; Census 1993w; DOC 1990c; DOC 1990d; DOC 1994j.						

Table D.2.1-13.--Population for the Los Alamos National Laboratory Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Los Alamos County	19,200	21,000	22,600	24,200	27,200	28,200

Rio Arriba County	36,900	40,300	43,500	46,400	52,200	54,000
Espanola	9,600	10,400	11,200	12,000	13,500	14,000
Santa Fe County	111,300	121,600	131,000	139,800	157,500	162,900
Santa Fe	62,500	68,200	73,500	78,400	88,300	91,400
Total ROI	167,400	182,900	197,100	210,400	236,900	245,100

City values are included in county totals.

Census 1993a; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j.

Table D.2.1-14.--Population for the Lawrence Livermore National Laboratory Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Alameda County	1,400,700	1,536,800	1,673,100	1,817,300	2,147,300	2,179,600
Livermore	64,300	70,600	76,800	83,500	98,600	100,100
Pleasanton	58,100	63,700	69,400	75,400	89,000	90,400

Contra Costa County	900,500	987,900	1,075,600	1,168,200	1,380,400	1,401,200
San Joaquin County	540,000	592,400	645,000	700,600	827,800	840,300
Manteca	45,500	49,900	54,300	59,000	69,700	70,800
Tracy	41,900	46,000	50,100	54,400	64,300	65,200
Total ROI	2,841,200	3,117,100	3,393,700	3,686,100	4,355,500	4,421,000

City values are included in county totals.

Census 1993a; Census 1993x; DOC 1990c; DOC 1990d; DOC 1994j.

Table D.2.1-15.--Population for the Sandia National Laboratories Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Bernalillo County	529,000	577,900	622,600	664,400	748,200	774,100
Albuquerque	422,200	461,200	497,000	530,300	597,200	617,800
Sandoval County	72,900	79,600	85,800	91,500	103,100	106,600

Valencia County	51,200	55,900	60,200	64,300	72,400	74,900
Total ROI	653,100	713,400	768,600	820,200	923,700	955,600

City values are included in county totals.

Census 1993a; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j.

Table D.2.1-16.--Population for the Nevada Test Site Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Clark County	941,100	1,084,100	1,181,200	1,250,500	1,392,900	1,441,100
Henderson	93,900	108,100	117,800	124,800	139,000	143,800
Las Vegas	328,900	378,800	412,800	437,000	486,800	503,600
North Las Vegas	61,800	71,200	77,600	82,200	91,500	94,700
Nye County	21,700	25,000	27,300	28,900	32,100	33,300
Total ROI	962,800	1,109,100	1,208,500	1,279,400	1,425,000	1,474,400

City values are included in county totals.

Census 1993a; Census 1993y; DOC 1990c; DOC 1990d; DOC 1994j.

D.2.2 Housing

No action housing characteristics are presented in tables D.2.2-1 through D.2.2-8. Projected housing needs are based upon housing unit and population data obtained from the 1990 Census of Population and Housing for each ROI. Future housing units needed for cities and counties in each ROI were developed by estimating the household size from the current population and housing unit ratios. The household size to population ratios were then applied to the estimated future population trends to obtain the number of housing units needed to accommodate the projected population for a No Action alternative future baseline.

Projected housing needs for the proposed alternatives were derived by a similar method, but a national average population-to-housing ratio was used. The additional housing needed for the estimated in-migrating workforce and their families are calculated after vacancy rates for the affected region are reduced to the lowest historical level. Past housing construction trends are also evaluated to assess potential impacts.

Table D.2.2-1.-- Owner and Renter Housing Units for the Oak Ridge Reservation Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Anderson County	30,500	32,200	33,600	34,900	37,300	37,700
Clinton	4,300	4,600	4,700	4,900	5,300	5,300
Oak Ridge	11,000	11,600	12,100	12,600	13,500	13,600
Knox County	150,400	158,800	165,600	171,700	183,600	185,900

Knoxville	78,000	82,400	86,000	89,100	95,300	96,500
Loudon County	13,900	14,600	15,300	15,800	16,900	17,100
Lenoir City	3,100	3,200	3,400	3,500	3,700	3,800
Roane County	20,300	21,400	22,300	23,100	24,700	25,000
Harriman	3,200	3,400	3,500	3,700	3,900	4,000
Kingston	2,100	2,300	2,400	2,500	2,600	2,700
Total ROI	215,100	227,000	236,800	245,500	262,500	265,700
City values are included in county totals. Census 1991c; appendix table D.2.1-9.						

Table D.2.2-2.--Owner and Renter Housing Units for the Savannah River Site Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030

Aiken County	52,600	56,000	58,800	61,600	67,500	68,100
Aiken	9,800	10,400	10,900	11,400	12,500	12,600
North Augusta	7,500	8,000	8,400	8,800	9,600	9,700
Barnwell County	8,100	8,600	9,000	9,500	10,400	10,500
Columbia County	26,400	28,000	29,500	30,900	33,800	34,100
Richmond County	81,800	87,000	91,500	95,800	105,000	105,900
Augusta	21,100	22,400	23,600	24,700	27,000	27,300
Total ROI	168,900	179,600	188,800	197,800	216,700	218,600

City values are included in county totals.

Census 1991a; Census 1991b; appendix table D.2.1-10.

Table D.2.2-3.-- Owner and Renter Housing Units for the Kansas City Plant Region of Influence, No Action Alternative, 1995-2030

County/City	**1995**	**2000**	**2005**	**2010**	**2020**	**2030**
Cass County	25,500	26,400	27,200	28,100	30,000	30,300
Belton	7,300	7,500	7,800	8,000	8,500	8,600
Harrisonville	4,200	4,300	4,400	4,600	4,900	4,900
Jackson County	276,300	285,500	294,600	304,300	324,600	328,200
Kansas City	195,600	202,000	208,500	215,400	229,700	232,300
Lee's Summit	38,200	39,400	40,700	42,000	44,800	45,300
Johnson County	153,100	158,100	163,200	168,600	179,800	181,800
Overland Park	51,400	53,100	54,800	56,600	60,300	61,000
Wyandotte County	66,800	69,000	71,200	73,600	78,500	79,400
Total ROI	521,700	539,000	556,200	574,600	612,900	619,700

City values are included in county totals.

Census 1991f; Census 1991ff; appendix table D.2.1-11.

Table D.2.2-4.-- Owner and Renter Housing Units for the Pantex Plant Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Armstrong County	800	900	900	1,000	1,100	1,100
Carson County	2,700	2,800	3,000	3,200	3,500	3,500
Potter County	44,000	46,400	48,900	51,500	56,600	56,600
Amarillo	71,300	75,200	79,300	83,400	91,800	91,700
Randall County	39,600	41,800	44,000	46,300	51,000	50,900
Total ROI	87,100	91,900	96,800	102,000	112,200	112,100

Amarillo is divided across Potter and Randall Counties. The number of housing units shown for Amarillo is for the whole city. Potter and Randall County totals represent their share of Amarillo.

Census 1991m; appendix table D.2.1-12.

Table D.2.2-5.-- Owner and Renter Housing Units for the Los

Alamos National Laboratory Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Los Alamos County	8,000	8,800	9,500	10,100	11,400	11,800
Rio Arriba County	15,400	16,900	18,200	19,400	21,800	22,600
Espanola	1,000	1,100	1,200	1,300	1,500	1,500
Santa Fe County	46,700	51,000	54,900	58,600	66,000	68,300
Santa Fe	27,600	30,100	32,500	34,700	39,000	40,400
Total ROI	70,100	76,700	82,600	88,100	99,200	102,700

City values are included in county totals.

Census 1991h; appendix table D.2.1-13.

Table D.2.2-6.-- Owner and Renter Housing Units for the Lawrence Livermore National Laboratory Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030

Alameda County	543,300	596,100	649,000	704,900	832,900	845,400
Livermore	24,200	26,500	28,900	31,400	37,100	37,600
Pleasanton	22,100	24,200	26,400	28,700	33,900	34,400
Contra Costa County	347,800	381,600	415,500	451,300	533,200	541,200
San Joaquin County	183,100	200,900	218,700	237,600	280,700	284,900
Manteca	10,400	11,400	12,400	13,500	16,000	16,200
Tracy	14,900	16,300	17,800	19,300	22,800	23,200
Total ROI	1,074,200	1,178,600	1,283,200	1,393,800	1,646,800	1,671,500

City values are included in county totals.

Census 1991j; appendix table D.2.1-14.

Table D.2.2-7.-- Owner and Renter Housing Units for the Sandia

National Laboratories Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Bernalillo County	221,500	242,000	260,700	278,200	313,300	324,100
Albuquerque	183,100	200,000	215,500	230,000	259,000	268,000
Sandoval County	27,200	29,800	32,100	34,200	38,500	39,900
Valencia County	19,000	20,700	22,300	23,800	26,900	27,800
Total ROI	267,700	292,500	315,100	336,200	378,700	391,800
City values are included in county totals. Census 1991h; appendix table D.2.1-15.						

Table D.2.2-8.-- Owner and Renter Housing Units for the Nevada Test Site Region of Influence, No Action Alternative, 1995-2030

County/City	1995	2000	2005	2010	2020	2030
Clark County	383,700	442,000	481,600	509,800	567,900	587,500

Henderson	35,700	41,100	44,800	47,500	52,900	54,700
Las Vegas	136,400	157,100	171,200	181,200	201,800	208,800
North Las Vegas	19,900	22,900	25,000	26,400	29,400	30,500
Nye County	8,600	9,900	10,800	11,400	12,800	13,200
Total ROI	392,300	451,900	492,400	521,200	580,700	600,700

City values are included in county totals.

Census 1991g; appendix table D.2.1-16.

D.2.3 Public Finance

Finances of ROI local jurisdictions were evaluated based on changes in historic revenue and expenditure levels, changes in fund balances, and reserve bonding capabilities. These historic fiscal characteristics were obtained from financial audits and budgets supplied by each jurisdiction. The analysis concentrated on each jurisdiction's governmental funds (general funds, special revenue funds, and, as applicable, capital projects, debt service, and expendable trust funds). Other funds, such as enterprise funds, which are funded principally through user charges without contributing to the general tax burden of area residents, were not included in the analysis. The analysis of local jurisdictions' public finances focused upon revenues and expenditures because no assumptions could be made for some projected fund balances (such as capital expenditures) so far into the future.

The following parameters were used to project changes in total revenues and expenditures: gains (or losses) of jobs in the region; population increases (or decreases) in each jurisdiction, including school districts; earnings and income gains (or losses); and potential changes in each jurisdiction's property tax base. Public finance and No Action characteristics are presented in tables D.2.3-1 through D.2.3-15.

Table D.2.3-1.-- County and City Revenues and Expenditures for the Oak Ridge Reservation Region of Influence, 1994

Revenues and Expenditures	Anderson County	Clinton	Oak Ridge	Knox County	Knoxville	Loudon County	Lenoir City	Roane County	Harriman	Kingston
Property tax (percent)	40	62	22	54	73	37	30	40	32	60
State shared and intergovernmental (percent)	48	27	69	36	20	52	61	49	49	30
Permits, fees, fines, and investment interest (percent)	12	2	5	2	5	8	6	9	4	3
Other (percent)	0	9	4	8	2	3	3	2	15	7
Total Revenues (dollars)	50,802,902	5,320,132	41,367,745	358,355,159	118,642,146	25,630,923	10,820,645	35,658,903	13,700,152	1,978,190
General government (percent)	23	26	2	23	6	20	8	15	6	36
Public safety, health, and community services (percent)	0	19	11	0	39	0	9	0	13	62
Public works, parks, culture, and recreation (percent)	5	26	14	2	30	8	10	5	11	0
Debt services (percent)	0	15	5	6	16	11	5	6	12	2
Education (percent)	51	0	62	60	5	57	67	59	54	0
Capital outlay (percent)	21	14	6	9	4	4	1	15	4	0
Other (percent)	0	0	0	0	0	0	0	0	0	0
Total Expenditures (dollars)	58,487,767	5,768,608	45,633,111	374,478,124	103,877,538	27,201,056	10,581,424	41,289,602	13,236,429	1,784,915

End-of-Year Fund Balance (dollars)	16,460,005	4,015,490	18,299,359	50,735,073	32,350,878	4,533,445	2,122,270	7,560,278	1,758,760	511,138

Financial information for ORR school districts is included in county and city financial audits.
OR City 1995b; OR County 1995a.

Table D.2.3-2.-- County and City Revenues and Expenditures for the Savannah River Site Region of Influence, 1994

Revenues and Expenditures	Aiken County, SC	Aiken	North Augusta	Barnwell County, SC	Columbia County, GA	Richmond County, GA	Augusta
Property tax (percent)	53	40	45	24	70	79	59
State shared and intergovernmental (percent)	31	7	10	74	4	0	20
Permits, fees, fines, and investment interest (percent)	7	49	41	0	12	14	9
Other (percent)	9	4	4	2	14	7	12
Total Revenues (dollars)	35,159,759	14,240,252	6,615,993	7,429,225	32,547,657	87,277,685	33,975,011
General government (percent)	10	7	17	40	9	11	20
Public safety, health, and community services (percent)	34	28	38	34	36	44	28
Public works, parks, culture, and recreation (percent)	20	27	32	20	22	18	18
Debt services (percent)	11	2	5	0	2	10	7
Education (percent)	5	0	0	0	0	0	0
Capital outlay (percent)	14	20	8	0	21	17	19

Other (percent)	6	16	0	6	10	0	8
Total Expenditures (dollars)	35,790,029	14,322,339	6,810,049	5,146,577	34,607,926	81,414,049	48,712,791
End-of-Year Fund Balance (dollars)	16,594,477	11,204,482	2,609,106	8,274,191	11,649,564	77,244,431	11,725,730
SR City 1995a; SR County 1995a.							

Table D.2.3-3.-- School District Revenues and Expenditures for the Savannah River Site Region of Influence, 1994

Revenues and Expenditures	Aiken County, SC	Barnwell County #19, SC	Barnwell County #29, SC	Barnwell County #45, SC	Columbia County, GA	Richmond County, GA
Local sources (percent)	39	21	34	33	36	35
State sources (percent)	55	69	58	58	60	54
Federal sources (percent)	6	10	8	9	4	11
Other (percent)	0	0	0	0	0	0
Total Revenues (dollars)	101,336,443	5,453,008	4,627,943	11,409,161	67,786,080	162,652,868
Total instruction (percent)	52	57	39	60	57	59
Support services (percent)	27	39	24	28	26	30
Food, community, and other services (percent)	2	2	1	1	6	7
Capital assets (percent)	10	0	32	0	5	1

Debt services (percent)	9	2	4	11	6	3
Total Expenditures (dollars)	113,866,054	5,413,238	6,981,754	11,343,781	70,300,960	157,087,533
End-of-Year Fund Balance (dollars)	15,139,008	764,024	671,935	1,866,666	33,103,796	33,919,859
SR School 1995b.						

Table D.2.3-4.-- County and City Revenues and Expenditures for the Kansas City Plant Region of Influence, 1994

Revenues and Expenditures	Cass County	Belton	Harrisonville	Jackson County	Kansas City	Lee's Summit	Johnson County	Overland Park	Wyandotte County
Property tax (percent)	NA	63	63	74	56	67	54	67	NA
State shared and intergovernmental (percent)	NA	8	1	10	9	18	19	14	NA
Permits, fees, fines, and investment interest (percent)	NA	10	31	13	28	11	19	13	NA
Other (percent)	NA	19	5	3	7	4	8	6	NA
Total Revenues (dollars)	NA	7,081,222	4,070,287	109,755,131	480,601,000	25,369,494	162,258,423	77,024,187	NA
General government (percent)	NA	11	17	54	6	9	19	10	NA
Public safety, health, and community services (percent)	NA	44	51	29	24	41	39	24	NA
Public works, parks, culture, and recreation (percent)	NA	22	28	15	33	22	16	29	NA
Debt services (percent)	NA	15	2	2	11	12	8	11	NA
Capital outlay (percent)	NA	8	0	0	11	16	18	26	NA
Other (percent)	NA	0	2	0	15	0	0	0	NA
Total Expenditures (dollars)	NA	6,498,171	3,385,267	109,901,97	459,477,00	23,522,269	157,076,221	80,500,054	NA
End-of-Year Fund Balance (dollars)	NA	3,637,533	4,301,121	60,948,809	276,086,000	20,044,897	77,735,985	60,793,238	NA

NA - not available.
KC City 1995a; KC County 1995a.

Table D.2.3-5.-- School District Revenues and Expenditures for the Kansas City Plant Region of Influence, 1994

Revenues and Expenditures	Belton	Center	Harrisonville	Hickman Hills	Kansas City	Lee's Summit	Unified School District #229
Local sources (percent)	49	81	55	59	40	NA	65
State sources (percent)	45	15	36	36	53	NA	28
Federal sources (percent)	6	4	5	4	7	NA	1
Other (percent)	0	0	4	1	0	NA	6
Total Revenues (dollars)	18,578,226	16,923,736	11,735,893	38,744,073	371,171,282	NA	80,571,877
Total instruction (percent)	59	57	53	62	41	NA	50
Support services (percent)	26	37	32	25	35	NA	24
Food, community, and other services (percent)	10	1	5	9	11	NA	4
Capital assets (percent)	0	4	2	1	7	NA	9
Debt services (percent)	5	1	8	3	6	NA	13
Total Expenditures (dollars)	17,802,120	17,134,971	11,425,842	40,641,975	368,956,267	NA	80,034,572
End-of-Year Fund Balance (dollars)	5,261,823	6,094,505	3,268,301	9,066,453	217,966,000	NA	67,979,753

NA - not available.

KC School 1995a.

Table D.2.3-6.-- County and City Revenues and Expenditures for the Pantex Plant Region of Influence, 1994

Revenues and Expenditures	Armstrong County	Carson County	Potter County	Amarillo	Randall County
Property tax (percent)	34	65	66	59	55
State shared and intergovernmental (percent)	17	2	9	11	13
Permits, fees, fines, and investment interest (percent)	46	26	20	18	30
Other (percent)	3	7	5	12	2
Total Revenues (dollars)	749,995	1,829,229	21,516,628	76,603,713	13,065,681
General government (percent)	31	46	15	7	18
Public safety, health, and community services (percent)	32	35	57	38	59
Public works, parks, culture, and recreation (percent)	30	5	11	45	4
Debt services (percent)	4	0	7	2	4
Capital outlay (percent)	3	9	5	8	5
Other (percent)	0	5	5	0	10
Total Expenditures (dollars)	746,983	2,585,350	19,633,506	69,837,313	11,968,123

End-of-Year Fund Balance (dollars)	593,463	18,239	20,960,491	52,263,778	5,011,059
PX City 1995a; PX County 1995a.					

Table D.2.3-7.-- School District Revenues and Expenditures for the Pantex Plant Region of Influence, 1994

Revenues and Expenditures	Amarillo	Canyon	Claude	Groom	Highland Park	Panhandle	White Deer
Local sources (percent)	43	48	42	55	89	82	92
State sources (percent)	49	47	54	40	6	14	4
Federal sources (percent)	8	5	4	5	5	4	4
Other (percent)	0	0	0	0	0	0	0
Total Revenues (dollars)	129,782,359	27,248,718	2,196,573	1341,890	3,932,722	4,388,125	2,684,692
Total instruction (percent)	58	49	56	55	55	58	57
Support services (percent)	26	20	30	26	26	31	35
Food, community, and other services (percent)	6	6	10	18	17	7	8
Capital assets (percent)	4	16	3	1	0	0	0
Debt (percent)	6	9	1	0	2	4	0
Total Expenditures (dollars)	128,143,906	31,082,492	2,128,995	1,334,653	3,952,534	4,091,362	2,763,782

End-of-Year Fund Balance (dollars)	31,696,194	11,461,816	688,758	635,061	887,714	1,853,969	745,117
1993 and 1994 financial audit data is not available for Groom and Highland Park School District. Data presented is for 1992. **PX School 1995b.**							

Table D.2.3-8.-- County and City Revenues and Expenditures for the Los Alamos National Laboratory Region of Influence, 1994

Revenues and Expenditures	Los Alamos County	Rio Arriba County	Espanola	Santa Fe County	Santa Fe
Property tax (percent)	32	74	11	72	83
State shared and intergovernmental (percent)	61	20	89	12	8
Permits, fees, fines, and investment interest (percent)	1	2	0	6	3
Other (percent)	6	4	0	10	6
Total Revenues (dollars)	29,717,452	10,662,842	6,679,263	29,528,335	65,044,193
General government (percent)	16	36	24	25	18
Public safety, health, and community services (percent)	38	36	37	45	30
Public works, parks, culture, and recreation (percent)	23	23	20	20	16
Debt services (percent)	3	4	12	1	11
Education (percent)	0	0	0	0	3
Capital outlay (percent)	20	1	7	8	22

Other (percent)	0	0	0	1	0
Total Expenditures (dollars)	30,986,489	9,280,844	7,015,513	27,221,324	62,458,448
End-of-Year Fund Balance (dollars)	27,443,804	5,570,366	2,851,826	17,676,743	61,911,387
LA City 1995a; LA County 1995a.					

Table D.2.3-9.-- School District Revenues and Expenditures for the Los Alamos National Laboratory Region of Influence, 1994

Revenues and Expenditures	Chama Valley	Dulce	Espanola	Jemez Mountain	Los Alamos	Pojaque Valley	Santa Fe
Local sources (percent)	12	31	6	38	6	8	21
State sources (percent)	77	40	70	50	52	69	71
Federal sources (percent)	10	28	22	11	34	13	6
Other (percent)	1	1	2	1	8	10	2
Total Revenues (dollars)	3,851,965	5,418,941	25,907,153	5,250,028	23,091,825	11,605,168	59,555,031
Total instruction (percent)	43	45	62	35	53	37	41
Support services (percent)	37	36	29	30	39	28	23
Food, community, and other services (percent)	12	5	1	15	6	11	7
Capital assets (percent)	3	6	4	0	2	19	18

Debt services (percent)	5	8	4	20	0	5	11
Total Expenditures (dollars)	3,886,197	4,535,793	25,790,674	4,034,170	21,561,064	10,673,138	66,958,009
End-of-Year Fund Balance (dollars)	824,466	1,960,709	2,729,798	2,061,502	4,511,190	1,958,054	10,345,713
LA School 1995b.							

Table D.2.3-10.-- County and City Revenues and Expenditures for the Lawrence Livermore National Laboratory Region of Influence, 1994

Revenues and Expenditures	Alameda County	Livermore	Pleasanton	Contra Costa County	San Joaquin County	Manteca	Tracy
Property tax (percent)	27	52	59	22	15	51	32
State shared and intergovernmental (percent)	54	12	0	57	67	24	16
Permits, fees, fines, and investment interest (percent)	14	17	5	16	16	20	36
Other (percent)	5	19	36	5	2	5	16
Total Revenues (dollars)	1,111,718,000	39,977,156	44,664,303	792,483,000	505,566,121	17,848,109	32,989,112
General government (percent)	6	7	15	9	10	12	7
Public safety, health, and community services (percent)	90	26	32	65	66	44	22
Public works, parks, culture, and recreation (percent)	2	9	23	20	19	25	28
Debt services (percent)	1	10	8	3	4	9	3

Capital outlay (percent)	1	35	21	2	1	2	40
Other (percent)	0	13	1	1	0	8	0
Total Expenditures (dollars)	1,150,106,000	58,087,750	45,191,452	777,803,000	522,340,513	16,405,126	33,796,549
End-of-Year Fund Balance (dollars)	362,808,000	34,291,803	38,104,992	161,995,000	106,530,027	16,254,955	52,444,145
1993 and 1994 financial audit data are not available for Alameda County. Data presented is for 1992. LL City 1995a; LL County 1995a.							

Table D.2.3-11.-- School District Revenues and Expenditures for the Lawrence Livermore National Laboratory Region of Influence, 1994

Revenues and Expenditures	Livermore	Manteca	Pleasanton	Tracy
Local sources (percent)	25	NA	43	54
State sources (percent)	18	NA	2	3
Federal sources (percent)	4	NA	16	21
Other (percent)	53	NA	39	22
Total Revenues (dollars)	45,153,012	NA	41,647,514	10,492,709
Total instruction (percent)	61	NA	64	67
Support services (percent)	10	NA	9	10
Food, community, and other services (percent)	15	NA	6	6

Capital assets (percent)	12	NA	13	14
Debt services (percent)	2	NA	8	3
Total Expenditures (dollars)	61,710,651	NA	62,763,588	17,080,415
End-of-Year Fund Balance (dollars)	20,793,153	NA	47,224,057	2,989,001

NA - not available.
LL School 1995b.

Table D.2.3-12.-- County and City Revenues and Expenditures for the Sandia National Laboratories Region of Influence, 1994

Revenues and Expenditures	Bernalillo County	Albuquerque	Sandoval County	Valencia County
Property tax (percent)	55	39	28	53
State shared and intergovernmental (percent)	34	42	40	22
Permits, fees, fines, and investment interest (percent)	5	12	23	8
Other (percent)	6	7	9	17
Total Revenues (dollars)	93,822,427	385,722,000	16,098,094	8,637,085
General government (percent)	33	10	21	47
Public safety, health, and community services (percent)	31	38	51	39
Public works, parks, culture, and recreation (percent)	11	18	21	14

Debt services (percent)	9	15	3	0
Education (percent)	0	0	0	0
Capital outlay (percent)	16	19	4	0
Other (percent)	0	0	0	0
Total Expenditures (dollars)	104,033,393	402,203,000	15,833,145	7,891,026
End-of-Year Fund Balance (dollars)	100,227,840	165,534,000	8,984,259	3,858,325
SN City 1995a; SN County 1995a.				

Table D.2.3-13.-- School District Revenues and Expenditures for the Sandia National Laboratories Region of Influence, 1994

Revenues and Expenditures	Albuquerque	Belen	Bernalillo	Cuba	Jemez Valley	Los Lunas
Local sources (percent)	15	12	9	7	10	9
State sources (percent)	77	78	68	68	84	82
Federal sources (percent)	8	10	22	23	6	9
Other (percent)	0	0	1	2	0	0
Total Revenues (dollars)	440,575,033	20,666,616	18,255,208	5,607,902	15,271,490	29,715,373
Total instruction (percent)	70	60	44	35	27	55

Support services (percent)	11	19	30	39	18	15
Food, community, and other services (percent)	7	11	9	17	7	10
Capital assets (percent)	9	4	12	6	10	15
Debt services (percent)	3	6	5	3	38	5
Total Expenditures (dollars)	431,378,717	21,036,713	19,110,291	5,585,793	15,989,616	30,399,901
End-of-Year Fund Balance (dollars)	65,734,673	6,535,537	1,507,421	350,155	727,740	6,925,651
SN School 1995b.						

Table D.2.3-14.-- County and City Revenues and Expenditures for the Nevada Test Site Region of Influence, 1994

Revenues and Expenditures	**Clark County**	**Henderson**	**Las Vegas**	**North Las Vegas**	**Nye County**
Property tax (percent)	20	16	16	15	28
State shared and intergovernmental (percent)	42	47	54	54	54
Permits, fees, fines, and investment interest (percent)	30	12	19	25	8
Other (percent)	8	25	11	6	10
Total Revenues (dollars)	728,952,912	70,207,217	254,132,758	52,451,349	26,331,990
General government (percent)	19	11	16	11	29

Public safety, health, and community services (percent)	39	25	40	52	37
Public works, parks, culture, and recreation (percent)	8	10	16	15	18
Debt services (percent)	8	13	4	5	0
Capital outlay (percent)	22	41	24	17	16
Other (percent)	4	0	0	0	0
Total Expenditures (dollars)	768,785,508	90,878,941	257,883,768	54,111,779	26,150,708
End-of-Year Fund Balance (dollars)	809,371,503	131,125,991	165,467,135	13,390,894	16,984,705

1994 financial audit for Clark County was not available. Data presented are for 1993.
NT City 1995a; NT County 1995b.

Table D.2.3-15.-- School District Revenues and Expenditures for the Nevada Test Site Region of Influence, 1994

Revenues and Expenditures	**Clark County**	**Nye County**
Local sources (percent)	65	53
State sources (percent)	32	44
Federal sources (percent)	3	3
Other (percent)	0	0
Total Revenues (dollars)	716,416,150	24,079,470

Total instruction (percent)	54	48
Support services (percent)	28	21
Food, community, and other services (percent)	0	6
Capital assets (percent)	11	9
Debt services (percent)	7	16
Total Expenditures (dollars)	776,079,680	25,176,765
End-of-Year Fund Balance (dollars)	82,578,235	5,060,909
NT School 1995b.		

D.2.4 Environmental Justice in Minority and Low-Income Populations

DOE is committed, and required by law, to incorporate environmental justice principles into its operations. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations* , requires Federal agencies to identify and address appropriately disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. DOE is in the process of finalizing its Environmental Justice Strategy and issued its first document in April 1995, which provides a structured framework. This strategy will be finalized once stakeholders' comments, concerns, and opinions are received, reviewed, and incorporated as appropriate. Because DOE is still in the process of developing guidance, the approach taken in this analysis may depart somewhat from the guidance that is eventually issued.

Any disproportionately high and adverse human health effects on minority populations and low-income populations that could result from the alternatives being considered are assessed for an 80 km (50 mi) area surrounding each site. The shaded areas in figures D.2.4-1 through D.2.4-8 show Census tracts where racial or ethnic minorities comprise 50 percent or more (simple majority) of the total population, and where racial or ethnic minorities comprise less than 50 but greater than 25 percent of the total population in the Census tract.
[figure D.2.4-2]
[figure D.2.4-3]
[figure D.2.4-4]
[figure D.2.4-5]
[figure D.2.4-6, page 1 of 5]
[figure D.2.4-6, page 2 of 5]
[figure D.2.4-6, page 3 of 5]
[figure D.2.4-6, page 4 of 5]
[figure D.2.4-6, page 5 of 5]
[figure D.2.4-7]
Figures D.2.4-9 through D.2.4-16 show low income communities generally defined as those where 25 percent or more of the population is characterized as living in poverty (income of less than $8,076 for a family of two).
[figure D.2.4-10]
[figure D.2.4-11]
[figure D.2.4-12]
[figure D.2.4-13]
[figure D.2.4-14, page 1 of 5]
[figure D.2.4-14, page 2 of 5]
[figure D.2.4-14, page 3 of 5]
[figure D.2.4-14, page 4 of 5]
[figure D.2.4-14, page 5 of 5]

[figure D.2.4-15] Socioeconomic impacts are assessed for the ROI of each site, since the impacts result from economic linkages rather than geographic proximity. Selected demographic characteristics of the ROI for each of the seven candidates sites are presented in tables D.2.4-1 through D.2.4-8. An assessment of any potential disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the alternatives being considered is presented in chapter 4.

Table D.2.4-1.-- Selected Demographic Characteristics for the Oak Ridge Reservation Region of Influence

					Total Region of Influence	
Characteristic/ Area	**Anderson County (number)**	**Knox County (number)**	**Loudon County (number)**	**Roane County (number)**	**(number)**	**(percent)**
Persons by Race/ Ethnicity						
Non-Hispanic, White	64,320	300,040	30,668	45,274	440,302	91.3
Hispanic	381	2,067	83	212	2,743	0.6
Non-Hispanic, American Indian	236	775	52	95	1,158	0.2
Non-Hispanic, Black	2,753	29,483	400	1,456	34,092	7.1
Non-Hispanic, Asian/Pacific Islander	537	3,263	49	186	4,035	0.8

Non-Hispanic, Other	23	121	3	4	151	0.0
Total 1990 Population	68,250	335,749	31,255	47,227	482,481	
Total Number of Households	27,384	133,639	12,155	18,453	191,631	
1989 Low Income						
Persons Below Poverty						
Number	9,664	45,608	4,192	7,467	66,931	
Percent1	14.3	14.1	13.6	16.0	14.3	

Table D.2.4-2.-- Selected Demographic Characteristics for the Savannah River Site Region of Influence

	South Carolina		**Georgia**		**Total Region of Influence**	
Characteristic/ Area	**Aiken County (number)**	**Barnwell County (number)**	**Columbia County (number)**	**Richmond County (number)**	**(number)**	**(percent)**
Persons by Race/ Ethnicity						

Non-Hispanic, White	90,130	11,421	56,141	103,009	270,727	63.6
Hispanic	867	146	962	3,707	5,918	1.4
Non-Hispanic, American Indian	213	31	150	491	918	0.2
Non-Hispanic, Black	29,176	8,677	7,239	79,221	142,608	33.5
Non-Hispanic, Asian/Pacific Islander	528	17	1,518	3,186	5,276	1.2
Non-Hispanic, Other	26	1	21	105	160	0.0
Total 1990 Population	120,940	20,293	66,031	189,719	425,607	99.9
Total Number of Households	44,883	7,100	21,841	68,675	151,877	
1989 Low Income						
Persons Below Poverty						
Number	16,671	4,367	4,255	32,590	66,267	

Percent[1]	14.0	21.8	6.6	18.2	17.3	

Table D.2.4-3.--Selected Demographic Characteristics for the Kansas City Plant Region of Influence

	Missouri		**Kansas**		**Total Region of Influence**	
Characteristic/ Area	**Cass County (number)**	**Jackson County (number)**	**Johnson County (number)**	**Wyandotte County (number)**	**(number)**	**(percent)**
Persons by Race/ Ethnicity						
Non-Hispanic, White	61,689	470,011	334,167	103,955	969,822	79.9
Hispanic	829	18,890	7,005	10,997	37,721	3.1
Non-Hispanic, American Indian	355	2,825	160	966	4,306	0.4
Non-Hispanic, Black	672	134,828	6,809	44,131	186,440	15.4
Non-Hispanic, Asian/Pacific Islander	251	6,145	5,739	787	12,922	1.1

Non-Hispanic, Other	12	533	174	157	876	0.1
Total 1990 Population	63,808	633,232	355,054	161,993	1,214,087	100
Total Number of Households	22,892	252,852	136,433	61,514	473,691	
1989 Low Income						
Persons Below Poverty						
Number	5,164	81,142	12,667	27,371	126,344	
Percent[1]	8.2	13.0	3.6	17.1	10.5	

Table D.2.4-4.-- Selected Demographic Characteristics for the Pantex Plant Region of Influence

					Total Region of Influence	
Characteristic/ Area	**Armstrong County (number)**	**Carson County (number)**	**Potter County (number)**	**Randall County (number)**	**(number)**	**(percent)**
Persons by Race/ Ethnicity						

Non-Hispanic, White	1,951	6,158	66,877	81,364	156,350	79.7
Hispanic	55	354	19,246	6,144	25,799	13.1
Non-Hispanic, American Indian	9	41	709	414	1,173	0.6
Non-Hispanic, Black	0	11	8,460	1,082	9,553	4.9
Non-Hispanic, Asian/Pacific Islander	5	9	2,431	626	3,071	1.6
Non-Hispanic, Other	1	3	151	43	198	0.1
Total 1990 Population	2,021	6,576	97,874	89,673	196,144	100.0
Total Number of Households	768	2,402	37,344	34,553	75,067	
1989 Low Income						
Persons Below Poverty						
Number	232	583	21,619	7,819	30,253	

Percent[1]	11.8	9.0	22.5	8.9	15.7	

Table D.2.4-5.-- Selected Demographic Characteristics for the Los Alamos National Laboratory Region of Influence

				Total Region of Influence	
Characteristic/ Area	**Los Alamos County (number)**	**Rio Arriba County (number)**	**Santa Fe County (number)**	**(number)**	**(percent)**
Persons by Race/ Ethnicity					
Non-Hispanic, White	15,467	4,375	46,450	66,292	43.8
Hispanic	2,008	24,955	48,939	75,902	50.1
Non-Hispanic, American Indian	112	4,830	2,284	7,226	4.8
Non-Hispanic, Black	88	117	505	710	0.5
Non-Hispanic, Asian/ Pacific Islander	421	40	439	900	0.6

Non-Hispanic, Other	19	48	311	378	0.2
Total 1990 Population	18,115	34,365	98,928	151,408	100
Total Number of Households	7,213	11,461	37,840	56,514	
1989 Low Income					
Persons Below Poverty					
Number	433	9,372	12,564	22,369	
Percent[1]	2.4	27.5	13	15.0	

Table D.2.4-6.-- Selected Demographic Characteristics for the Lawrence Livermore National Laboratory Region of Influence

				Total Region of Influence	
Characteristic/Area	**Alameda County (number)**	**Contra Costa County (number)**	**San Joaquin County (number)**	**(number)**	**(percent)**
Persons by Race/ Ethnicity					

Non-Hispanic, White	680,017	560,146	282,766	1,522,929	59.4
Hispanic	181,805	91,282	112,673	385,760	15
Non-Hispanic, American Indian	6,763	4,441	3,807	15,011	0.6
Non-Hispanic, Black	222,873	72,799	24,791	320,463	12.5
Non-Hispanic, Asian/ Pacific Islander	184,813	73,810	55,774	314,397	12.3
Non-Hispanic, Other	2,911	1,254	817	4,982	0.2
Total 1990 Population	1,279,182	803,732	480,628	2,563,542	100
Total Number of Households	479,518	300,288	158,156	937,962	
1989 Low Income					
Persons Below Poverty					
Number	132,011	57,867	73,163	263,041	

Percent[1]	10.6	7.3	15.7	10.5	

Table D.2.4-7.--Selected Demographic Characteristics for the Sandia National Laboratories Region of Influence

				Total Region of Influence	
Characteristic/ Area	**Bernalillo County (number)**	**Sandoval County (number)**	**Valencia County (number)**	**(number)**	**(percent)**
Persons by Race/ Ethnicity					
Non-Hispanic, White	267,965	32,390	20,659	321,014	54.5
Hispanic	178,310	17,372	22,733	218,415	37.1
Non-Hispanic, American Indian	14,191	12,176	1,169	27,536	4.7
Non-Hispanic, Black	11,862	844	448	13,154	2.2
Non-Hispanic, Asian/ Pacific Islander	6,692	455	139	7,286	1.2

Non-Hispanic, Other	1,557	82	87	1,726	0.3
Total 1990 Population	480,577	63,319	45,235	589,131	100
Total Number of Households	185,582	20,867	15,170	221,619	
1989 Low Income					
Persons Below Poverty					
Number	68,845	9,852	8,288	86,985	
Percent[1]	14.6	15.6	19	15.0	

Table D.2.4-8.--Selected Demographic Characteristics for the Nevada Test Site Region of Influence

			Total Region of Influence	
Characteristic/Area	**Clark County** **(number)**	**Nye County** **(number)**	**(number)**	**(percent)**
Persons by Race/Ethnicity				

Non-Hispanic, White	558,875	15,635	574,510	75.7
Hispanic	82,904	1,237	84,141	11.1
Non-Hispanic, American Indian	5,514	475	5,989	0.8
Non-Hispanic, Black	68,858	274	69,132	9.1
Non-Hispanic, Asian/Pacific Islander	24,483	148	24,631	3.2
Non-Hispanic, Other	825	12	837	0.1
Total 1990 Population	741,459	17,781	759,240	100.0
Total Number of Households	287,025	6,664	293,689	
1989 Low Income				
Persons Below Poverty				
Number	76,737	1,840	78,577	

Percent[1]	10.5	10.5	10.5	

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[1] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Census 1993s; Census 1994o.

APPENDIX E: HUMAN HEALTH

E.1 Introduction

Supplemental information is presented in this appendix on the potential impacts to humans from the normal operational releases of radioactivity and hazardous chemicals from the Stockpile Stewardship and Management Program facilities. This information is intended to support assessments of normal operation for the management and stewardship facilities described in sections 4.2.3.9, 4.3.3.9, 4.4.3.9, 4.5.3.9, 4.6.3.9, 4.7.3.9, 4.8.3.9, and 4.9.3.9 of this programmatic environmental impact statement (PEIS). Section E.2 provides information on radiological impacts while section E.3 provides information on hazardous chemical impacts.

E.2 Radiological Impacts to Human Health

Section E.2 presents supporting information on the potential radiological impacts to humans during normal operation of the PEIS alternatives. This section provides the reader with background information on the nature of radiation (section E.2.1), the methodology used to calculate radiological impacts (section E.2.2), and radiological releases from stockpile management facilities (section E.2.3). Releases associated with the No Action alternative for each site can be found in the referenced site environmental reports.

E.2.1 Background

E.2.1.1 Nature of Radiation and Its Effects on Humans

What is Radiation? Humans are constantly exposed to radiation from the solar system and from the earth's rocks and soil. This radiation contributes to the natural background radiation that has always surrounded us. But there are also manmade sources of radiation, such as medical and dental x rays, household smoke detectors, and materials released from nuclear and coal-fired powerplants.

All matter in the universe is composed of atoms, and radiation comes from the activity of these tiny particles. Atoms are made up of even smaller particles (protons, neutrons, and electrons). The number and arrangement of these particles distinguishes one atom from another.

Atoms of different types are known as elements. There are over 100 natural and manmade elements. Some of these elements, such as uranium, radium, plutonium, and thorium, share a very important quality: they are unstable. As they change into more stable forms, invisible waves of energy or particles, known as ionizing radiation, are released. Radioactivity is the emitting of this radiation.

Ionizing radiation refers to the fact that this energy force can ionize, or electrically charge atoms by stripping off electrons. Ionizing radiation can cause a change in the chemical composition of many things, including living tissue (organs), which can affect the way they function.

The effects on people of radiation that is emitted during disintegration (decay) of a radioactive substance depends on the kind of radiation (alpha and beta particles and gamma and x rays) and the total amount of radiation energy absorbed by the body. Alpha particles are the heaviest of these direct types of ionizing radiation, and despite a speed of about 16,100 kilometers (km) per second(s) (kps) (10,000 miles [mi] per second [mps]), they can travel only a few inches in the air. Alpha particles lose their energy almost as soon as they collide with anything. They can easily be stopped by a sheet of paper or the skin's surface.

Beta particles are much lighter than alpha particles. They can travel as fast as 161,000 kps (100,000 mps) and can travel in the air for a distance of about 3 meters (m) (10 feet [ft]). Beta particles can pass through a sheet of paper but may be stopped by a thin sheet of aluminum foil or glass.

Gamma and x rays, unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light (300,000 kps [186,000 mps]). Gamma radiation is very penetrating and requires a thick wall of concrete, lead, or steel to stop it.

The neutron is another particle that contributes to radiation exposure, both directly and indirectly. Indirect exposure is associated with the gamma rays and alpha particles that are emitted following neutron capture in matter. A neutron has about one quarter the weight of an alpha particle and can travel at speeds of up to 38,600 kps (24,000 mps). Neutrons are more penetrating than beta particles, but less penetrating than gamma rays. They can effectively be shielded by water, graphite, paraffin, or concrete.

The radioactivity of a material decreases with time. The time it takes a material to lose half of its original radioactivity is its half-life. For example, a quantity of iodine-131, a material that has a half-life of 8 days, will lose half of its radioactivity in that amount of time. In 8 more days, half of the remaining radioactivity will be lost, and so on. Eventually, the radioactivity will essentially disappear. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements may vary from millionths of a second to millions of years.

As a radioactive element gives up its radioactivity, it often changes to an entirely different element, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation may take place in several steps and is known as a decay chain. Radium, for example, is a naturally occurring radioactive element with a half-life of 1,622 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays to polonium and, through a series of steps, to bismuth and ultimately to lead.

Units of Radiation Measure. Scientists and engineers use a variety of units to measure radiation. These different units can be used to determine the amount, type, and intensity of radiation. Just as heat can be measured in terms of its intensity or its effects, using units of calories or degrees, amounts of radiation can be measured in curies, rads, or rems.

The curie, named after the French scientists Marie and Pierre Curie, describes the "intensity" of a sample of radioactive material. The rate of decay of 1 gram of radium is the basis of this unit of measure. It is equal to 3.7x10 *10* disintegrations (decays) per second.

The total energy absorbed per unit quantity of tissue is referred to as absorbed dose. The rad is the unit of measurement for the physical absorption of radiation. Much like sunlight heats the pavement by giving up an amount of energy to it, radiation gives up rads of energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram (kg) of absorbing material.

A rem is a measurement of the dose from radiation based on its biological effects. The rem is used to measure the effects of radiation on the body, much like degrees Celsius can be used to measure the effects of sunlight heating pavement. Thus, 1 rem of one type of radiation is presumed to have the same biological effects as 1 rem of any other type of radiation. This standard allows comparison of the biological effects of radionuclides that emit different types of radiation.

An individual may be exposed to ionizing radiation externally from a radioactive source outside the body and/or internally from ingesting radioactive material. An external dose is delivered only during the actual time of exposure to the external radiation source. An internal dose, however, continues to be delivered as long as the radioactive source is in the body, although both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time. The dose from internal exposure is calculated over 50 years following the initial exposure.

The three types of doses calculated in this PEIS include an external dose, an internal dose, and a combined external and internal dose. Each type of dose is discussed below.

External Dose. The external dose can arise from several different pathways. All these pathways are similar because the radiation causing the exposure is external to the body. In this PEIS, these pathways include being exposed to a cloud of radiation passing over the receptor, standing on ground that is contaminated with radioactivity, swimming in contaminated water, and boating in contaminated water. The appropriate measure of dose is called the effective dose equivalent. It should be noted that if the receptor departs from the source of radiation exposure, his dose rate will be reduced. It is assumed that external exposure occurs uniformly during the year.

Internal Dose. The internal dose arises from a radiation source entering the human body through ingestion of contaminated food and water or inhalation of contaminated air. In this PEIS, pathways for internal exposure include ingestion of crops contaminated by airborne radiation that has been deposited on the crops or by irrigation of crops using contaminated water sources, ingestion of animal products from animals that ingested contaminated food, ingestion of contaminated water, inhalation of contaminated air, and absorption of contaminated water through the skin during swimming. Unlike external exposures, once radioactive material enters the body, it remains there for various periods of time depending on decay and biological elimination rates. The unit of measure for internal doses is the committed dose equivalent. It is the internal dose that each body organ receives from 1 "year intake" (ingestion plus inhalation). Normally, a 50- or 70-year dose-commitment period is used (i.e., the 1-year intake period plus 49 or 69 years). The dose rate increases during the 1 year of intake. The dose rate, after the 1 year of intake, slowly declines as the radioactivity in the body continues to produce a dose. The integral of the dose rate over the 50 or 70 years gives the committed dose equivalent. In this PEIS, a 50-year dose-commitment period was used.

The various organs of the body have different susceptibilities to harm from radiation. The committed effective dose equivalent takes these different susceptibilities into account and provides a broad indicator of the risk to the health of an individual from radiation. It is obtained by multiplying the committed dose equivalent in each major organ or tissue by a weighting factor associated with the risk susceptibility of the tissue or organ, then summing the totals.

The committed dose equivalent to an organ is larger than the committed effective dose equivalent because the organ has a weighting factor of less than one. The concept of committed effective dose equivalent applies only to internal pathways.

Differences in radionuclide characteristics lead to different internal doses. For example, for the same amount of radioactivity, in curies, taken into the body, the dose from tritium is much less than from uranium or plutonium. Tritium emits a weak beta particle and is biologically eliminated from the body over several weeks. Uranium and plutonium emit relatively high-energy alpha particles and are retained in the body for periods of several months to many years.

Combined External and Internal Dose. For convenience, the sum of the committed effective dose equivalent from internal pathways and the effective dose equivalent from external pathways is also called the committed effective dose equivalent in this PEIS (note that in DOE Order 5400.5, Radiation Protection of the Public and the Environment, this quantity is called the effective dose equivalent).

The units used in this PEIS for committed dose equivalent, effective dose equivalent, and committed effective dose equivalent to an individual are the rem and millirem (mrem) (1/1000 of 1 rem). The corresponding unit for the collective dose to a population (the sum of the doses to members of the population, or the product of the number of exposed individuals and their average dose) is the person-rem.

Sources of Radiation. The average American receives a total of about 350 mrem per year from all sources of radiation, both natural and manmade. The sources of radiation can be divided into six different categories: cosmic radiation, terrestrial radiation, internal radiation, consumer products, medical diagnosis and therapy, and other sources. Each category is discussed below.

Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting the earth's atmosphere. These particles and the secondary particles and photons they create are cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with altitude above sea level. For the sites considered in this PEIS, the cosmic radiation ranged from about 30 to 50 mrem per year. The average annual dose to people in the United States is about 27 mrem.

External terrestrial radiation is the radiation emitted from the radioactive materials in the earth's rocks and soils. The average annual dose from external terrestrial radiation is about 28 mrem. The external terrestrial radiation for the sites in this PEIS ranged from about 30 to 75 mrem per year.

Internal radiation arises from the human body metabolizing natural radioactive material that has entered the body by inhalation or ingestion. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributors to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon which contribute about 200 mrem per year. The average dose from other internal radionuclides is about 39 mrem per year.

Consumer products also contain sources of ionizing radiation. In some products, like smoke detectors and airport x-ray machines, the radiation source is essential to the products' operation. In other products, such as televisions and tobacco products, the radiation occurs incidentally to the product function. The average annual dose is about 10 mrem.

Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic x rays result in an average annual exposure of 39 mrem. Nuclear medical procedures result in an average annual exposure of 14 mrem.

There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The doses from nuclear fuel cycle facilities, such as uranium mines, mills, and fuel processing plants; nuclear power plants; and transportation routes has been estimated to be less than 1 mrem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions of radioactive material from Department of Energy (DOE) facilities, emissions from certain mineral extraction facilities, and transportation of radioactive materials contributes less than 1 mrem per year to the average dose to an individual. Air travel contributes approximately 1 mrem per year to the average dose.

The collective (or population) dose to an exposed population is calculated by summing the estimated doses received by each member of the exposed population. This total dose received by the exposed population is measured in person-rem. For example, if 1,000 people each received a dose of 1 mrem (0.001 rem), the collective dose is 1,000 persons x 0.001 rem = 1.0 person-rem. Alternatively, the same collective dose (1.0 person-rem) results from 500 people, each of whom received a dose of 2 mrem (500 persons x 2 mrem = 1 person-rem).

Limits of Radiation Exposure. The amount of manmade radiation that the public may be exposed to is limited by Federal regulations. Although most scientists believe that radiation absorbed in small doses over several years is not harmful, U.S. Government regulations assume that the effects of all radiation exposures are cumulative.

The exposure to a member of the general public from DOE facility releases into the atmosphere is limited by the Environmental Protection Agency (EPA) to an annual dose of 10 mrem, in addition to the natural background and medical radiation normally received (40 Code of Federal Regulations [CFR] 61, Subpart H). DOE also limits to 10 mrem, the dose annually received from material released into the atmosphere (DOE Order 5400.5). EPA and DOE also limit the annual dose to the general public from radioactive releases to drinking water to 4 mrem (40 CFR 141; DOE Order 5400.5). The DOE annual limit of radiation dose to a member of the general public from all DOE facilities is 100 mrem total from all pathways (DOE Order 5400.5). For people working in an occupation that involves radiation, DOE and the Nuclear Regulatory Commission (NRC) limit doses to 5 rem (5,000 mrem) in any one year (10 CFR 20; 10 CFR 835).

E.2.1.2 Health Effects

Radiation exposure and its consequences are topics of interest to the general public. For this reason, this PEIS places much emphasis on the consequences of exposure to radiation, even though the effects of radiation exposure under most circumstances evaluated in this PEIS are small. This section explains the basic concepts used in the evaluation of radiation effects in order to provide the background for later discussion of impacts.

Radiation can cause a variety of ill-health effects in people. The most significant ill-health effects that result from environmental and occupational radiation exposure are cancer fatalities. These ill-health effects are referred to as "latent" cancer fatalities because the cancer may take many years to develop and for death to occur and may not actually be the cause of death. In the discussions that follow, it should be noted that all fatal cancers are latent; therefore, the term "latent" is not used.

Health impacts from radiation exposure, whether from sources external or internal to the body, generally are identified as "somatic" (affecting the individual exposed) or "genetic" (affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects rather than genetic effects. Therefore, for this PEIS, only the somatic risks are presented. The somatic risks of most importance are the induction of cancers. Except for leukemia, which can have an induction period (time between exposure to carcinogen and cancer diagnosis) of as little as 2 to 7 years, most cancers have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues. The thyroid and skin demonstrate a greater sensitivity than other organs; however, such cancers also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because of the readily available data for cancer mortality rates and the relative scarcity of prospective epidemiologic studies, somatic effects leading to cancer fatalities rather than cancer incidence are presented in this PEIS. The numbers of cancer fatalities can be used to compare the risks among the various alternatives.

The fatal cancer risk estimators presented in this appendix for radiation technically apply only to low-Linear Energy Transfer radiation (gamma rays and beta particles). However, on a per rem rather than a per rad basis, the fatal risk estimators are higher for this type of radiation than for high-Linear Energy Transfer radiation (alpha particles). In this PEIS, the low-Linear Energy Transfer risk estimators are conservatively assumed to apply to all radiation exposures.

The National Research Council's Committee on the Biological Effects of Ionizing Radiations (BEIR) has prepared a series of reports to advise the U.S. Government on the health consequences of radiation exposure. The latest of these reports, *Health Effects of Exposure to Low Levels of Ionizing Radiation BEIR V* , published in 1990, provides the most current estimates for excess mortality from leukemia and cancers other than leukemia expected to result from exposure to ionizing radiation. The BEIR V Report updates the models and risk estimates provided in the earlier report of the BEIR III Committee, *The Effects of Exposure of Populations to Low-Levels of Ionizing Radiation*, published in 1980. BEIR V models were developed for application to the U.S. population.

BEIR V provides estimates that are consistently higher than those in BEIR III. This is attributed to several factors, including the use of a linear dose response model for cancers other than leukemia, revised dosimetry for the Japanese atomic bomb survivors, and additional followup studies of the atomic bomb survivors and other cohorts. BEIR III employs constant relative and absolute risk models, with separate coefficients for each sex and several age-at-exposure groups, while BEIR V develops models in which the excess relative risk is expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. BEIR III models were based on the assumption that absolute risks are comparable between the atomic bomb survivors and the U.S. population, while BEIR V models were based on the assumption that the relative risks are comparable. For a disease such as lung cancer, where baseline risks in the United States are much larger than those in Japan, the BEIR V approach leads to larger risk estimates than the BEIR III approach.

The models and risk coefficients in BEIR V were derived through analyses of relevant epidemiologic data, including the Japanese atomic bomb survivors, ankylosis spondylitis patients, Canadian and Massachusetts fluoroscopy patients (breast cancer), New York postpartum mastitis patients (breast cancer), Israel tinea capitis patients (thyroid cancer), and Rochester thymus patients (thyroid cancer). Models for leukemia, respiratory cancer, digestive cancer, and other cancers used only the atomic bomb survivor data, although results of analyses of the ankylosis spondylitis patients were considered. Atomic bomb survivor analyses were based on revised dosimetry with an assumed Relative Biological Effectiveness of 20 for neutrons and were restricted to doses of less than 400 rads. Estimates of risks of fatal cancers other than leukemia were obtained by totaling the estimates for breast cancer, respiratory cancer, digestive cancer, and other cancers.

Risk Estimates for Doses Received During an Accident. BEIR V includes risk estimates for a single exposure of 10 rem to a population of 100,000 people (10 *6* person-rem). In this case, fatality estimates for leukemia, breast cancer, respiratory cancer, digestive cancer, and other cancers are given for both sexes and nine age-at-exposure groups. These estimates, based on the linear model, are summarized in table E.2.1.2-1. The average risk estimate from all ages and both sexes is 885 excess cancer fatalities per million person-rem. This value has been conservatively rounded up to 1,000 excess cancer fatalities per million person-rem.

Table E.2.1.2-1.-- Lifetime Risks per 100,000 Persons Exposed to a Single Exposure of 10 Rem

Gender	**Type of Fatal Cancer**		
	Leukemia [1]	**Cancers Other Than Leukemia**	**Total Cancers**
Male	220	660	880
Female	160	730	890
Average	190	695	885 [2]

Although values for other health effects are not presented in this PEIS, the risk estimators for nonfatal cancers and for genetic disorders in future generations are estimated to be approximately 200 and 260 per million person-rem, respectively. These values are based on information presented in the 1990 Recommendations of the International Commission on Radiological Protection (ICRP Publication 60) and are seen to be 20 and 26 percent, respectively, of the fatal cancer estimator (ICRP 1991a:22). Thus, if the number of excess fatal cancers is projected to be "Z", the number of excess genetic disorders would be 0.26xZ.

Risk Estimates for Doses Received During Normal Operation. For low doses and dose rates, a linear-quadratic model was found to provide a significantly better fit to the data for leukemia than a linear one, and leukemia risks were based on a linear-quadratic function. This reduces the effects by a factor of two over estimates that are obtained from the linear model. For other cancers, linear models were found to provide an adequate fit to the data, and were used for extrapolation to low doses. However, the BEIR V Committee recommended reducing these linear estimates by a factor between 2 and 10 for doses received at low dose rates. For this PEIS, a risk reduction factor of 2 was adopted for conservatism.

Based on the above discussion, the resulting dose-to-risk conversion factor would be equal to half the value observed for accident situations or approximately 500 excess fatal cancers per million person-rem (0.0005 excess fatal cancers per person-rem). This is the risk value used in this PEIS to calculate fatal cancers to the general public during normal operation. For workers, a dose-to-risk conversion factor of 400 excess fatal cancers per million person-rem (0.0004 excess fatal cancers per person-rem) is used in this PEIS. This lower value reflects the absence of children in the workforce. Again, based on information provided in ICRP Publication 60, the health risk estimators for nonfatal cancers and genetic disorders among the public are 20 percent and 26 percent, respectively, of the fatal cancer dose-to-risk conversion factor. For workers, the health risk estimators for nonfatal cancers and genetic disorders are both 20 percent of the fatal cancer dose-to-risk conversion factor. For this PEIS, only fatal cancers are presented.

The risk estimates may be applied to calculate the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to natural background radiation (0.3 rem per year), 15 cancer fatalities per year would be inferred to be caused by the radiation (100,000 persons x 0.3 rem per year x 0.0005 cancer fatalities per person-rem = 15 cancer fatalities per year).

Sometimes, calculations of the number of excess cancer fatalities associated with radiation exposure do not yield whole numbers and, especially in environmental applications, may yield numbers less than 1.0. For example, if a population of 100,000 were exposed as above, but to a total dose of only 0.001 rem, the collective dose would be 100 person-rem, and the corresponding estimated number of cancer fatalities would be 0.05 (100,000 persons x 0.001 rem x 0.0005 cancer fatalities/person-rem = 0.05 fatal cancers).

How should one interpret a nonintegral number of cancer fatalities such as 0.05? The answer is to interpret the result as a statistical estimate. That is, 0.05 is the *average* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no person (0 people) would incur a cancer fatality from the 0.001 rem dose each member would have received. In a small fraction of the groups, one fatal cancer would result; in exceptionally few groups, two or more fatal cancers would occur. The *average* number of deaths over all the groups would be 0.05 fatal cancers (just as the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome is 0 cancer fatalities.

These same concepts apply to estimating the effects of radiation exposure on a single individual. Consider the effects, for example, of exposure to background radiation over a lifetime. The "number of cancer fatalities" corresponding to a single individual's exposure over a (presumed) 72-year lifetime to 0.3 rem per year is the following:

1 person x 0.3 rem/year x 72 years x 0.0005 cancer fatalities/person-rem = 0.011 cancer fatalities.

Again, this should be interpreted in a statistical sense; that is, the estimated effect of background radiation exposure on the exposed individual would produce a 1.1-percent chance that the individual might incur a fatal cancer caused by the exposure. Presented another way, this method estimates that approximately 1.1 percent of the population might die of cancers induced by the background radiation.

E.2.2 Methodology for Estimating Radiological Impacts of Normal Operation

The radiological impacts of normal operation of alternatives were calculated using Version 1.485 of the GENII computer code. Site-specific and technology-specific input data were used, including location, meteorology, population, food production and consumption, and source terms. The GENII code was used for analysis of normal operations and design basis accidents. Section E.2.2.1 briefly describes GENII and outlines the approach used for normal operations.

E.2.2.1 GENII Computer Code

The GENII computer model, developed by Pacific Northwest Laboratory for DOE, is an integrated system of various computer modules that analyze environmental contamination resulting from acute or chronic releases to, or initial contamination in, air, water, or soil. The model calculates radiation doses to individuals and populations. The GENII computer model is well documented for assumptions, technical approach, methodology, and quality assurance issues (*GENII -- The Hanford Environmental Radiation Dosimetry Software System* [December 1988]). The GENII computer model has gone through extensive quality assurance and quality control steps. These include the comparison of results from model computations against those from hand calculations, and the performance of internal and external peer reviews. Recommendations given in these reports were incorporated into the final GENII computer model, as deemed appropriate.

For this PEIS only the ENVIN, ENV, and DOSE computer modules were used. The codes are connected through data transfer files. The output of one code is stored in a file that can be used by the next code in the system. In addition, a computer code called CREGENII was prepared to aid the user with the preparation of input files into GENII.

CREGENII. The CREGENII code helps the user, through a series of interactive menus and questions, prepare a text input file for the environmental dosimetry programs. In addition, CREGENII prepares a batch processing file to manage the file handling needed to control the operations of subsequent codes and to prepare an output report.

ENVIN. The ENVIN module of the GENII code controls the reading of the input files prepared by CREGENII and organizes the input for optimal use in the environmental transport and exposure module, ENV. The ENVIN code interprets the basic input, reads the basic GENII data libraries and other optional input files, and organizes the input into sequential segments on the basis of radionuclide decay chains.

A standardized file that contains scenario, control, and inventory parameters is used as input to ENVIN. Radionuclide inventories can be entered as functions of releases to air or water, concentrations in basic environmental media (air, soil, or water), or concentrations in foods. If certain atmospheric dispersion options have been selected, this module can generate tables of atmospheric dispersion parameters that will be used in later calculations. If the finite plume air submersion option is requested in addition to the atmospheric dispersion calculations, preliminary energy-dependent finite plume dose factors also are prepared. The ENVIN module prepares the data transfer files that are used as input by the ENV module; ENVIN generates the first portion of the calculation documentation--the run input parameters report.

ENV. The ENV module calculates the environmental transfer, uptake, and human exposure to radionuclides that result from the chosen scenario for the user-specified source term. The code reads the input files from ENVIN and then, for each radionuclide chain, sequentially performs the precalculations to establish the conditions at the start of the exposure scenario. Environmental concentrations of radionuclides are established at the beginning of the scenario by assuming decay of preexisting sources, considering biotic transport of existing subsurface contamination, and defining soil contamination from continuing atmospheric or irrigation depositions. Then, for each year of postulated exposure, the code estimates air, surface soil, deep soil, groundwater, and surface water concentrations of each radionuclide in the chain. Human exposures and intakes of each radionuclide are calculated for pathways of external exposure from finite atmospheric plumes, inhalation, external exposure from contaminated soil, sediments, and water, external exposure from special geometries, and internal exposures from consumption of terrestrial foods, aquatic foods, drinking water, animal products, and inadvertent intake of soil. The intermediate information on annual media concentrations and intake rates are written to data transfer files. Although these may be accessed directly, they are usually used as input to the DOSE module of GENII.

GENII is a general purpose computer code used to model dispersion, transport, and long-term exposure effects of specific radionuclides and pathways. Sophisticated codes such as UFOTRI and ETMOD (Environmental Tritium Model) are used exclusively for modeling tritium transport and dosimetry. The UFOTRI and ETMOD codes were not chosen for use in this PEIS because of the lack of information on detailed facility design and on the breakdown of tritium into elemental and tritiated water forms, and because these codes cannot be used for modeling the exposure effects of radionuclides other than tritium. GENII was chosen because it can model both air and surface transport pathways and is not restricted to any radionuclides.

DOSE. The DOSE module reads the annual intake and exposure rates defined by the ENV module and converts the data to radiation dose. External dose is calculated with precalculated factors from the EXTDF module or from a data file prepared outside of GENII. Internal dose is calculated with precalculated factors from the INTDF module.

EXTDF. The EXTDF module calculates the external dose-rate factors for submersion in an infinite cloud of radioactive materials, immersion in contaminated water, and direct exposure to plane or slab sources of radionuclides. EXTDF was not used. Instead, the dose rate factors listed in *External Dose Rate Factors for Calculation of Dose to the Public* (DOE/EH-0070) were used for this PEIS.

INTDF. Using the *Limits for Intakes of Radionuclides by Workers* (ICRP Publication 30) model, the INTDF module calculates the internal (inhalation and ingestion) dose conversion factors of radionuclides for specific organs. The factors generated by INTDF were used for the calculations presented in this PEIS.

E.2.2.2 Data and Assumptions

In order to perform the dose assessments for this PEIS, different types of data must be collected and/or generated. In addition, calculational assumptions have to be made. This section discusses the data collected and/or generated for use in the dose assessment and assumptions made for this PEIS.

Meteorological Data. The meteorological data used for all applicable DOE sites were in the form of joint frequency data files. A joint frequency data file is a table listing the fractions of time the wind blows in a certain direction, at a certain speed, and within a certain stability class. The joint frequency data files were based on measurements over a 1-year period at various locations and at different heights at the sites. Average meteorological conditions (averaged over the 1-year period) were used for normal operation. For use in design basis accidents, the 50 percentile option was used.

Population Data. Population distributions were based on *1990 Census of Population and Housing* data. Projections were determined for the year 2030 for areas within 80 km (50 mi) of the proposed facilities at each candidate site. This year of analysis was selected as conservatively representative of the population over the operational period evaluated, and was used in the impact assessments. The population was spatially distributed on a circular grid with 16 directions and 10 radial distances up to 80 km (50 mi). The grid was centered on the facility from which the radionuclides were assumed to be released.

Source Term Data. The source terms (quantities of radionuclides released into the environment over a given period) were estimated on the basis of latest conceptual designs of facilities and experience with similar facilities. The source terms used to generate the estimated impacts of normal operation are provided in section E.2.3.

Food Production and Consumption Data. Data from the 1987 Census of Agriculture were used to generate site-specific data for food production. Food production was spatially distributed on the same circular grid as was used for the population distributions. The consumption rates were those used in GENII for the maximum individual and average individual. People living within the 80 km (50 mi) assessment area were assumed to consume only food grown in that area.

Calculational Assumptions. Dose assessments were performed for members of the general public and workers. Dose assessments for members of the public were performed for two different types of receptors considered in this PEIS: a maximally exposed offsite individual and the general population living within 80 km (50 mi) of the facility. It was assumed that the maximally exposed individual was located at a position on the site boundary that would yield the highest impacts during normal operation of a given alternative. If more than one facility was assumed to be operating at a site, the dose to the individual from each facility was calculated. The doses were then summed to give the total dose to the individual. A 80 km (50 mi) population dose was calculated for each operating facility at a site. These doses were then added to give the total population dose at that site.

To estimate the radiological impacts from normal operation of Stockpile Stewardship and Management alternatives, additional assumptions and factors were considered in using GENII:

- No prior deposition of radionuclides on ground surfaces was assumed.
- For the maximally exposed offsite individual, the annual exposure time to the plume and to soil contamination was 0.7 years (NRC 1977b:1.109-68).
- For the population, the annual exposure time to the plume and to soil contamination was 0.5 years (NRC 1977b:1.109-68).
- A semi-infinite/finite plume model was used for air immersion doses. Other pathways evaluated were ground exposure, inhalation, ingestion of food crops and animal products contaminated by either deposition of radioactivity from the air or irrigation, ingestion of fish and other aquatic food raised in contaminated water, exposure through swimming and boating in contaminated surface water, and ingestion of contaminated water. It should be noted that not all pathways were available at every site.
- For atmospheric releases, it was assumed that ground-level releases would occur for all stockpile stewardship and

management designated facilities. For site-dependent facilities, reported release heights were used and assumed to be the effective stack height. Use of the effective stack height negates plume rise, thereby making the resultant doses conservative.

- The calculated doses were 50-year committed doses from 1 year of intake.

Resuspension of particulates was not considered because prior calculations of dust loading in the atmosphere showed that this pathway was negligible compared with others. The exposure, uptake, and usage parameters used in the GENII model are provided in tables E.2.2.2-1 through E.2.2.2-4.

Annual average doses to workers for No Action at all DOE sites were based on measured values received by radiation workers during the 1992 time period. The average No Action dose received by a worker at these sites in future years was assumed to remain the same as the annual average during the 1992 period. The total workforce dose in future years was calculated by multiplying the average worker dose by a projected number of future workers.

Table E.2.2.2-1.-- GENII Annual Exposure Parameters to Plumes and Soil Contamination

Maximally Exposed Individual				General Population			
External Exposure (hours)		Inhalation of Plume		External Exposure (hours)		Inhalation of Plume	
Plume	Soil Contamination	Exposure Time (hours)	Breathing Rate (cc/s)	Plume	Soil Contamination	Exposure Time (hours)	Breathing Rate (cc/s)
6,136	6,136	6,136	270	4,383	4,383	4,383	270
HNUS 1995a.							

Table E.2.2.2-2.-- GENII Annual Usage Parameters for Consumption of Terrestrial Food

	Maximally Exposed Individual				General Population			
Food Type	Growing Time (days)	Yield (kg/m^2)	Holdup Time (days)	Consumption Rate (kg/yr)	Growing Time (days)	Yield (kg/m^2)	Holdup Time (days)	Consumption Rate (kg/yr)

Leafy vegetables	90.0	1.5	1.0	30.0	90.0	1.5	14.0	15.0
Root vegetables	90.0	4.0	5.0	220.0	90.0	4.0	14.0	140.0
Fruit	90.0	2.0	5.0	333	90.0	2.0	14.0	64.0
Grains/ cereals	90.0	0.8	180.0	80.0	90.0	0.8	180.0	72.0
HNUS 1995a.								

Table E.2.2.2-3.-- GENII Annual Usage Parameters for Consumption of Animal Products

	Maximally Exposed Individual									
	Human Consumption		**Stored Feed**				**Fresh Forage**			
Food Type	**Consumption Rate (kg/yr)**	**Holdup Time (days)**	**Diet Fraction**	**Growing Time (days)**	**Yield (kg/m^3)**	**Storage Time (days)**	**Diet Fraction**	**Growing Time (days)**	**Yield (kg/m^3)**	**Storage Time (days)**
Beef	80.0	15.0	0.25	90.0	0.80	180.0	0.75	45.0	2.00	100.0
Poultry	18.0	1.0	1.00	90.0	0.80	180.0				
Milk	270.0	1.0	0.25	45.0	2.00	100.0	0.75	30.0	1.50	0.0

Eggs	30.0	1.0		1.00	90.0	0.80	180.0					
	General Population											
Beef	70.0	34.0		0.25	90.0	0.80	180.0		0.75	45.0	2.00	100.0
Poultry	8.5	34.0		1.00	90.0	0.80	180.0					
Milk	230.0	4.0		0.25	45.0	2.00	100.0		0.75	30.0	1.50	0.0
Eggs	20.0	18.0		1.00	90.0	0.80	180.0					
HNUS 1995a.												

Table E.2.2.2-4.-- GENII Annual Usage Parameters for Aquatic Activities

	Maximally Exposed Individual				**General Population**		
Activity	**Transit Time to Usage Point (days)**	**Holdup Time (days)**	**Usage Rate (per year)**		**Transit Time to Usage Point (days)**	**Holdup Time (days)**	**Usage Rate**
Drinking water	0.0	0.0	730 L		0.0	0.0	Site dependent
Swimming	0.0	0.0	100 hours		0.0	0.0	Site dependent
Boating	0.0	0.0	100 hours		0.0	0.0	Site dependent
Shoreline	0.0	0.0	500 hours		0.0	0.0	Site dependent

Ingestion of fish	0.0	0.0	40 kg		0.0	0.0	Site dependent
Ingestion of mollus	0.0	0.0	6.9 kg		0.0	0.0	Site dependent
Ingestion of crusta	0.0	0.0	6.9 kg		0.0	0.0	Site dependent
Ingestion of plants	0.0	0.0	6.9 kg		0.0	0.0	Site dependent

HNUS 1995a.

Doses to workers directly associated with stewardship and management facilities were taken either from data reports prepared by the DOE Complex sites or from occupational dose histories for similar operations. To obtain the total workforce dose at a site with particular stewardship and/or management facilities in operation, the site dose from No Action was added to that from the facilities being evaluated. The average dose to a site worker was then calculated by dividing this dose by the total number of workers at the site. All doses to workers include a component associated with the intake of radioactivity into the body and another component resulting from external exposure to direct radiation.

E.2.2.3 Health Effects Calculations

Doses calculated by GENII were used to estimate health effects using the risk estimators presented in section E.2.1.2. The incremental cancer fatalities in the general population and groups of workers due to radiation exposure were therefore estimated by multiplying the collective combined effective dose equivalent by 0.0005 and 0.0004 fatal cancers/person-rem, respectively. In this PEIS, the collective combined effective dose equivalent is the sum of the collective committed effective dose equivalent (internal dose) and the collective effective dose equivalent (external dose), section E.2.1.1.

Although health risk factors are statistical factors and therefore not strictly applicable to individuals, they have been used in the past to estimate the incremental risk to an individual from exposure to radiation. Therefore, the factors of 0.0005 and 0.0004 per rem of individual committed effective dose equivalent for a member of the public and for a worker, respectively, have also been used in this PEIS to calculate the individual's incremental fatal cancer risk from exposure to radiation.

For the public, the health effects expressed in this PEIS are the risk of fatal cancers for the maximally exposed individual and the number of fatal cancers in the 80 km (50 mi) population from exposure to radioactivity released from any site over the 25-year operational period. For workers, the health effects expressed are the risk to the average worker at a site and the number of fatal cancers to all workers at the site from 25 years of site operation.

E.2.3 Normal Operation Releases

This section presents source terms (i.e., radiological releases) to the environment from the normal operation of stockpile management alternatives at each of the applicable proposed sites (Oak Ridge Reservation [ORR], table E.2.3-1; Savannah River Site [SRS], table E.2.3-2; Pantex Plant [Pantex], table E.2.3-3; Los Alamos National Laboratory [LANL], tables E.2.3-4 and E.2.3-5; Lawrence Livermore National Laboratory [LLNL], table E.2.3-6; and Nevada Test Site [NTS], table E.2.3-7). These source terms were used in the GENII dose model calculations, which were ultimately used in estimating the most conservative radiological impacts at each site from each of the applicable management alternatives presented in this PEIS. These resultant incremental doses (and associated cancer risks) can be found in sections 4.2.3.9, 4.3.3.9, 4.5.3.9, 4.6.3.9, 4.7.3.9, and 4.9.3.9, respectively, by subtracting the applicable site's No Action impacts from each management alternative's impact total. Only atmospheric releases have been presented because liquid radiological discharges are not expected from any of the alternatives at any of the sites.

Table E.2.3-1.-- Normal Operational Atmospheric Releases for the Y-12 Downsize Secondary and Case Fabrication Alternative

Isotope	Release (Ci)
Uranium-235	4.2x10 -4
Uranium-238	1.5x10 -3
OR MMES 1996j.	

Table E.2.3-2.-- Normal Operational Atmospheric Releases for the Savannah River Site Pit Fabrication Alternative	
Isotope	**Release (Ci)**
Plutonium-238	1.9x10 -8
Plutonium-239	1.3x10 -7
Plutonium-240	3.0x10 -8
Plutonium-241	9.0x10 -7
Americium-241	2.8x10 -8
Total	1.1x10 -6
Representative of unclassified isotopic distribution associated with weapons-grade plutonium. **LANL1995g.**	

Table E.2.3-3.-- Normal Operational Atmospheric Releases for the Pantex Plant Downsize Assembly/ Disassembly Alternative

Isotope	Release (Ci)

Hydrogen-3	0.45
PX MH 1995a.	

Table E.2.3-4.-- Normal Operational Atmospheric Releases for the Los Alamos National Laboratory Pit Fabrication Alternative

Isotope	**Release (Ci)**
Plutonium-238	1.9x10^{-8}
Plutonium-239	1.3x10^{-7}
Plutonium-240	3.0x10^{-8}
Plutonium-241	9.0x10^{-7}
Americium-241	2.8x10^{-8}
Total	1.1x10^{-6}
Representative of unclassified complete isotopic distribution associated with weapons-grade plutonium. **LANL 1995g.**	

Table E.2.3-5.-- Normal Operational Atmospheric Releases for the Los Alamos National Laboratory Secondary and Case Fabrication Alternative

Isotope	**Release (Ci)**
Uranium-235	4.9x10^{-4}
Uranium-238	1.8x10^{-3}
LANL 1995e.	

Table E.2.3-6.-- Normal Operational Atmospheric Releases for the Lawrence Livermore National Laboratory Secondary and Case Fabrication Alternative

Isotope	**Release (Ci)**
Uranium-235	1.4x10 -*4*
Uranium-238	4.8x10 -*4*
LLNL 1995c.	

Table E.2.3-7.-- Normal Operational Atmospheric Releases for the Nevada Test Site Assembly/Disassembly Alternative

Isotope	**Release (Ci)**
Hydrogen-3	0.45
PX MH 1995a.	

E.3 Hazardous Chemical Impacts to Human Health

E.3.1 Background

Two general types of adverse human health effects are assessed for hazardous chemical exposure in this PEIS. These are carcinogenic and noncarcinogenic effects. A Chemical Health Effects Technical Reference (TTI 1996b) was developed to assist the risk assessor in the evaluation process. Part I of the Technical Reference contains a table of chemical toxicity profiles which characterizes each chemical in terms of physical properties, potential exposure routes, and the effects on target tissues/organs that might be expected. It is to be used qualitatively by the risk assessor to determine how exposure might occur (exposure route), what tissue or organ system might be impacted (e.g., central nervous system dysfunction, or liver cancer), and whether the chemical might possess other properties affecting its bioavailability in a given matrix (e.g., air, water, or soil). Part II of the Technical Reference contains a table of exposure limits which provides the risk assessor with the necessary information to calculate risk or expected adverse effects should an individual be exposed to a hazardous chemical for a long time at low levels (chronic exposure) or to higher concentrations for a short-term (acute) exposure. Where a dose effect calculation is required (milligram [mg]/kg/day), the reference dose is applicable, and where an inhalation concentration effect is required, the reference concentration (i.e., RfC in mg/m3) is applicable for chronic exposures. The permissible exposure limit values, which regulate worker exposures over 8-hour periods, determine the concentration allowed for occupational exposures that would be without adverse acute effects. Other values, such as the threshold limit value (TLV), are presented because they are prepared by the American Conference of Governmental Industrial Hygienists for guidance on exposures of 8-hour periods, and can be used to augment permissible exposure limits or serve as exposure levels in the absence of a permissible exposure limit. All currently regulated chemicals associated with each site and every hazardous chemical are presented in the Chemical Health Effects Technical Reference.

It was assumed that under normal operation conditions members of the public would only receive chronic exposures at low levels in the form of air emissions from a centrally located source term at each site. Since hazardous chemicals are not released into surface or groundwaters or onto soil, inhalation is assumed to be the only route of exposure. However, all chemical quantities are accounted for as air emissions which are several orders of magnitude greater than all other possible routes combined. It was further assumed that the maximally exposed individual member of the public would be at the site boundary, and this assumption was used when calculating all public exposures, which under normal operating conditions are expected to be chronic and at very low levels. For worker exposures to hazardous chemicals, it was assumed that individuals were exposed only to low air emission concentrations during an 8-hour day for a 40-hour week for a maximum working lifetime of 40 years. The point of exposure chosen was 100 meters from a centrally located source term, since the precise placement of source terms onsite could not be made. Further, it could not be determined where the involved and noninvolved workers would be relative to the emission sources.

For every site involved in the analysis, hazard indexes (HIs) were calculated for every alternative action relative to the site. The exposure concentrations of hazardous chemicals for the public and the onsite workers were developed using the industrial source complex short-term model recommended for point, area, and volume sources. This model, which estimates dispersion of emissions from these sources, has been field-tested and recommended by the EPA. The modeled concentrations were compared to the reference concentration and permissible exposure limit values unique to each chemical to yield hazard quotients (HQs) for the public and onsite workers, respectively. The HQs were summed to give the HIs for each alternative action at each site, as well as total HIs (i.e., No Action HI + alternative HI). For cancer risk estimation, the inhaled concentrations were converted to doses in mg/kg/day, which were then multiplied by the slope factors unique to each identified carcinogen. The risks for all carcinogens associated with each alternative (incremental risk) at each site were summed, and the No Action cancer risk for each site was added in order to show the total risk should that alternative action be implemented at a given site. This PEIS does not purport to provide the level of detail needed to go beyond a conservative screening process for hazardous chemicals. As such, the analysis in this PEIS for the No Action alternative should not be relied upon as a basis for judging the sites as having a hazardous chemical health concern.

E.3.2 Chemical Toxicity Profiles

Part I of the Chemical Health Effects Technical Reference provides the pertinent facts about each chemical that is included in the risk assessment of this PEIS. This reference includes the chemical abstracts service number, which aids in a search for information available on any specific chemical and ensures a positive identity regardless of which name or synonym is used. It also contains physical information (i.e., solubility, vapor pressure, and flammability), as well as incompatibility data that is useful in determining whether a hazard might exist and the nature of the hazard. The route of exposure, target organs/tissues, and carcinogenicity provide an abbreviated summary on how individuals may get exposed, what body functions could be affected, and whether chronic exposure could lead to increased cancer incidence in an exposed population.

E.3.3 Regulated Exposure Limits

Hazardous chemicals are regulated by various agencies in order to provide protection to the public (EPA regulated) and to workers (Occupational Safety and Health Administration [OSHA]), while others (National Institute for Occupational Safety and Health and the American Conference of Governmental Industrial Hygienists) provide guidelines. The reference doses and reference concentrations set by EPA represent exposure limits for long-term (chronic) exposure at low doses and concentrations, respectively, that can be considered safe from adverse noncancer effects. The permissible exposure limit represents concentration levels set by OSHA that are safe for 8-hour exposures without causing noncancer adverse effects. The slope factor or the unit risk is used to convert the daily uptake of a carcinogenic chemical averaged over a lifetime to the incremental risk of an individual developing cancer. Part II of the Chemical Health Effects

Technical Reference presents the information on exposure limits used to develop HQs for each of the hazardous chemicals and the HIs derived from their summation and the slope factors used to calculate cancer risk for each chemical at the exposure concentrations identified at the various sites or associated with a proposed alternative action.

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[1] These are the linear estimates and are double the linear-quadratic estimates provided in BEIR V for leukemia at low doses and dose-rates.

[2] This value has been rounded up to 1,000 excess cancer fatalities per million person-rem.

NAS 1990a.

E.3.4 Hazardous Chemical Risks/Effects Calculations

Tables E.3.4-1 through E.3.4-30 show the chemicals associated with the various activities and the various sites considered for each alternative. The increment added by each activity to the site is totalled to show how much the risk at the site would increase should that alternative be implemented. Calculations used to derive the hazard indices for workers and for the public are presented as footnotes to each of the appendix tables. In addition, the slope factor used to calculate the cancer risk for workers and for the public are presented as footnotes in the appendix tables, and the footnotes to the tables show how the cancer risk was performed.

Table E.3.4-1.--Risk Assessments from Exposure to Hazardous Chemicals from No Action at Oak Ridge Reservation

Chemical	Regulated Exposure Limits/ Risk Factors								
				Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/ m3)	PEL[1] (mg/ m3)	Slope Factor (mg/ kg/ day)	Boundary Annual MEI[2] (mg/m3)	Worker 100 m 8 hours (mg/ m3)	Boundary Annual MEI[2], [3]	Worker 100 m 8 hours[4]	Boundary Annual MEI[2], [5]	Worker 100 m 8 hours[6]
Acetic acid	0.6125	25	None	3.30x10-8	1.98x10-5	5.39x10-8	7.93x10-7	0	0
Carbon monoxide	1.35	55	None	3.14x10-3	1.88	2.32x10-3	3.42x10-2	0	0
Chlorine	0.35	3	None	5.78x10-5	3.47x10-2	1.65x10-4	1.16x10-2	0	0
Hydrogen chloride	0.0070	7.0	None	2.12x10-4	1.27x10-1	3.03x10-2	1.82x10-2	0	0

Hydrogen fluoride	0.21	2.49	None	2.31x10-6	1.39x10-3	1.10x10-5	5.57x10-4	0	0
Methyl alcohol	1.75	260	None	8.72x10-4	5.23x10-1	4.98x10-4	2.01x10-3	0	0
Nitric acid	0.1225	5	None	3.14x10-4	1.88x10-1	2.56x10-3	3.76x10-2	0	0
Sulfuric acid	0.0245	1	None	8.25x10-5	4.95x10-2	3.37x10-3	4.95x10-2	0	0
1,1,1-Trichloroethane (TCA)	1.000	1,900	None	7.26x10-6	4.36x10-3	5.93x10-5	2.29x10-6	0	0
Volatile organic compounds (toluene)	0.4	766	None	1.22x10-4	7.33x10-2	3.05x10-4	9.57x10-5	0	0
Hazard Index [7]						3.95x10-2	1.54x10-1		
Total Cancer Risk [8]								0	0

Table E.3.4-2.-- Risk Assessments from Exposure to Hazardous Chemicals from Downsize/ Consolidate Secondary and Case Fabrication at Oak Ridge Reservation

	Regulated Exposure Limits/ Risk Factors	

Chemical				**Emissions Inventory**		**Hazard Quotient**		**Cancer Risk**	
	RfC (mg/m3)	**PEL [9] (mg/m3)**	**Slope Factor (mg/kg/day)**	**Boundary Annual MEI[10] (mg/m3)**	**Worker 100 m 8 hours (mg/m3)**	**Boundary Annual MEI[10], [11]**	**Worker 100 m 8 hours [12]**	**Boundary Annual MEI[10], [13]**	**Worker 100 m 8 hours [14]**
Carbon monoxide	1.35	55	None	4.85x10-4	2.91x10-1	3.59x10-4	5.30x10-3	0	0
Chlorine	0.35	3	None	8.91x10-6	5.35x10-3	2.55x10-5	1.78x10-3	0	0
Hydrogen chloride	0.0070	7.0	None	3.17x10-4	1.90x10-1	4.53x10-2	2.72x10-2	0	0
Methyl alcohol	1.75	260	None	9.57x10-4	5.75x10-1	5.47x10-4	2.21x10-3	0	0
Nitric acid	0.1225	5	None	4.62x10-4	2.77x10-1	3.77x10-3	5.65x10-2	0	0
Ozone	0.0049	0.2	None	4.62x10-6	2.77x10-3	9.43x10-4	1.39x10-2	0	0
Sulfuric acid	0.0245	1	None	1.19x10-4	7.13x10-2	4.85x10-3	7.13x10-2	0	0

Uranium-235	0.0105	0.25	None	6.60x10-9	3.96x10-6	6.29x10-7	1.59x10-5	0	0
Uranium-238	0.0105	0.25	None	1.32x10-7	7.93x10-5	1.22x10-5	3.17x10-4	0	0
Volatile organic compounds (toluene)	0.4	766	None	7.92x10-5	4.76x10-2	1.98x10-4	6.21x10-5	0	0
Hazard Index 15						5.60x10-2	1.78x10-1		
Total Cancer Risk 16								0	0

Table E.3.4-3.-- Risk Assessments from Exposure to Hazardous Chemicals from Phaseout of Secondary and Case Fabrication at Oak Ridge Reservation

Chemical	**Regulated Exposure Limits/ Risk Factors**			**Emissions Inventory**		**Hazard Quotient**		**Cancer Risk**	
	RfC (mg/ m3)	**PEL 17 (mg/ m3)**	**Slope Factor (mg/ kg/ day)**	**Boundary Annual MEI18 (mg/m3)**	**Worker 100 m 8 hours (mg/ m3)**	**Boundary Annual MEI18, 19**	**Worker 100 m 8 hours 20**	**Boundary Annual MEI18, 21**	**Worker 100 m 8 hours 22**

Carbon monoxide	1.35	55	None	1.36x10-2	2.60	1.01x10-2	4.73x10-2	0	0
Chlorine	0.35	3	None	2.63x10-4	5.04x10-2	7.51x10-4	1.68x10-2	0	0
Hydrogen chloride	0.0070	7.0	None	1.12x10-4	2.16x10-2	1.61x10-2	3.08x10-3	0	0
Methyl alcohol	1.75	260	None	4.30x10-4	8.24x10-2	2.46x10-4	3.17x10-4	0	0
Nitric acid	0.1225	5	None	1.65x10-4	3.17x10-2	1.35x10-3	6.34x10-3	0	0
Sulfuric acid	0.0245	1	None	5.29x10-5	1.01x10-2	2.16x10-3	1.01x10-2	0	0
1,1,1-Trichloroethane (TCA)	0.1225	1,900	None	3.31x10-6	6.34x10-4	2.70x10-5	3.34x10-7	0	0
Volatile organic compounds (toluene)	0.4	766	None	3.80x10-4	7.29x10-2	9.51x10-4	9.52x10-5	0	0
Hazard Index [23]						3.16x10-2	8.41x10-2		

Total Cancer Risk [24]								0	0

Table E.3.4-4.--Risk Assessments from Exposure to Hazardous Chemicals from No Action at Savannah River Site

Chemical	**Regulated Exposure Limits/ Risk Factors**								
				Emissions Inventory		**Hazard Quotient**		**Cancer Risk**	
	RfC (mg/m3)	**PEL [25] (mg/m3)**	**Slope Factor (mg/kg/day)**	**Boundary Annual MEI[26] (mg/m3)**	**Worker 100 m 8 hours (mg/m3)**	**Boundary Annual MEI[26], [27]**	**Worker 100 m 8 hours [28]**	**Boundary Annual MEI[26], [29]**	**Worker 100 m 8 hours [30]**
Benzene	0.0796	3.25	0.029	1.25x10-6	1.37x10-2	1.57x10-5	4.2x10-3	1.04x10-8	1.53x10-5
Benzene	0.0796	3.25	0.029	1.23x10-5	1.35x10-1	1.55x10-4	4.15x10-2	1.02x10-7	1.51x10-4
Carbon Monoxide	1.35	55	None	5.41x10-3	5.91x10-1	4.01x10-3	1.07	0	0
Chlorine	0.35	3	None	9.27x10-9	1.01x10-4	2.65x10-8	3.37x10-5	0	0
Chloroform	0.035	240	0.0061	4.79x10-6	5.24x10-2	1.37x10-4	2.18x10-4	8.36x10-9	1.24x10-5

Cobalt	0.00245	0.1	None	7.46x10-9	8.15x10-5	3.05x10-6	8.15x10-4	0	0
Hydrogen Fluoride	0.21	2.49	None	4.29x10-8	4.69x10-4	2.04x10-7	1.88x10-4	0	0
Hydrogen Fluoride	0.21	2.49	None	8.39x10-12	9.16x10-8	3.99x10-11	3.68x10-8	0	0
Mercury	0.0003	0.1	None	5.17x10-8	5.65x10-4	1.72x10-4	5.65x10-3	0	0
Mercury (vapor)	0.0003	0.1	None	1.89x10-7	2.06x10-3	6.29x10-4	2.06x10-2	0	0
Mercury oxide	0.0003	0.1	None	6.36x10-18	6.95x10-14	2.12x10-14	6.95x10-13	0	0
Nickel compounds	0.0245	1	0.84	3.16x10-16	3.45x10-12	1.29x10-14	3.45x10-12	7.6x10-17	1.12x10-13
Nickel (vapor and compounds)	0.0245	1	0.84	4.31x10-8	4.7x10-4	1.76x10-6	4.7x10-4	1.03x10-8	1.53x10-5
Nitric acid	0.1225	5	None	3.73x10-6	4.07x10-2	3.04x10-5	8.15x10-3	0	0

Phosphoric acid	0.0245	1	None	1.5x10-7	1.63x10-3	6.11x10-6	1.63x10-3	0	0
Hazard Index [31]						5.16x10-3	1.16		
Total Cancer Risk [32]								1.31x10-7	1.94x10-4

Table E.3.4-5.--Risk Assessments from Exposure to Hazardous Chemicals from Pit Fabrication at Savannah River Site

Chemical	**Regulated Exposure Limits/ Risk Factors**			**Emissions Inventory**		**Hazard Quotient**		**Cancer Risk**	
	RfC (mg/m3)	**PEL [33] (mg/m3)**	**Slope Factor (mg/kg/day)**	**Boundary Annual MEI[34] (mg/m3)**	**Worker 100 m 8 hours (mg/m3)**	**Boundary Annual MEI[34], [35]**	**Worker 100 m 8 hours [36]**	**Boundary Annual MEI[34], [37]**	**Worker 100 m 8 hours [38]**
Carbon monoxide	1.35	55	None	1.06x10-6	1.55x10-2	7.82x10-7	2.10x10-4	0	0
Carbon dioxide	221	9,000	None	6.99x10-5	7.64x10-1	3.16x10-7	8.48x10-5	0	0
Volatile organic compounds (toluene)	0.4	766	None	2.94x10-7	3.21x10-3	7.34x10-7	4.19x10-6	0	0

Hazard Index [39]						1.83x10-6	2.99x10-4		
Total Cancer Risk [40]								0	0

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[1] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[2] MEI - maximally exposed individual of the public.

[3] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[4] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[5] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[6] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[7] Hazard index - sum of individual hazard quotients.

[8] Total cancer risk - sum of individual cancer risks.

OR LMES 1995e.

9

See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

10

MEI - maximally exposed individual of the public.

11

Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

12

Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

13

Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

14

Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

15

Hazard index - sum of individual hazard quotients.

16

Total cancer risk - sum of individual cancer risks.

OR MMES 1996j.

17

See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

18

MEI - maximally exposed individual of the public.

19

Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

20

Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

21

Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

22

Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

23

Hazard index - sum of individual hazard quotients.

24

Total cancer risk - sum of individual cancer risks.

OR LMES 1996i.

25

See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

26

MEI - maximally exposed individual of the public.

27

Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

28

Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

29

Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

30

Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

31

Hazard index - sum of individual hazard quotients.

32

Total cancer risk - sum of individual cancer risks.

SRS 1995a:2.

33

See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

34

MEI - maximally exposed individual of the public.

35

Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

36

Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

37

Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

38

Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

39

Hazard index - sum of individual hazard quotients.

40

Total cancer risk - sum of individual cancer risks.

WSRC 1995c.

E.4 HEALTH EFFECTS STUDIES: EPIDEMIOLOGY

Various epidemiologic studies have been conducted at some of the sites evaluated in this PEIS because of the concern for potential adverse health effects associated with the manufacture and testing of nuclear weapons. These studies focus on the DOE workforce and residents of communities surrounding DOE sites.

E.4.1 Background

The health effects associated with ionizing radiation exposure were first published about 60 years ago. Studies published in the 1930s first documented cancer among painters who used radium to paint watch dials back in 1910 to 1920. Radiation therapy for disease has been used since the 1930s and studies have shown that the risk of cancer was related to the amounts of radiation received. Nuclear weapons research and manufacture, and consequent exposure to radiation occurred beginning in the late 1930s. Exposure to radionuclides has changed over time with higher levels occurring in the early days of research and production. Numerous epidemiologic studies have been conducted among workers who manufactured and tested nuclear weapons due to the concern with potential adverse health effects. More recently, concerns about radiologic contaminants offsite have resulted in health studies among communities that surround DOE facilities. The following section briefly gives an overview of epidemiology followed by a review of epidemiologic studies of sites evaluated in this PEIS.

Epidemiology is the study of the distribution and determinants of disease in human populations. The distribution of disease is considered in relation to time, place, and person. Relevant population characteristics should include the age, race, and sex distribution of a population, as well as other characteristics related to health, such as social characteristics (e.g., income and education), occupation, susceptibility to disease, and exposure to specific agents. Determinants of disease include the causes of disease, as well as factors that influence the risk of disease.

E.4.1.1 Study Designs

Ecologic Studies. Ecologic studies compare the frequency of a disease in groups of people in conjunction with simple descriptive studies of geographical information in an attempt to determine how health events among populations vary with levels of exposure. These groups may be identified as the residents of a neighborhood, a city, or a county where demographic information and disease or mortality data are available. Exposure to specific agents may be defined in terms of residential location or proximity to a particular area, such as distance from a waste disposal site. An example of an ecologic study is a comparison of the rate of heart disease among community residents by drinking water quality.

The major disadvantage of ecologic studies is that the measure of exposure is based on the average level of exposure in the community, when what is really of interest is each individual's exposure.

Ecologic studies do not take into account other factors such as age and race that may also be related to disease. These types of studies may lead to incorrect conclusions, an "ecologic fallacy." For the above example, it would be incorrect to assume that the level of water hardness influences the risk of getting heart disease. Despite the obvious problems with ecologic studies, they can be a useful first step in identifying possible associations between the risk of disease and environmental exposures. However, because of their potential for bias they should never be considered more than an initial step in investigation of disease causation.

Cohort Studies. The cohort study design is a type of epidemiologic study frequently used to examine occupational exposures within a defined workforce. A cohort study requires a defined population that can be classified as being exposed or not exposed to an agent of interest, such as radiation or chemicals that influence the probability of occurrence of a given disease. Characterization of the exposure may be qualitative (e.g., high, low, or no exposure) or very quantitative (e.g., radiation measured in Sieverts (Sv), chemicals in parts per million [ppm]). Surrogates for exposure, such as job titles, are frequently used in the absence of quantitative exposure data.

Individuals enumerated in the study population are tracked for a period of time and fatalities recorded. In general, overall rates of death and cause-specific rates of death have been assessed for workers at the PEIS sites. Death rates for the exposed worker population are compared with death rates of workers who did not have the exposure (internal comparison), or compared with expected death rates based on the U.S. population or state death rates (external comparison). If the rates of death differ from what is expected, an association is said to exist between the disease and exposure. In cohorts where the exposure has not been characterized, excess mortality can be identified, but these deaths cannot be attributed to a specific exposure, and additional studies may be warranted. More recent studies have looked at other disease endpoints, such as overall and cause-specific cancer incidence (newly diagnosed) rates.

Most cohort studies at PEIS sites have been historical cohort studies, that is, the exposure occurred some time in the distant past. These studies rely on past records to document exposure. This type of study can be problematic if exposure records are incomplete or were destroyed. Cohort studies require extremely large populations that have been followed for many (20 to 30) years. They are generally difficult to conduct and are very expensive. These studies are not well suited to studying diseases that are rare. Cohort studies do, however, provide a direct estimate of the risk of death from a specific disease, and allow an investigator to look at many disease end points.

Case-Control Studies. The case-control study design starts with the identification of persons with the disease of interest (case) and a suitable comparison (control) population of persons without the disease. Controls must be persons who are at risk for the disease and are representative of the population that generated the cases. The selection of an appropriate control group is often quite problematic. Cases and controls are then compared with respect to the proportion of individuals exposed to the agent of interest. Case-control studies require fewer persons than cohort studies, and therefore, are usually less costly and less time consuming, but are limited to the study of one disease (or cause of death). These types of studies are well suited for the study of rare diseases and are generally used to examine the relationship between a specific disease and exposure.

E.4.1.2 Definitions

Unfamiliar terms frequently used in epidemiologic studies, including those used in this document, are defined below.

Age, gender, and cigarette smoking are the principal determinants of mortality. Standardization is a statistical method used as a control for the effects of age, gender, or other characteristics so that death rates may be compared among different population groups. There are two ways to standardize rates, the indirect or direct methods. In general, the indirect method of standardization is most frequently used.

Indirect Standardization: The disease rates in the reference (comparison) population are multiplied by the number of individuals in the same age and gender groups in the study population to obtain the expected rate of disease for the study population.

Direct Standardization: The disease rates in the study population are multiplied by the number of individuals in the same age and gender group in the reference (comparison) population. This gives the expected rates of disease for the reference population if these rates had prevailed in that group.

Standardized Mortality Ratio: The standardized mortality rate (SMR) is the ratio of the number of deaths observed in the study population to the number of expected deaths. The expected number of deaths is based on a reference (or comparison population). Death rates for the U.S. (or state) population are most frequently used as the comparison to obtain expected rates. An SMR of 1 indicates a similar risk of disease in the study population compared with the reference population. An SMR greater than 1 indicates excess risk of disease in the study population compared with the reference group, and an SMR less than 1 indicates a deficit of disease.

Relative Risk: The ratio of the risk of disease among the exposed population to the risk of disease in the nonexposed population. Relative risks are estimated from cohort studies.

Odds Ratio: The ratio of the odds of disease if exposed, to the odds of disease if not exposed. Under certain conditions the odds ratio approximates the relative risk. Odds ratios are estimated from case-control studies.

E.4.2 Oak Ridge Reservation

Surrounding Communities. The population-based National Cancer Institute's mortality survey for selected nuclear facilities Cancer in Populations Living Near Nuclear Facilities (NIH Publication No. 90-874, July 1990) examined the cancer mortality within an 80 km (50 mi) radius around several nuclear facilities, including Anderson and Roane counties (JAMA 1991a:1403-1408). No excess cancer mortality was observed in the population living in the exposed counties when compared to the U.S. white male population, nor when compared to the population of the control counties (Blount, Bradley, Coffee, Jefferson, and Hamblen, TN, and Henderson, NC), nor when time trends were assessed.

Tennessee Medical Management, Inc. used data from the Tennessee Cancer Reporting System to compare mortality and incidence data for counties near Oak Ridge, Tennessee, for the 3-year period, 1988 to 1990, to the U.S. population (TMM 1993a). For Oak Ridge, total deaths from all causes was significantly lower than expected. For Anderson County, the observed number of deaths from uterine cancer and from cancer of respiratory and intrathoracic organs was statistically greater than expected and the number of deaths from brain cancer, breast cancer, and the "all other sites" category were lower than expected for Anderson County. For Roane County, the number of deaths from cancer of the respiratory and intrathoracic organs was statistically greater than expected. The number of deaths from cancer of the digestive organs and the peritoneum; from uterine cancer; and from lip, oral cavity, and pharynx cancer was lower than expected.

Tennessee Medical Management, Inc. examined new (incident) cancer cases and identified the following as statistically significant: For Anderson County, the observed numbers of cases of cancer of the prostate and of cancer of the lung and bronchus were greater than expected. Leukemia, stomach and small intestine cancers, and cancers of the colon and intestinal tract were lower than expected. For Roane County, the number of cases of cancer of the lung and bronchus was greater than expected. Non-Hodgkin's lymphoma, female breast cancer, esophageal cancer, cancer of the pancreas, and cancer in all sites were lower than expected. The only consistent excess reported for both cancer mortality and cancer incidence was for cancer of respiratory and intrathoracic organs.

Because of a concern for possible contamination of the population by mercury, the Tennessee Department of Health and Environment conducted a pilot study in 1984 (TN DHE 1984a). The study showed no difference in urine or hair mercury exposures (residence or activity in contaminated areas based on soil measurements or consumption of fish caught in the contaminated areas), compared to those with little potential exposure. Mercury levels in some soils measured as high as 2,000 ppm. Analysis of a few soil samples showed that most of the mercury in the soil, however, was inorganic, thereby lowering the probability of bioaccumulation and health effects. Examination of the long-term effects of exposure to mercury and other chemicals continues.

State Health Agreement Program. Under the State Health Agreement Program managed by DOE's Office of Epidemiologic Studies, a grant was awarded to the Tennessee Department of Health and Environment. The purpose of the grant was to determine the extent of exposure to contaminants among workers and residents of the surrounding community as a result of ORR operations, and to assess the current status of health outcomes and determine their potential association with these exposures.

A dose reconstruction feasibility study began in 1992, with the contract awarded by the State of Tennessee to ChemRisk. The contractor performed extensive review of Oak Ridge documents and issued a report, which concluded that sufficient information exists to reconstruct past releases and offsite doses caused by radioactive and hazardous materials. The report also concluded that doses from mercury, polychlorinated biphenyl, radioactive iodine, and radioactive cesium may have been great enough to cause harmful health effects in the offsite population. Based on this information, a full dose reconstruction study was initiated in August 1994.

Other activities supported under the grant include: development of a birth defects registry, a quality improvement program for the Tennessee cancer registry, a review and evaluation of the DOE occupational medical program, and the implementation of a community participation/public information program.

Technical support to the State health department is provided by a 12-member Oak Ridge Health Agreement Steering Panel. The Health Advisory Panel provides direction and oversight to those working on health studies, ensures public input, and informs the public of activities related to the health studies. A representative of the Centers for Disease Control and Prevention's National Center for Environmental Health is a member of the advisory panel. A representative from DOE serves as an ex-officio member.

Workers. Between 1943 and 1985, there were 118,588 male and female individuals of all races who were employed in any of the Oak Ridge facilities. These included Oak Ridge National Laboratory (ORNL) for nuclear research (also called the X-10 Facility); the Y-12 Plant (Y-12) under management of the Tennessee-Eastman Corporation (1943 to 1947), which produced enriched uranium by the electromagnetic separation process; Y-12 under management of Union Carbide (1948 to 1984), which fabricated and certified nuclear weapons parts; and the K-25 Site (K-25) (Oak Ridge Gaseous Diffusion Plant), which produced enriched uranium through the gaseous process. Analyses at the Oak Ridge facilities have been carried out mostly for white males, and for specific cohorts taking into consideration time-related exposure risks.

Oak Ridge National Laboratory. The mortality experience of 8,375 white males employed at least a month between 1943 and 1972 at ORNL was compared with the U.S. white male population using SMR analyses in a 1985 paper by Checkoway et al. (BJIM 1985a:525-533). Increases in deaths from leukemia (SMR - 1.49, 16 observed), cancer of the prostate (SMR - 1.16, 14 observed), and Hodgkin's disease (SMR - 1.10, 5 observed) were observed, although none were statistically significant. Dose response analyses were performed for all causes of death combined, all cancers combined, leukemia, and prostate cancer comparing exposed worker death rates with nonexposed worker death rates. Dosimetry data were available for the entire period of the study with the total population external radiation dose measuring 13,500 mrem. No dose response gradients were observed. Death rates were calculated for 11 different job categories by length of time in each job in an attempt to determine whether specific work environments were related to cancer and leukemia. Leukemia mortality was observed to be related to length of employment in engineering and maintenance jobs.

Followup to this cohort study was expanded through 1984 in an updated study by Wing et al. (JAMA 1991a:1397-1402). Again, death rates in the worker population were compared with those in the U.S. population. Nonstatistically significant increases were noted for cancers of the pancreas (SMR - 1.09, 25 observed), prostate (SMR - 1.05, 26 observed), brain (SMR - 1.04, 15 observed), and lymphosarcoma and/or reticulasarcoma (SMR - 1.05, 9 observed). There was a significant increase in deaths from leukemia (SMR - 1.63, 28 observed, 95 percent confidence interval [CI] 1.08-2.35). The total population external radiation dose was 144 Sv. Dose response analyses performed for all causes except cancer, lung cancer, and leukemia did not demonstrate a relationship between level of external radiation and increased risk of death from these outcomes. There was a significant dose response relationship (4.94 percent per 1,000 mrem) between cancer deaths and level of external radiation dose using models with a 20-year lag. A subgroup of workers who were monitored for internal contamination had nonstatistically elevated SMRs for cancer of the prostate (SMR - 1.12, 10 observed) and lymphosarcoma and/or reticulasarcoma (SMR - 1.65, 6 observed). The workers monitored for internal contamination had a statistically significant elevated SMR for leukemia (SMR - 2.23 16 observed, 95 percent CI 1.27-3.62).

A second publication on the above data set examined the effect of controlling for a number of possible selection and confounding factors on the risk coefficient for all cancer dose responses (AJIM 1993a:265-279). Models were adjusted for the following variables with little change in the previously reported risk coefficient: employment during the World War II era, short-term employment, job category, and exposure to beryllium, lead, and mercury. The authors concluded that the previously calculated dose response estimate was fairly stable when adjustments were made for a wide range of potential confounders that were not explored in the earlier study.

Y-12 Plant. Y-12 is a nuclear weapons materials fabrication plant where the radiologic exposure of greatest concern is internal exposure from the inhalation of uranium compounds. The Tennessee Eastman Corporation managed the plant from 1943 to 1947. Polednak and Frome reported a followup through 1974 of all 18,869 white male workers employed at Y-12 from 1943 to 1947 (JOM 1981a:169-178). The workers included those exposed to internal (alpha) and external (beta) radiation through the inhalation of uranium dusts, electrical workers who performed maintenance in the exposed areas, and other nonexposed workers. Individual measures of exposure were not available for any members of this cohort, so exposure levels were inferred from plant areas of work and jobs. High average air levels of uranium dust were documented in departments employing chemical workers. Elevated SMRs were observed for mental, psychoneurotic, personality disorders (SMR - 1.36, 36 observed), emphysema (SMR - 1.16, 100 observed), diseases of the bones and organs of movement (SMR - 1.22, 11 observed), lung cancer (SMR - 1.09, 324 observed), and external causes of death (SMR - 1.09, 623 observed). The lung cancer SMR was greater among workers employed for 1 year or more compared with workers employed less than 1 year and was more pronounced in workers hired at the age of 45 or older (SMR - 1.51; 95 percent CI 1.01-2.31). Of the workers employed after the age of 44, the SMR for lung cancer was greatest for electrical workers (SMR - 1.55, 7 observed), alpha chemistry workers (SMR - 3.02, 7 observed), and beta process workers (SMR - 1.51, 11 observed).

During the early operation of Y-12 from 1942 to 1947, a group of male workers was exposed to phosgene gas on a chronic basis (N - 694) and a smaller group of males received acute exposures (N - 106) along with a small group of females (N - 91) (ER 1980a:357-367; TIH 1985a:137-147). A control group of 9,280 workers who also worked at Y-12 during the same era, but who did not have phosgene exposure, was also described. All groups were followed through the end of 1978. The SMRs for the chronically exposed group and the control group were similar for all causes examined. There was no evidence for increased mortality from respiratory diseases in this group and the SMR for lung cancer, while elevated, was similar to the lung cancer SMR for workers in the rest of the plant. Among those with acute exposures, the SMR for respiratory diseases was elevated (SMR - 2.66, 5 observed) and this elevation may be related to residual lung damage from the acute phosgene exposure. It was difficult to trace the vital status of the 91 women; therefore, description of these highly exposed workers was limited to listing the frequency of their initial symptoms after exposure. As expected, nausea, vomiting, and coughing were the most frequently reported symptoms. Unexpectedly, the women experienced a lower frequency of pneumonitis than their male counterparts.

The portion of the Y-12 cohort employed between 1947 and 1974 was described in a study by Checkoway et al. (AJE 1988a:255-266). This study included 6,781 white male workers first employed at Y-12 between 1947 and 1974 who were employed for at least 30 days. Mortality data were collected for the cohort through the end of 1979 and were used to perform SMR and cause specific dose-response analyses. Nonstatistically significant increases were observed for all cancers (SMR - 1.01, 196 observed), diseases of the blood-forming organs (SMR - 1.48, 3 observed), kidney cancer (SMR - 1.22, 6 observed), brain cancer (SMR - 1.80, 14 observed), and other lymphatic cancers (SMR - 1.86, 9 observed). A statistically significant increase in deaths from lung cancer (SMR - 1.36, 89 observed; 95 percent CI - 1.09-1.67) was observed compared with the U.S. lung cancer rates, but not with Tennessee lung cancer rates (SMR - 1.18, 95 percent CI - 0.95-1.45). Dose-response analyses for lung cancer and internal alpha radiation dose and external gamma radiation dose did not reveal a positive relationship for a 0- or 10-year lag. Examination of lung cancer rates distributed across both internal and external dose categories suggested a dose-response with external radiation dose among individuals who had 5 or more rems of internal dose. Brain cancer was not related to the level of internal or external radiation dose.

The Y-12 cohort studied by Checkoway was updated through the end of 1990 by Loomis and Wolf and included African-American and white female workers (AJIM 1996a:131-141). The dose-response analyses were not included in the update; therefore, only SMR analyses are reported. For all workers examined as a group, nonstatistically significant elevations were observed for cancer of the pancreas (SMR - 1.36, 34 observed), skin cancer (SMR - 1.07, 11 observed), breast cancer (females only, SMR - 1.21, 11 observed), prostate cancer (SMR - 1.31, 36 observed), kidney cancer (SMR - 1.30, 16 observed), brain cancer (SMR - 1.29, 20 observed), cancers of other lymphatic tissues (SMR - 1.32, 22 observed), and diseases of the blood-forming organs (SMR - 1.23, 6 observed). The SMR for lung cancer was statistically significant (SMR - 1.17, 202 observed; 95 percent CI 1.01-1.34), particularly in the white male segment of the population (SMR - 1.20, 194 observed; 95 percent CI - 1.04-1.38). Examination of the lung cancer mortality by year of hire, latency, duration of employment, and calendar year at risk indicated the excess was confined to those who were first hired before 1954 (SMR - 1.27, 161 observed), and was greatest in persons employed 5 to 20 years with 10 to 30 years of followup. Elevated lung cancer deaths was first evident between 1955 and 1964 and continued to increase from 1975 to 1979, followed by a decrease in lung cancer death rates.

Between 1953 and 1963 Y-12 used mercury in a process to produce large quantities of enriched lithium. Cragle et al. studied all workers employed at Y-12 at least 5 months between January 1, 1953 and April 30, 1958 (N - 5,663) (JOM 1984a:817-821). This group was categorized into workers exposed to mercury and workers not exposed to mercury based on results of urinalysis data supplied by the plant. Vital status followup was complete through the end of 1978 and SMRs were calculated. Compared with nonexposed workers, there were no differences in the mortality patterns for: 1) mercury-exposed workers as a whole, 2) workers with the highest mercury exposures, and 3) workers employed more than a year in a mercury process. The authors acknowledge that mortality is not the optimal end point to assess health effects related to mercury exposure.

The mercury workers were involved in a clinical study by Albers et al. who examined 502 Y-12 workers, 247 of whom worked in the mercury process 20 to 35 years prior to the examination (AN 1988a:651-659). Correlations between declining neurological function and increasing exposure were identified. An exposure assessment was determined for each mercury worker during the time of employment in the mercury process. Study subjects who had at least one urinalysis equal to or greater than 0.6 mg/liters of mercury showed decreased strength, coordination, and sensation along with increased tremor, and prevalence of Babinski and snout reflexes when compared with the 255 nonexposed workers. Clinical polyneuropathy was associated with the level of the highest exposure, but not with the duration of exposure.

K-25 Site. K-25 enriched uranium beginning in 1945 using a gaseous diffusion process. There was potential exposure to uranium dust, oxidized uranium compounds, uranium hexafluoride, and a number of chemical compounds used in the process. In later years of operation, the gas centrifuge process was used to enrich uranium. No analyses of death rates for this population have been published; however, health effects have been studied.

Powdered nickel was used at K-25 in the production of the barrier material used to separate and enrich uranium. Workers who fabricated the barrier material were exposed to nickel powder through inhalation. Cragle et al. (IARC 1984a:57-63) updated an earlier study by Godbold et al. (JOM 1979a:799-806) of 814 workers who were employed in the manufacture of barrier material between 1948 and 1953. A comparison group of white males employed at K-25 sometime between 1948 and 1953 (N - 7,552) was also selected. The SMRs in the barrier group were similar to those in the nonbarrier worker group for most noncancer outcomes. The nickel workers were noted to have a higher rate of death from cancers of the buccal cavity and pharynx (SMR - 2.92, 3 observed) than the nonnickel workers (SMR - 0.23, 3 observed). When the directly standardized rates were compared, the rate of buccal cavity and pharynx cancer in the nickel workers was approximately 19 times higher than the rate in the nonnickel workers. The authors acknowledge that the number of cases is quite small and recommended additional followup to determine if this trend continued. There were no nasal sinus cancers observed in the worker population exposed to metallic nickel, in contrast to the results of studies of workers in nickel refineries where the rates of sinus cancer related to nickel compounds are quite high.

K-25 workers employed in the gas centrifuge process were the focus of an interview study by Cragle et al. (AOEH 1992a:826-834). The study was conducted in order to determine the incidence rate for cancer and illness symptoms among workers exposed to epoxy resin and solvents prevalent in the process. A total of 263 workers determined to have worked closest and longest to the process were compared with 271 employees employed at the plant during the same time, but did not work in the centrifuge process. The centrifuge workers and the noncentrifuge workers had similar overall cancer incidence rates. However, the centrifuge workers reported five incident bladder cancers versus none reported by the noncentrifuge group. The centrifuge workers also reported significantly more rashes, dizziness, and numb or tingling limbs during employment, which are symptoms associated with high solvent exposure. One of the epoxy resins used in the early years of the process was a potential bladder carcinogen, but none of the workers with bladder cancer had jobs that required routine, hands-on work with that material. A specific causative agent for the increase in bladder cancer was not identified.

Combined Oak Ridge Reservation Facilities. Frome et al. reported on the mortality experience of World War II workers employed at three ORR facilities between 1943 and 1947 (RR 1990a:138-152). Poisson regression analyses were used as a control for potential confounders such as facility of employment, socioeconomic status, period of follow-up, and birth year. The cohort included white males employed at any ORR facility at least 30 days between the start of the operation and 1947 and were never employed at an ORR facility after 1947 (N - 28,008). Elevated mortality was statistically significant for all causes (SMR - 1.11, 11,671 observed); tuberculosis (SMR - 1.37, 108 observed); mental, psychoneurotic, and personality disorders (SMR - 1.60, 81 observed); cerebrovascular disease (SMR - 1.11, 833 observed); diseases of the respiratory system (SMR - 1.25, 792 observed); emphysema (SMR - 1.24, 209 observed); all accidents (SMR - 1.28, 694 observed); and motor vehicle accidents (SMR - 1.44, 339 observed). The only elevated site-specific cancer that was statistically significant was lung cancer (SMR - 1.27, 850 observed). A surrogate for radiation exposure based on a worker's job and department was used to indicate the probability of exposure. This surrogate for actual radiation exposure was not associated with increased rates of cancer.

Carpenter investigated earlier reports of an association between brain cancer and employment at Y-12 by conducting a case-control study of workers employed between 1943 and 1977 at ORNL or Y-12 (JOM 1987a:601-604). Cases consisted of 72 white males and 17 white females with brain cancer. Four controls were selected for each case matched on age, sex, cohort, year of birth, and year of hire. Analyses with respect to internal and external radiation exposures indicated no association with brain cancer. Two companion papers were also published from this case-control study, one examined relationships between brain cancer and chemical exposures (AJIM 1988a:351-362) and the other examined nonoccupational risk factors (AJPH 1987a:1180-1182). No statistically significant association between the use of 26 chemicals evaluated and the risk of brain cancer was observed. The chemicals evaluated included those encountered in welding fumes, beryllium, mercury, 4,4-methylene bis 2-chloroaniline or MOCA, cutting oils, thorium, methylene chloride, and other solvents. Excess brain cancer was observed, however, among individuals employed for more than 20 years (odds ratio - 7.0, 9 cases; 95 percent CI 1.2-41.1). Analysis of 82 cases with complete medical records revealed an association with a previous diagnosis of epilepsy (odds ratio - 5.7, 4 cases; 95 percent CI 1.0-32.1) recorded for pre-employment and health status followup.

Causes of death among white male welders (N - 1,059) employed between 1943 and 1973 at Y-12, K-25, and ORNL were studied by Polednak (AEH 1981a:235-242). Based on deaths reported through 1974, mortality from all causes for welders was slightly lower than that expected based on death rates for U.S. white males (SMR - 0.87, 173 observed). Nonstatistically significant decreases in mortality were also observed for all cancers (SMR - 0.88, 32 observed), especially digestive cancer (SMR -

0.49, 5 observed); diseases of the circulatory system (SMR - 0.74, 72 observed); diseases of the digestive system (SMR - 0.76, 9 observed); and accidents (SMR - 0.89, 16 observed). Nonstatistically significant increases were noted for lung cancer (SMR - 1.50, 17 observed); diseases of the respiratory system (SMR - 1.33, 13 observed), especially emphysema (SMR - 2.21, 6 observed); and suicide (SMR - 1.64, 10 observed). A sub-group of welders (N - 536) exposed to nickel oxides (possible respiratory carcinogens) at K-25 were compared with welders at the other two facilities (N - 523). The risk of lung cancer and other respiratory diseases did not differ between the two groups.

Combined Nuclear Sites. ORR workers have been included in several studies that have examined occupational risks across the nuclear complex, both in the United States and internationally. These combined studies have been undertaken in an attempt to increase the statistical power of the studies to detect the effects of low-level chronic radiation exposure.

Y-12 workers were included in a lung cancer case-control study of workers from the Fernald Feed Materials and Production Center cohort and the Mallinckrodt Chemical Works cohort. Dupree et al. conducted a nested case-control study of lung cancer (N - 787) to investigate the relationship between lung cancer and uranium dust exposure (Epidemiology 1995a:370-375). Eligible cases included workers who were employed at least 183 days in any of the facilities and died before January 1, 1983, with lung cancer listed anywhere on the death certificate. Inclusion of deaths through 1982 allowed over 30 years of observation at each facility. One control was matched to each case on facility, race, gender, and birth and hire dates within 3 years. Data collected on all study members included smoking history, first pay code (a surrogate for socioeconomic status), complete work histories, and occupational radiation monitoring records. Annual radiation lung dose from deposited uranium was estimated for each study member. Annual external whole body doses from gamma radiation were determined for workers who had personal monitoring data available. Potential confounders considered in the analysis were smoking (ever/never used tobacco) and pay code (monthly/ nonmonthly). With a 10-year lag, cumulative lung doses ranged from 1 to 137 rads for cases and from 0 to 80 rads for controls. The odds ratios for lung cancer mortality for seven cumulative internal dose groups did not demonstrate increasing risk with increasing dose. An odds ratio of 2.0 was estimated for those exposed to 25 rads or more, but the 95 percent confidence interval of -.20 to 20 showed great uncertainty in the estimate. There was a suggestion of an exposure effect for workers hired at age 45 years or older.

A combined site mortality study included workers from ORNL, the Hanford Site, and the Rocky Flats Plant (RR 1993a:408-421). Earlier analyses of these cohorts indicated that risk estimates calculated through extrapolation from high-dose data to low-dose data did not seriously underestimate risks of exposure to low-dose radiation (AJE 1990a:917-927; RR 1989a:19-35). The updated analyses were performed in order to determine whether the extrapolated risks represented an over-estimation of the true risk at low doses. The study population consisted of white males employed at one of the three facilities for at least 6 months and monitored for external radiation. The Hanford population also included females and nonwhite workers. The total population dose was 123,700 rem. Analyses included trend tests for site-specific cancer deaths and several broad noncancer categories. Statistically significant trends were noted for cancer of the esophagus, cancer of the larynx, and Hodgkin's disease. These cancers were not related to radiation exposure levels in previously published studies. Excess relative risk models were calculated for the combined DOE populations and for each DOE site separately. Without exception, all risk estimates included the possibility of zero risk (i.e., the confidence interval for the risk coefficient went from below zero to above zero). There was evidence of an increase in the excess relative risk for cancer with increasing age in the Hanford and ORNL populations; both populations showed significant correlations of all cancer with radiation dose among those 75 years and older.

An international effort to pool data from populations exposed to external radiation included the ORNL population in addition to other radiation worker populations in the United States, Canada, and Britain (RR 1995a:117-132). The cohort comprised 95,673 workers (85.4 percent men) employed 6 months or longer and the population dose was 384,320 rem. There was no evidence of an association between radiation dose and mortality from all causes or from all cancers. There was a significant dose-response relationship with leukemia, excluding chronic lymphocytic leukemia (excess relative risk - 2.18 per 100 rem; 90 percent CI 0.1-5.7) and multiple myeloma (excess relative risk not computed; 44 observed). The study results do not suggest that current radiation risk estimates for cancer at low levels of exposure are appreciably in error.

Memorandum of Understanding. DOE entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The National Institute for Occupational Safety and Health is responsible for the conduct or management of worker studies.

The following studies are managed by the National Institute for Occupational Safety and Health with funding from DOE: a study of multiple myeloma among workers at K-25 at ORR (expected completion date 1996), a multisite study to assess the potential association between paternal exposure to ionizing radiation and the risk of leukemia in offspring of exposed male workers, a study of neurologic health outcomes in workers exposed to high levels of mercury between 1953 and 1963, studies of mortality among ORR workers, a multisite study of mortality among female nuclear workers, a multisite exposure assessment of hazardous waste/cleanup workers, a chronic beryllium disease study, and a multisite study of heat stress and performance among carpenters.

E.4.3 Savannah River Site

SRS, established in 1953 in Aiken, SC, produces plutonium, tritium, and other nuclear materials. There are reports that millions of curies of tritium have been released over the years both in plant exhaust plumes and in surface and groundwater streams (ED 1982a:135-152).

Surrounding Communities. In 1984, Sauer and Associates examined mortality rates in Georgia and South Carolina by distance from the Savannah River Plant (now known as SRS) (SR duPont 1984b). Rates for areas near the plant were compared with U.S. rates and with rates for counties located more than 80-km (50-mi) away. Breast cancer, respiratory cancer, leukemia, thyroid cancer, bone cancer, malignant melanoma of the skin, nonrespiratory cancer, congenital anomalies or birth defects, early infancy death rates, stroke, or cardiovascular disease in the populations living within 80 km (50 mi) of the plant did not show any excess risk compared with the reference populations.

State Health Agreement Program. Under the State Health Agreement Program managed by DOE's Office of Epidemiologic Studies, a grant was awarded to the Medical University of South Carolina in 1991 to develop the Savannah River Region Health Information System. The purpose of the Savannah River Region Health Information System database was to assess the health of populations surrounding SRS by tracking cancer rates and birth defects rates in the area. Information from the registry is available to public and private health care providers for use in evaluating cancer control efforts. A steering committee provides advice to the Savannah River Region Health Information System and communicates public concerns to the System. It consists of 12 community members and persons with technical expertise representing South Carolina and Georgia. The meetings are open to the public.

Workers. A descriptive mortality study was conducted that included 9,860 white male workers who had been employed at lease 90 days at the Savannah River Plant between 1952 and the end of 1974 (AJIM 1988b:379-401). Vital status was followed through the end of 1980 and mortality was compared with the U.S. population. SMRs were computed separately for hourly and salaried employees. For hourly employees, nonstatistically significant increases were seen for cancer of the rectum (SMR - 1.09, 5 observed), cancer of the pancreas (SMR - 1.08, 10 observed), leukemia and aleukemia (SMR - 1.63, 13 observed), other lymphatic tissue (SMR - 1.06, 5 observed), benign neoplasms (SMR - 1.33, 4 observed), and motor vehicle accidents (SMR - 1.10, 63 observed). Salaried employees exhibited nonstatistically significant increases in cancer of the liver (SMR - 1.84, 3 observed), cancer of the prostate (SMR - 1.35, 5 observed), cancer of the bladder (SMR - 1.87, 4 observed), brain cancer (SMR - 1.06, 4 observed), leukemia and aleukemia (SMR - 1.05, 4 observed), and other lymphatic tissue (SMR - 1.23, 3 observed). No trends between increasing duration of employment and SMRs were observed. A statistically significant excess of leukemia deaths was observed for hourly workers employed at least 5, but less than 15 years (SMR - 2.75, 6 observed). Review of the plant records and job duties of the workers who died from leukemia indicated that two of the cases had potential routine exposure to solvents, four had potential occasional exposure to solvents, and one had potential for minimal exposure. Benzene, a known carcinogen, was reportedly not used at the plant.

Epidemiologic Studies. DOE's Office of Epidemiologic Studies has implemented an Epidemiologic Surveillance Program at SRS to monitor the health of current workers. This program will evaluate the occurrence of illness and injury in the workforce on a continuing basis, and the results will be issued in annual reports. The implementation of this program will facilitate an ongoing assessment of the health and safety of the SRS workforce and will help identify emerging health issues.

Epidemiologic surveillance, which is currently operational at a number of DOE sites, including production sites and research and development (R&D) facilities, uses routinely collected health data, including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data for an extended period of time become available, time trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring the health of the workforce provides a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate the need for more detailed study or increased health and safety measures to ensure adequate protection for workers.

Memorandum of Understanding. DOE entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The Centers for Disease Control and Prevention's National Center for Environmental Health is responsible for dose reconstruction studies and the National Institute for Occupational Safety and Health is responsible for worker studies. These activities are funded by DOE.

A study of mortality among SRS workers employed from 1952 to 1974 to examine whether risks of death due to selected causes may be related to occupational exposures at SRS is being conducted by the National Institute for Occupational Safety and Health. SRS is also included in several multisite studies managed by the institute. The first study is to assess the potential association between paternal work-related exposure to ionizing radiation and the risk of leukemia in offspring of exposed male workers. The second study is to examine causes of death among female workers at nuclear weapons facilities to develop risk estimates based on exposures to external and internal ionizing radiation and to hazardous chemicals. A third multisite project is a case-control study of multiple myeloma, a type of blood cell cancer.

A dose reconstruction project around SRS is being conducted by the National Center for Environmental Health to determine the type and amount of contaminants to which people living around the site may have been exposed, to identify exposure pathways of concern, and to quantify the doses people may have received as a result of SRS operations. The estimated completion date is 1999 or 2000.

E.4.4 Kansas City Plant

Surrounding Communities. No known epidemiologic studies have been conducted in the surrounding communities to date.

Epidemiologic Surveillance. DOE's Office of Epidemiologic Studies has implemented an Epidemiologic Surveillance Program at the Kansas City Plant to monitor the health of current workers. This program will evaluate the occurrence of illness and injury in the workforce on a continuing basis and annual reports will be issued reporting the results of the ongoing surveillance. The implementation of this program currently supports the automation of occupational medical data management at the site to facilitate electronic access to key information used in surveillance. The program will facilitate an ongoing assessment of the health and safety of the site's workforce and help to identify any emerging health issues in a timely manner.

Currently operational at a number of DOE sites, including production sites and R&D laboratories, epidemiologic surveillance makes use of routinely collected health data, including reasons for illness, absence lasting 5 or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data become available for an extended period of time, trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring for changes in the health of the workforce provides both a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Epidemiologic surveillance also provides an early warning of noteworthy changes in health and safety that may indicate areas in need of additional, more-detailed study or increased health and safety measures to ensure adequate protection for workers.

E.4.5 Pantex Plant

Surrounding Communities. A June 1994 study by the Texas Cancer Registry, Texas Department of Health, showed significant increases in prostate cancer mortality among Potter County and Randall County males, and leukemia mortality among Carson County males during the period between 1981 and 1992 (TX DOH 1994a). There were no statistically significant increases observed in site-specific cancer mortality among females during this period. For cancer incidence during the period between 1986 and 1992, no statistically significant excesses in males were seen; however, cancer of the prostate was slightly elevated in Potter/Randall County males. Analysis of the four major cell-specific types of leukemia, showed a significant excess in the incidence of chronic lymphocytic leukemia among Potter/Randall County females. This study was conducted in Carson, Potter, and Randall Counties, which are located near Pantex. This study focused only on cancers of the breast, prostate, brain, thyroid, and leukemia, which were of specific concern to citizens in the area. Other radiation-associated cancers, such as bone and lung, were not included in this study. Although prostate cancer and chronic lymphocytic leukemia have not been linked to radiation exposure, further followup to this study was recommended.

Workers. An epidemiologic study of Pantex workers was published by Acquavella (HP 1985b:735-746). This study compared total and cause-specific mortality for Pantex workers employed between 1951 and December 31, 1978, with expected cause-specific mortalities based on U.S. death rates. Significantly fewer deaths were observed in the workforce than would be expected based on U.S. death rates for the following causes of death: all cancers, arteriosclerotic heart disease, and digestive diseases. No specific causes of death occurred significantly more frequently than expected. Slightly elevated mortality ratios were observed for brain cancer and leukemia; neither excess was statistically significant. The four deaths from brain cancer all occurred among those who had worked at the plant less than 5 years. The four deaths from leukemia occurred with equal frequency among those who had worked at the plant a short time and those who had worked more than 15 years.

Memorandum of Understanding. A followup of the 1985 mortality study of the Pantex workforce is planned. The update will be conducted by the National Institute for Occupational Safety and Health as part of a research program funded by DOE under a Memorandum of Understanding with the

Department of Health and Human Services. The followup study is scheduled to commence either in late 1996 or early 1997. In addition, female workers at Pantex will be included in a National Institute for Occupational Safety and Health funded multisite study of mortality among female nuclear weapons workers.

Epidemiologic Surveillance. DOE's Office of Epidemiologic Studies Epidemiologic Surveillance Program was implemented at Pantex in 1993 in order to monitor the health of current workers. This program evaluates the occurrence of illness and injury in the workforce on a continuing basis and issues the results of the ongoing surveillance in annual reports. The program facilitates an ongoing assessment of the health and safety of the site's workforce and helps to identify any emerging health issues in a timely manner. Monthly data collection began on January 1, 1994, and the results of the first complete year of epidemiologic surveillance will be presented to workers and other site stakeholder groups in spring 1996.

Currently operational at a number of DOE sites, including production sites and R&D laboratories, epidemiologic surveillance makes use of routinely collected health data including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data become available for an extended period of time, trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring for changes in the health of the workforce provides both a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate areas in need of more detailed study or increased health and safety measures to ensure adequate protection for workers.

E.4.6 Los Alamos National Laboratory

Los Alamos and adjacent counties comprise a unique setting and history. LANL, for much of its existence, was a closed community where most of the residents had direct economic ties to the laboratory. Nearly all male residents and some of the female residents are employed at LANL. Medical care in Los Alamos County had been centralized at the laboratory and a single community hospital. This is a unique, highly educated community situated adjacent to lands populated by Native Americans.

Surrounding Communities. Selected cancer mortality and incidence (newly diagnosed cancer) rates between 1950 and 1969, for 11 selected cancers among white males in Los Alamos County were compared with rates for the State of New Mexico, U.S. rates, and with rates of five socioeconomic and occupational control counties and five high-education western counties, based on U.S. Bureau of the Census information (ER 1981a:86-105). The comparisons were made to identify cancer types that were greater than expected while taking into account important factors, such as income and education, associated with cancer patterns. Six cancer types were identified that had rates greater than cancer rates for one or more of the four comparison groups; they are: cancer of the bile ducts and liver, bladder, prostate, brain and nervous system, lympho- and reticulo-sarcoma, and leukemia. Cancer rates of the prostate, bladder, and leukemia were also greater than expected.

Compared with New Mexico white males, Los Alamos County Anglo-white males show nonstatistically significant excesses in cancer incidence from 1969 to 1974 for the stomach, colon, rectum, pancreas, lung, and bladder (ER 1981a:86-105). All cancers combined show a 35-percent statistically significant excess. Los Alamos County white females show nonstatistically significant excesses for cancer of the stomach, large intestine, lymphosarcoma and reticulasarcoma, and leukemia. All cancers combined show a statistically significant 40-percent excess.

In 1991, the New Mexico Department of Health initiated epidemiologic studies in response to citizen concerns about an apparent excess of brain tumors among residents of the western area neighborhood of Los Alamos County as a result of historical LANL nuclear operations. The New Mexico Department of Health conducted a descriptive study of brain cancer incidence in Los Alamos County and for 22 other sites (NM DOH 1993a). The study showed that during the mid- to late-1980s an excess of approximately 80 percent of brain cancer had occurred in Los Alamos County compared with a New Mexico reference population and national statistics. The excess incidence had disproportionately occurred among persons who were residents of the western area at the time of diagnosis or death; however, there were only three cases, and they were confined to the 2-year time period, 1986 to 1987. Additional descriptive studies showed that the brain cancer rates for Los Alamos County were within the range of rates observed across New Mexico counties from 1983 to 1987 and 1988 to 1991. A review of mortality statistics for benign or unspecified neoplasms of the brain and nervous system showed no deaths from these causes in Western Area residents during 1984 to 1990.

Los Alamos County breast cancer incidence rates remained level, but higher than New Mexico rates from 1970 to 1990. Reproductive and demographic factors associated with the risk of breast cancer were thought to account for the higher rates. A special study was conducted to examine the recent increase in breast cancer since 1988 (NM DOH 1994a). The New Mexico Tumor Registry concluded that the increase seen between 1988 and 1992 was primarily due to increased detection of early stage disease.

The incidence of ovarian cancer in Los Alamos County women was elevated from the mid-1970s to 1990. From 1986 through 1990, ovarian cancer incidence in Los Alamos County was roughly two-fold higher compared with New Mexico reference population rates. The excess ovarian cancer rate was confined to a census tract corresponding to two neighborhoods and was four- to six-fold higher than that observed in the remaining Los Alamos County census tracts.

The incidence rates for melanoma (cancer of the skin) in Los Alamos County were elevated from 1970 through 1990, with peak elevations occurring from the mid- to late-1980s. There was approximately a twofold excess risk compared with a New Mexico State reference population. The excess melanoma incidence observed in Los Alamos County was thought to be related to the high ambient solar ultraviolet radiation intensity due to its high altitude.

A fourfold increase in thyroid cancer incidence during the late 1980s was noted in a study by Athas (NM DOH 1996a). A case-series records review was initiated to examine data relating to the detection, diagnosis, and known risk factors for thyroid cancer. All cases of thyroid cancer diagnosed among Los Alamos County residents between 1970 and 1995 were identified through the New Mexico Tumor Registry. The incidence rate for thyroid cancer in Los Alamos County was slightly higher than New Mexico rates between 1970 and the mid-1980s. There was a statistically significant fourfold increase during the late 1980s and early 1990s compared with the State, but the rate began to decline in 1994 and 1995.

The higher than expected number of thyroid cancer cases could not be explained by changes in diagnosis of thyroid cancer among Los Alamos County residents. Additional analyses suggested that increased medical surveillance and greater access to medical care were responsible for the recent excess in Los Alamos County.

Potential risk factors for thyroid cancer including therapeutic irradiation, genetic susceptibility, occupational radiation exposure, and weight were also examined. However, the investigation did not identify a specific cause for the elevated rate of thyroid cancer in Los Alamos County.

Male Workers. A mortality study of 224 white males with the highest internal depositions of plutonium 239 (10 nanocuries or more) at LANL were examined by Voelz et al. (LANL 1985a). Followup was through April 1980. SMRs were low for all cause of death (SMR - 0.56, 95 percent CI - 0.40-0.75), all malignant neoplasms (SMR - 0.54, 95 percent CI - 0.23-1.06), compared with U.S. white males and lung cancer (SMR - 20, 95 percent CI - 0-110).

A cohort mortality study by Wiggs et al. examined the causes of death among 15,727 white males hired at LANL between 1943 and 1977 (HP 1994a:577-588). The purpose of the study was to determine if plutonium deposition and external ionizing radiation were related to worker mortality. After nearly 30 years of followup, the LANL workforce experienced 37 percent fewer deaths from all causes, and 36 percent fewer deaths due to cancer than expected when compared with death rates for the U.S. population.

The researchers identified a subset of 3,775 workers who had been monitored for plutonium exposure; of these, 303 workers were categorized as "exposed" based on a urine bioassay for plutonium; the remainder were nonexposed. One case of rare bone cancer, osteogenic sarcoma, a type of cancer related to plutonium exposure in animal studies, was noted among the plutonium exposed group. The overall mortality and site-specific rates of cancer did not differ significantly between the two groups of workers. A nonstatistically significant increase in lung cancer among the exposed group was noted, but there was no information on cigarette use among the workers.

When researchers examined data for the 10,182 workers who were monitored for exposure to external ionizing radiation (including 245 workers exposed to plutonium) they observed a dose-response relationship for cancers of the brain/central nervous system, cancer of the esophagus, and Hodgkin's disease. When the 225 plutonium-exposed workers were excluded from the analysis, there was a statistically significant dose response between external ionizing radiation and kidney cancer and lymphocytic leukemia.

A special lifetime medical study was conducted on 26 of the workers who have the largest internal depositions of plutonium at LANL. Voelz and Lawrence reported on the 42-year followup of the 26 white males who designed and built the first atomic bomb and were determined to have had a significant deposition of plutonium-239 sometime in 1944 or 1945 based on job assignment, working conditions, and urine levels of plutonium (HP 1991a:181-190). Their mortality experience was compared to U.S. white males adjusted for age and calendar time. The mortality rates were also compared with rates for a cohort of LANL workers hired at the same time and born between the same years; no significant differences were for all cause mortality and all cancer mortality. One of the seven reported deaths was due to bone sarcoma, the most frequent radiation-induced cancer observed in persons with radium depositions.

Wiggs reported on 6,970 women employed at LANL for at least 6 months from 1943 through 1979, with deaths determined through 1981 (LA Wiggs 1987a). The mortality rates for all causes of death combined and all cancers combined were 24 and 22 percent below the rate for the U.S. population, respectively. Although the overall rates are low, women occupationally exposed to ionizing radiation have elevated rates for cancer of the ovary and of the pancreas relative to those not exposed. An unusual finding was that female radiation workers experienced a statistically significant excess of death from suicide. In a special in-depth study, the suicides were compared to two control groups, deaths from other injuries and deaths from noninjuries. History of employment as a radiation worker was significantly associated with death from suicide for both comparison groups. No significant associations for duration of employment, plutonium exposure, or martial status were seen (APHA 1988a).

As result of a reported threefold excess of malignant melanoma among laboratory workers at LLNL in California and similarities between occupational exposures and prevailing sunshine conditions at LANL and LLNL, an investigation was undertaken to assess the risk of melanoma at LANL (Lancet 1981a:712-716). Incidence data were obtained from the New Mexico Tumor Registry. No excess risk for melanoma was detected at LANL among 11,308 laboratory workers between 1969 and 1978. Six cases were identified where about 5.7 were expected (Lancet 1982a:883-884). The rate for the total cohort, Hispanic males and females, non-Hispanic males and females were not significantly different from the corresponding New Mexico rates.

A special in-depth study of 15 cases diagnosed through 1982 did not detect an association between melanoma and exposure to any type of external radiation as measured by film badges, neutron exposures, plutonium body burden based on urine samples, or employment as a chemist or physicist (HP 1983c:587-592). However, the workers with melanoma were more educated than the comparison group using the college and graduate degree as a measure of education, a finding consistent with other reports of malignant melanoma according to the authors. The numbers in this study are too small to detect any but large excesses.

Memorandum of Understanding. DOE entered into a Memorandum of Understanding with the

Department of Health and Human Services to conduct health studies at DOE sites. The National Institute for Occupational Safety and Health is responsible for managing or conducting the worker studies. The following multisite studies that include LANL are currently underway: a study of mortality among female nuclear weapons workers, a case-control study of multiple myeloma, a leukemia study, and an exposure assessment of hazardous waste/cleanup workers.

E.4.7 Lawrence Livermore National Laboratory

Surrounding Communities. The California Department of Health Services released a study of cancer occurrence among children and young adults living or born in Livermore, California (CA DHS 1995a). The study specifically aimed to determine the risk of leukemia and non-Hodgkin's lymphoma among young people living near LLNL. An increased risk of these two cancers among children living near the Sellafield nuclear facility in England had been suggested by a British study (JRSS 1989a:307-325).

Investigators studied two groups of children and young adults under the age of 25: those who were born in Livermore between 1960 and 1990 and those who actually lived in Livermore between 1960 and 1991. No increased risk of leukemia or non-Hodgkins lymphoma was detected among Livermore children living near a nuclear facility, as suggested by the British study. However, a 2.4-fold increase in the risk of malignant melanoma, a form of skin cancer which can be fatal, was found for children and young adults who lived in Livermore between 1960 and 1991 compared with youngsters who lived other places within Alameda County. An even more significant 6.4-fold increased risk of malignant melanoma was found in children born in Livermore between 1960 and 1991. The rate of melanoma was highest in those under 20 years of age. No increased risk of any other type of cancer was found. The report states that "it is not possible, within the scope of the current study, to assess whether or not melanoma cases had any affiliation with LLNL."

Workers. In 1981, a joint study undertaken by the California Department of Health Services and LLNL reported that 19 cases of malignant melanoma were observed between 1972 and 1977 among approximately 5,100 LLNL employees (Lancet 1981a:712-716). This incidence rate was significantly higher than that expected in the comparable population of the San Francisco Bay Area. Preliminary findings, however, suggested that this apparent increase in the malignant melanoma was not associated with length of employment at LLNL, nor with type of monitored radiation exposure. No other cancers were increased among LLNL employees from 1969 to 1980 (WJM 1985a:214-218).

The reasons for the malignant melanoma increase were not clear, and a series of studies was prompted to investigate the problem. A case-control study reported five occupational factors having causal relationships with the observed excess in malignant melanoma: exposure to radioactive materials, exposure to volatile photographic chemicals, Site 300 at LLNL, chemist duties based on job titles, and Pacific Test Site (LLNL 1984b). The association between melanoma and occupational factors reported in the study was criticized by Shy et al. (LLNL 1985a). A question concerning surveillance bias was also raised, because the number of cases was too small and because of the excessive number of exposure factors analyzed. The authors noted that evidence for a dose-response gradient was not provided and the biological plausibility of causal hypothesis was not established.

Various studies investigated the role of surveillance bias in relation to the elevated incidence of melanoma. Hiatt and Fireman reported that the increase among melanoma incidence is associated with increased biopsy rates for pigmented nevi in LLNL employees compared with matched controls who belonged to the same prepaid health plan but who did not work at LLNL (PM 1986a:652-660). The occupational physicians caring for LLNL employees may be more aware of the potential malignancy of pigmented lesions than those caring for non-LLNL employees. Subsequently, the increasing percentage of thin cutaneous malignant melanoma over time (1969 to 1976, 1977 to 1984, and 1984 to 1986) reported at LLNL suggests increased efforts to diagnosis cutaneous malignant melanoma early on (Lancet 1987a: 1435). The mean thickness of cutaneous malignant melanoma among LLNL employees has decreased more rapidly between 1976 and 1984 than those from the comparison laboratory (AD 1990a:967-969). On the other hand, others reported that the thinner lesions were only confirmed prior to 1976, and after 1976 there was no difference in lesion thickness (Epidemiology 1993a:43-47).

The most recent case-control study of malignant melanoma concluded that there was no association between occupational factors and the increased melanoma diagnosis among LLNL employees (LLNL 1994e). No clear explanation for the increased melanoma among LLNL workers has been provided. Increased awareness and enhanced surveillance are currently suspected, and monitoring of mortality from melanoma continues at LLNL.

Memorandum of Understanding. DOE entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The National Institute for Occupational Safety and Health is responsible for managing or conducting the worker studies. The Institute funded a grant to examine the industrial hygiene system at LLNL that will allow the study of complex exposure scenarios.

E.4.8 Sandia National Laboratories

Community Studies. There are no known epidemiologic studies that have been conducted which examine the impact of SNL on the health of the surrounding communities.

Epidemiologic Surveillance. The Office of Epidemiologic Studies Epidemiologic Surveillance Program has been implemented at SNL to monitor the health of current workers at the Albuquerque site. This program monitors and evaluates the occurrence of illness and injury in the workforce on a continuing basis and annual reports are issued reporting the results of the ongoing surveillance. The program facilitates a continuing assessment of the health and safety of the site's workforce and helps to identify any emerging health issues. Refinements to epidemiologic surveillance at SNL include the anticipated addition of selected dosimetry data, enhancing the program's ability to monitor potential health effects associated with radiation exposure.

Epidemiologic surveillance makes use of routinely collected health data including reasons for illness absence lasting five or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at SNL. As the program continues and data become available for an extended period of time, trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring for changes in the health of the workforce provides a baseline rate of illness and injury among the workers and a tool to evaluate changes in industrial hygiene and health physics practices. Epidemiologic surveillance also provides an early warning of changes in health and safety that may indicate areas in need of more detailed study or increased safety measures to ensure adequate protection for workers.

Workers. Broadwell et al. report that 25 workers, 5 currently, and 20 formerly involved in the manufacture of hybrid microcircuits, underwent clinical evaluations at the request of a management union committee concerned about chronic solvent exposures in an R&D laboratory (AJIM 1995a:677-698). A battery of neurobehavioral tests was administered to compare the solvent-exposed group with age-, ethnicity-, and education-matched controls. The tests included MMPI-I, handgrip strength, tactile sensitivity, dexterity, color discrimination, visual acuity and contrast sensitivity, and tests selected from the computerized Neurobehavioral Evaluation System. Clinical narratives and retrospective exposure assessments in the study group suggested chronic low-level exposure to solvents, with intermittent acute excursions. The most frequently reported symptoms from the clinical questionnaires were upper respiratory irritation (68 percent), poor concentration and memory loss (48 percent), depressed mood (40 percent), lower respiratory irritation (28 percent), eye irritation (28 percent), distal upper extremity paresthesia (24 percent), and skin rash (12 percent). Work-related diagnosis included upper respiratory mucosal irritation and sinusitis (44 percent), lower respiratory reactive disease (12 percent), and dermatitis (5 percent). Ten of the 25 exposed workers (40 percent) had a history of a clinical syndrome with headache, dizziness, disequilibrium, fatiguability, memory impairment, difficulty in concentration, and loss of initiative following acute solvent exposures. Solvent exposures linked to this syndrome were intermittent, and symptoms were reversible after cessation of what were reported as high-level exposures. Several exposed workers showed clinical evidence of an acquired toxic encephalopathy supporting an association between long-term solvent exposure and depressed mood, with increased somatic symptoms. Significant differences (after Bonferroni correction) were found between the two groups on the following Neurobehavioral Evaluation System subtests: finger tapping, simple reaction time, symbol digit substitution, mood scale, and symptom questionnaire. Differences also reached significance for contrast sensitivity, vibrotactile threshold, and handgrip strength. Attention to engineering controls, chemical fume hood ventilation, work practices, safety training, and personal protective gear was markedly improved when the lab was moved in the fall of 1990.

E.4.9 Nevada Test Site

Surrounding Communities. Above ground testing of nuclear weapons at NTS Test Range Complex in southern Nevada between 1951 and 1958 resulted in the dissemination of radioactive fallout over southeastern Nevada and southwestern Utah through wind dispersion. Several epidemiologic studies have been conducted to investigate possible adverse health effects of low-level radiative fallout on residents of these states. These studies focused on leukemia and thyroid disease in children downwind of NTS.

A series of ecologic studies showed equivocal results in potentially exposed children. A cross sectional review of thyroid nodularity among teenage children reported by Weiss et al. found no significant difference in the frequency of nodules among potentially exposed and nonexposed children (AJPH 1971a:241-249). Exposure was defined in terms county of residence. Rallison et al. reported no significant difference in any type of thyroid disease between Utah children exposed to fallout radiation in the 1950s and control groups drawn from Utah and Arizona (AJM 1974a:457-463; JAMA 1975a:1069-1072).

To investigate the possible relationship between childhood leukemia and radioactive fallout, Lyon et al. conducted a mortality study of Utah children under 15 years old who died in Utah between 1944 and 1975 (NEJM 1979a:397-402). Lyon et al. selected this age group because of the reported increased susceptibility of children to the neoplastic effects of radiation and the lack of a comparison group over 14 years of age with suitable low exposures. Lyon et al. obtained death certificates from the Utah vital statistics registrar and based on year of death, categorized decedents into either high (fallout years of 1951 to 1958) or low exposure periods (combined pre-fallout years of 1944 to 1950 and post-fallout years of 1959 to 1975). From estimated fallout patterns contained in maps of 26 tests, Lyon et al. categorized 17 southern rural counties as high fallout area and the remaining northern urban counties as low fallout area. Age-specific mortality rates derived for deaths which occurred in the combined low exposure periods were compared with those in the high exposure period. For reasons unknown, leukemia mortality during the low exposure periods in high fallout counties was half that of the United States and Utah. A significant excess of leukemia occurred among children statewide who died during the high fallout period compared to those who died during the low fallout periods (SMR - 1.40, 95 percent CI - 1.08-1.82, $p<0.01$). This excess was more pronounced among those who resided in the high fallout area (SMR - 2.44, 95 percent CI - 1.18-5.03). No pattern was found for other childhood cancers in relation to fallout exposure. Actual radiation dosage was not available, and the effects of migration were not determined for this study.

Beck and Krey (Science 1983a:18-24) reconstructed exposure of Utah residents studied by Lyon et al. (NEJM 1979a:397-402) to external gamma-radiation from NTS fallout through measurements of residual cesium-137 and plutonium in soil. Beck and Krey found that residents in southwest Utah closest to NTS received the highest exposures, but noted that residents of urban northern areas received a higher mean dose and a significantly greater population dose than did residents of most counties closer to the test site. Northern Utah residents received higher average bone doses than southern Utah residents; therefore, distance from NTS should not be the sole criteria for dividing the state into geographic subgroups for the purpose of conducting epidemiologic studies. Beck and Krey concluded that bone doses to southern Utah residents were too low to account for the excess leukemia deaths identified by Lyon et al. They also determined that bone and whole body doses from NTS fallout were small relative to lifetime doses most Utah residents receive from background radiation, and that it was unlikely that these exposures would have resulted in any observed health effects.

Land et al. (Science 1984a:139-144) attempted to confirm the association between leukemia and fallout reported by Lyon et al. (NEJM 1979a:397-402) using cancer mortality data from the National Center for Health Statistics for the period 1950 through 1978. No statistically significant differences in mortality from leukemia or other childhood malignancies between northern and southern Utah were observed. The small observed difference in leukemia mortality between the border and interior counties was opposite in direction to that reported by Lyon et al. Results indicated a downward trend in childhood leukemia mortality over time. Eastern Oregon and the State of Iowa also were selected for comparison with Utah. The leukemia mortality rate for eastern Oregon was higher, and Iowa lower than the rate for Utah. Although both were not statistically significant, Land et al. concluded that these results suggest that the association reported by Lyon et al. merely reflects an unexplained low leukemia rate in southern Utah for the period 1944 to 1949.

Another study that assessed the development of cancer among individuals potentially exposed to radioactive fallout has been reported by Rallison et al. (HP 1990c:739-746). This study examined the thyroid neoplasia risk in a cohort of children born between 1947 to 1954 in two counties near nuclear test sites, one in Utah and one in Nevada. A comparison group of Arizona children presumed to have no fallout exposures was also evaluated. The children (11 to 18 years of age) were examined between 1965 to 1968 for thyroid abnormalities and were reexamined in 1985 and 1986. Children living in the nuclear testing (Utah/Nevada) area had a higher rate of thyroid neoplasia than the comparison children (in Arizona), but the differences were not statistically significant. The authors concluded that living near NTS in the 1950s has not resulted in a statistically significant increase in thyroid neoplasms.

A study by Johnson examined cancer incidence in a cohort of Mormon families in southwest Utah near the NTS (JAMA 1984b:230-236). The study compared cancer incidence among all Utah Mormons during the period 1967 to 1975 with cancer incidence among two exposed populations: persons residing in a high fallout area and an exposure effects group residing in a broader area that received less intense exposure from radioactive fallout. Limitations of the study include: the inability to locate 40 percent of the defined population, the lack of verifying the reported diagnosis of cancer, and the inability to interview a comparable control group.

Cancer incidence for both exposed groups was compared with that of all Utah Mormons for two time periods, 1958 to 1966 and 1972 to 1980. Johnson found an apparent increased incidence of leukemia and cancers of the thyroid and bone for residents of the high fallout area for both time periods (p - 0.01). Additional analyses suggested that a higher proportion of the cancers among exposed groups were in radiosensitive tissues and the proportional excess increased with time compared with all Utah Mormons. The ratio of radiosensitive cancers to all other cancers from 1958 to 1966 was 24 percent higher among the high fallout area group and 29.6 percent higher among those in the fallout effects group. For 1972-80, the ratio was 53.3 percent higher in the high fallout area group and 300 percent higher in the fallout effects group.

Machado examined cancer mortality rates of a three-county region in southwestern Utah in comparison to the remainder of Utah (AJE 1987c:44-61). There was no excess risk of cancer mortality in southwest Utah, with the exception of leukemia, which showed a statistically significant excess for all ages combined, and for children age 0 to 14. In fact, mortality from all cancer sites combined was lower in southwest Utah than the remainder of the state. The authors noted that their findings, including those for leukemia, were inconsistent with the cancer incidence study conducted by Johnson (JAMA 1984b:230-236).

Archer measured soil, milk, and bone strontium-90 levels to identify states with high-, intermediate-, and low-fallout contamination (AEH 1987a:263-271). He then correlated the deaths from radiogenic and nonradiogenic leukemias with the time periods of aboveground nuclear testing both in the United States and Asia. The results show that leukemia deaths in children were higher in states with high exposure and lower in states with less exposure. He showed that leukemia deaths in children peaked approximately 5.5 years following nuclear testing peaks. The last leukemia peak in the United Sates occurred from 1968 to 1969, 5.5 years after the last year of a 3-year period of intensive testing in Asia. The increases were seen in the radiogenic leukemias (myeloid and acute leukemias), and not with all other leukemias.

Kerber et al. updated a previously identified cohort of children living in portions of Utah, Nevada, and Arizona, to estimate individual radiation doses and determine thyroid disease status through 1985 to 1986 (JAMA 1993a:2076-2082). Of the 4,818 children originally examined between 1965-70, 2,473 were included in the followup exam. Outcomes of interest included thyroid cancers, neoplasms, and nodules based on physical examinations of the thyroid. Exposure of the thyroid to radioiodines was based on radionuclide deposition rates provided by DOE and surveys of milk producers. Children with questionable findings were referred to a panel of endocrinologists for further examination. The authors reported an excess number of thyroid neoplasms (combined benign and malignant) and a positive dose-response trend for neoplasms, both of which were statistically significant. The authors also reported a positive dose-response trend for thyroid nodules, not statistically significant, and a positive dose-response trend for thyroid carcinomas with marginal statistical significance. The authors estimated that an excess of between 1 and 12 neoplasms (between 0 to 6 excess malignancies) was probably caused by exposure to radioiodines from the nuclear weapons testing. A letter to the editor criticized Kerber et al. for relying on food histories obtained 22 years after the fact to depict radioiodine intake, and for the untested modeling approach for determining dose to the thyroid (JAMA 1994a:825-826). These concerns were addressed by Kerber et al., which acknowledged the uncertainties in the dose estimates, but concluded that their estimates were conservative (JAMA 1994b:826).

Till et al. estimated doses to the thyroid of 3,545 subjects who were exposed to radioiodine fallout from NTS (HP 1995a:472-483). The U.S. Public Health Service first examined this cohort for thyroid disease between 1965 to 1970 and later in 1985 to 1986. Till et al. assigned individual doses based on age, residence histories, dietary histories, and lifestyle. Individualized dose and uncertainty was combined with the results of clinical examinations to determine the relationship between dose from NTS fallout and thyroid disease incidence.

Workers. Military personnel and civilian employees of the Department of Defense observed and participated in maneuvers at the NTS Test Range Complex during above ground tests. An excess number of leukemia cases was reported (9 cases, 3.5 expected) among the 3,224 men who participated in military maneuvers in August 1957 at the time of the nuclear test explosion "Smoky" (JAMA 1980a:1575-1578). The participants were located and queried on their health status, diseases, or hospitalizations as of December 1981. Various Federal records systems were linked, including clinical files, and next of kin were queried about cause of death for those participants who were deceased. Exposure information was available from film badges records, and the mean gamma dose for the entire cohort was 466.2 mrem. In a later report of the same cohort, the number of incident cases of leukemia had increased to 10 with 4 expected (JAMA 1983a:620-624). No excess in "total cancers" was observed, however. In addition, four cases of polycythemia vera were reported where 0.2 was expected (JAMA 1984a:662-664). The excess in leukemia cancer incidence and mortality appear to be limited to the soldiers who participated in "Smoky."

The leukemia excess was not observed in a National Research Council mortality study of soldiers exposed to five series of tests at two sites: Nevada Test Site (PLUMBBOB) and the Pacific Proving Ground (DOE 1985b; NAS 1985a). The National Research Council reported that the number of leukemia cases in "Smoky" was greater, but the increase was considered nonsignificant when analyzed with the data from the other four tests. In 1989, however, it was discovered that the roster of the atomic veterans cohort on which the National Research Council based its 1985 study contained misclassification errors. As a result, this study is being reanalyzed, and the National Research Council anticipates publishing the new results by 1997.

APPENDIX F: FACILITY ACCIDENTS

F.1 Evaluation Methodologies and Assumptions

F.1.1 Introduction

The potential for facility accidents and the magnitudes of their consequences are important factors in evaluating the stockpile stewardship and management alternatives addressed in this programmatic environmental impact statement (PEIS). The health risk issues are twofold:

- Whether accidents at any of the individual stockpile stewardship and management facilities (or reasonable combinations thereof) pose unacceptable health risks to workers or the general public.
- Whether alternative locations for stockpile stewardship and management facilities (or reasonable combinations thereof) can provide lesser public or worker health risks. These lesser risks may arise either from a greater isolation of the site from the public or from a reduced frequency of such external accident initiators as seismic events, and aircraft crashes.

Guidance for implementing Council on Environmental Quality regulation, 40 Code of Federal Regulations 1502.22, as amended (51 FR 15618), requires the evaluation of impacts which have low probability of occurrence but high consequences if they do occur; thus, facility accidents must be addressed to the extent feasible in this PEIS. Further, public comments received during the scoping process clearly indicated the public's concern with facility safety and consequent health risks and the need to address these concerns in the decision-making process.

For the No Action case, potential accidents are defined in existing facility documentation, such as safety analysis reports, hazards assessment documents, National Environmental Policy Act (NEPA) of 1969 documents, and probabilistic risk assessments. The accidents include radiological and chemical accidents that produce high consequences but have a low likelihood of occurrence, and a spectrum of other accidents that have a higher likelihood of occurrence and lesser consequences than the high consequence accidents. The data in these documents includes accident scenarios, probabilities, materials at risk, source terms (quantities of hazardous materials released to the environment), and consequences.

For new, modified, or upgraded stockpile stewardship and management facilities, the identification of accident scenarios and associated data would normally be a product of safety analysis reports performed on completed facility designs. However, facility designs have not been completed for the alternatives analyzed in the programmatic portion of this PEIS. Accordingly, the accident information developed for this PEIS has been developed based upon existing information for similar facilities. The likelihood and consequences of accidents (which are site dependent) are recomputed for each of the stockpile stewardship and management proposed sites where a facility may be located. This calculation reflects the effects of such site parameters as population size and distribution, meteorology, and distance to the site boundary.

This analysis also acknowledges, semi-quantitatively, the differences in likelihood of accident initiators at specific sites (e.g., aircraft impacts, beyond design basis seismic events, and so forth), as well as qualitatively discussing the opportunities for risk reduction afforded by the potential incorporation of new technologies, processes, or protective features in the stockpile stewardship and management facilities that will enhance public health and safety over the existing facilities.

Subsequent to this PEIS, evaluation of the specific benefits achieved by such measures would be presented in the tiered project-specific NEPA document for each facility. Also, for each new facility, a Hazards Analysis Document that identifies and estimates the effects of all major hazards that have the potential to impact the environment, workers, and the public would be issued in conjunction with the Conceptual Design Package. Additional accident analyses for identified major hazards would be provided in a Preliminary Safety Analysis Report (SAR) to be issued during the period of Definitive Design (Title II) Review. A Final SAR would be prepared during the construction period and issued before testing begins as final documented evidence that the new facility can be operated in a manner that does not present any undue risk to the health and safety of workers and the public.

The accident scenarios chosen to represent the impacts for each alternative were arrived at through a screening process based on a larger set of accidents presented in existing safety documentation for similar facilities. Documents such as those shown in table F.1.1-1 were reviewed for applicable accident scenarios and data. The process sought to identify a bounding accident in each of several classes of events (e.g., fire, explosion, spill, mechanical, criticality, natural phenomena initiators, and external initiators) applicable to the alternative. The process also sought to identify bounding accidents over the spectrum of high to low probability of occurrence in order to include high-consequence/low-probability and low-consequence/high-probability accidents. These accidents are generally referred to as beyond evaluation basis accidents and evaluation basis accidents, respectively. In accordance with Department of Energy (DOE) NEPA Guidelines, beyond evaluation basis accidents are generally in the probability of occurrence range of 10 -*7* to 10 -*6* per year (yr), and evaluation basis accidents generally have a probability of occurrence greater than 10 -*6* /yr. These two designations are used only if formal SARs have not been prepared. In cases where SARs have been prepared, they are the source documents for two equivalent designations "beyond design basis accidents" and "design basis accidents." Based on discussions and meetings with experts, including a workshop, the accident scenarios were modified to reflect expected stockpile management facility conditions. For example, the material at risk identified in a safety report for a similar facility was adjusted to reflect the material at risk applicable to the Stockpile Stewardship and Management Program. A complete description of the development of accident scenarios for the alternatives is provided in a topical report (HNUS 1996a).

For each alternative, a number of evaluation and beyond evaluation basis accidents have been identified and are generally referred to as the "composite set of accidents." Two subsets of the composite set are also referred to as the "composite set of evaluation basis accidents" and the "composite set of beyond evaluation basis accidents." Impacts are presented for the composite set of accidents to reflect the combined impacts of evaluation basis and beyond evaluation basis accidents.

The impacts for the composite set of evaluation basis accidents are also provided to reflect the impacts of high-frequency/low-consequence accidents and impacts for the composite set of beyond evaluation basis accidents are provided to show the impacts of low-frequency/high-consequence accidents. Evaluation basis accidents are generally in a frequency range greater than 10-6/yr, while beyond evaluation basis accidents are generally in a frequency range of 10-7 to 10-6/yr. In some cases, accidents less than 10-7 are included in the composite set of beyond evaluation basis accidents to provide information that is relevant to decisionmaking and that otherwise would not be considered.

For each alternative, each accident is analyzed to estimate its risk (i.e., mathematical product of an accident's probability of occurrence and the accident's consequences) and consequences (e.g., cancer fatalities) to a noninvolved worker, a member of the public at the site boundary and the population out to 80 kilometers (km) (50 miles [mi]) from the accident. The estimated risks for the composite set of accidents analyzed for the alternative are mathematically combined to obtain an average risk (cancer fatalities per year) and consequences (cancer fatalities), given that the accidents occurred. The data on individual accidents used to calculate the composite values are provided in section F.2.

Table F.1.1-1.-- Source Documents Reviewed for Applicable Accident Scenarios

Item Number	Title	Site	Report Number	Date Published
01	"The Continued Operation of the Pantex Plant & Associated Storage of Nuclear Weapon Components EIS" Safety Information Document	Pantex	Draft Rev. 2	January 1995
02	Stockpile Stewardship and Management/PEIS Expanded Data Call Addendum to the Alternative Report for "Pit Manufacturing at Los Alamos National Laboratory"	LANL	none	June 1995
03	Stockpile Stewardship and Management/PEIS Expanded Data Call Addendum to Alternative Report for "Pit Manufacturing at Los Alamos National Laboratory"	LANL	LA-UR-95-2670	Sept. 1995
04	Appendix D "Accident Analysis"	LLNL	Volume II	Feb. 1992

05	Stockpile Stewardship and Management PEIS "Canned Secondary Assembly and Case Manufacturing Facility" Data Report Chapter 8 - Design Process for Accident Mitigation	LLNL	SST 95-07-006 Revision 1	July 17, 1995
06	Draft EIS and EIR for "The Continued Operation of Lawrence Livermore National Laboratory & Sandia National Laboratories, Livermore" **Unclassified Controlled Nuclear Information**	Sandia/ LLNL	Volume 1 DOE/EIS - 0157 SCH90030847	Feb. 1992
07	Preliminary Draft EIS "The Continued Operation of the Pantex Plant & Associated Storage of Weapons Components" **Unclassified Controlled Nuclear Information**	Pantex	DOE/EIS 0225 DEIS Vol.1 & 2	Sept. 1995
08	EA for the "Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee"	Y-12	DOE/EA-0929	Sept. 1994
09	"Basis for Interim Operation for the Pantex Plant, Amarillo, Texas"	Pantex	none	June 1995
10	"Revision 2 of the Basis for Interim Operation for TA-55-4"	LANL	ESH-3:94-105	June 1994
11	"Submittal of Revised JCO for CMR Facility" **Unclassified Controlled Nuclear Information**	LANL	none	Feb. 1995
12	"Accident/Event Analysis" (Safety Information Document)	Pantex	Draft-Rev. 2	Jan. 1995
13	"CMR Facility (SM-29) Final Safety Analysis Report" **Unclassified Controlled Nuclear Information**	LANL	CMR-FAC-94-001	Feb. 1994

14	Executive Summary - "Hazards Analysis of the Los Alamos National Laboratory Plutonium Facility (TA-55)" **Unclassified Controlled Nuclear Information**	LANL	TA-55 FSAR	July 13, 1995
15	Stockpile Stewardship and Management/PEIS "Alternative Report for Pit Manufacturing at SRS" **Unclassified Controlled Nuclear Information**	SRS	NMP-PLS-950176	Sept. 1, 1995
16	Draft Safety Analysis Report for "The Device Assembly Facility at the Nevada Test Site" **Unclassified Controlled Nuclear Information**	NTS	DAF SAR- 001-193-5394C	March 1995
17	"U.S. Department of Energy Defense Programs Safety Survey Report" Volume III: Appendix B - Uranium Facilities **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	Nov. 1993
18	"U.S. Department of Energy Defense Programs Safety Survey Report" Volume I: Main Report **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	Nov. 1993
19	"U.S. Department of Energy Defense Programs Safety Survey Report" Volume II: Appendix A - Plutonium Facilities **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	Nov. 1993
20	"U.S. Department Of Energy Defense Programs Safety Survey Report" Volume VI: Appendix E - Spent-fuel Handling Facilities **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	Nov. 1993
21	"TA-55 Final Safety Analysis Report" Volume I **Unclassified Controlled Nuclear Information**	LANL	TA-55-PRD-108-01.0	July 13, 1995

22	"TA-55 Final Safety Analysis Report" Volume II **Unclassified Controlled Nuclear Information**	LANL	LA-CP-95-169	July 13, 1995
23	"TA-55 Hazard Analysis" **Unclassified Controlled Nuclear Information**	LANL	LA-CP-94-0076	July 13, 1995
24	"Nuclear Explosive Facilities Final Safety Analysis Report Nuclear Explosive Cells Module" (Buildings 12-44 Cells 1-6, 12-85, 12-96, and 12-98) **Unclassified Controlled Nuclear Information**	Pantex	Volume 1 - Draft B	July 1995
25	"Nuclear Explosive Facilities Final Safety Analysis Report Nuclear Explosive Cells Module" (Buildings 12-44 Cells 1-6, 12-85, 12-96, and 12-98) **Unclassified Controlled Nuclear Information**	Pantex	Volume 2 - Draft B	July 1995
26	"Chemical High Explosives Hazards Assessment for the Pantex Plant, Amarillo, Texas"	Pantex	none	Oct. 1993
27	(Data Call) Tab D: "Facility Operations" **Unclassified Controlled Nuclear Information**	Y-12	OR-9183	no date
28	"Nuclear Explosive Facilities Final Safety Analysis Report Nuclear Explosive Bays Module" (Buildings 12-64, 12-84, 12-99, and 12-104) **Unclassified Controlled Nuclear Information**	Pantex	Rev. 1 Draft 2 Volume 1	Dec. 1994
29	"Nuclear Explosive Facilities Final Safety Analysis Report Nuclear Explosive Bays Module" (Buildings 12-64, 12-84, 12-99, and 12-104) **Unclassified Controlled Nuclear Information**		Rev. 1 Draft 2 Volume 2	Dec. 1994

30	"Preliminary Safety Analysis Report Special Nuclear Materials Component Staging Facility" **Unclassified Controlled Nuclear Information**	Pantex	none	April 1989
31	"Safety Analysis Report - On-Site Transportation" **Unclassified Controlled Nuclear Information**	Pantex	Draft B	Sept. 1995
32	Stockpile Stewardship and Management/PEIS "Assembly/ disassembly Nevada Test Site Alternative"	NTS	Volume 1	Aug. 4, 1995
33	Appendix 11-K - Release Fraction Data, Appendix 11-J - Consequence Equations Used in the Accident Analysis, Appendix 11-F - Seismic Accident Analysis, Appendix 11-E - Derivation of Data Values Used in the Accident Analysis **Unclassified Controlled Nuclear Information**	LANL	CMR-FAC-94-001	Feb., 1994
34	Draft "Design Process for Accident Mitigation" **Pit Disassembly and Conversion Facility Unclassified Controlled Nuclear Information**	LANL	Section 8	Aug. 21, 1995
35	**"U.S. Department of Energy Defense Programs Safety Survey Report" Volume V: Appendix D - Laboratory Facilities Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	Nov. 1993

F.1.2 Safety Design Process

One of the major design goals for stockpile stewardship and management facilities is to achieve a reduced risk to workers and the public relative to that associated with similar facilities in the existing Nuclear Weapons Complex. Significant changes exist between stockpile stewardship and management facilities and the current facilities design criteria and safety standards, which will reduce total risk to the public. These changes include design to current DOE structural and safety criteria; smaller throughput, batch size and inventories of certain hazardous materials; and elimination of some hazardous materials. This will reduce potential offsite health effects if an accidental release were to occur.

Stockpile stewardship and management facilities will be designed to comply with current Federal, state, and local laws; DOE orders; and industrial codes and standards. As a result, a facility will be provided that is highly resistant to the effects of natural phenomena, including earthquake, flood, tornado, high wind, as well as credible events appropriate to the site, such as fire and explosions, and manmade threats to its continuing structural integrity for containing hazardous materials. The facilities will be designed to maintain their continuing structural integrity in the event of any credible accident or event, including an aircraft crash, if credible at these sites.

The design process for new and modified stockpile stewardship and management facilities will comply with the requirements for safety analysis and evaluation in DOE O 430.1, Life-Cycle Asset Management and DOE Order 5480.23, Nuclear Safety Analysis Reports. Safety assessment is required to be an integral part of the design process to ensure compliance with all DOE safety criteria by the time that the facilities are constructed and in operation.

For new facilities, the safety analysis process begins early in conceptual design by identifying hazards with the potential to produce unacceptable safety consequences to workers or the public. As the design develops, failure mode and effects analyses are performed to identify events that have the potential to release hazardous material. The kinds of events considered include equipment failure, spills, human error, fire and explosions, criticality, earthquake, electrical storms, tornado, flood, and aircraft crash. These postulated events become focal points for design changes or improvements to prevent unacceptable accidents. These analyses continue as the design progresses to assess the need for safety equipment and to assess the performance of this equipment in accident mitigation. Eventually, the safety analyses are formally documented in an SAR and/or in a probabilistic risk assessment. The probabilistic risk assessment documents the estimated frequency and consequence for an entire spectrum of accidents and helps to identify design improvements that could make meaningful safety improvements.

The first SAR is completed at the conclusion of conceptual design and includes identification of hazards and some limited assessment of a few enveloping design basis accidents. This analysis includes deterministic safety analysis and failure modes and effects analysis of major systems. A detailed, comprehensive Preliminary SAR is completed by the completion of preliminary design and provides a broad assessment of the range of design basis accident scenarios and the performance of equipment provided in the facility specifically for accident consequence mitigation. A limited probability risk assessment may be included in that analysis.

The SAR continues to be developed during detailed design. The safety review of this report and any supporting probabilistic risk assessment is completed and safety issues resolved before the facility construction is initiated. There is also a Final SAR produced that documents safety-related design changes during construction and the impact of those changes on the safety assessment. It also includes the results of any safety-related research and development that has been performed to support the safety assessment of the facility. Final approval of the Final SAR is required before the facility is allowed to commence operation.

F.1.3 Analysis Methodology

F.1.3.1 Introduction

The MELCOR Accident Consequence Code System (MACCS) was used to estimate the radiological consequences of all stockpile stewardship and management facilities for all accidents. The CHEMS-PLUS (CHEMS-PLUS, Enhanced Chemical Hazard Evaluation Methodologies, Arthur D. Little, Inc., July 1988) computer code was used to estimate the consequences of nonradiological accidents. A discussion of the MACCS code is provided in section F.1.3.2. A detailed description of the MACCS model is available in a three volume report: *MELCOR Accident Consequence Code System* (MACCS), NUREG/CR-4691, SAND 86-1562, February 1990.

F.1.3.2 MELCOR Accident Consequence Code System

MACCS models the offsite consequences of an accident that releases a plume of radioactive materials to the atmosphere. Should such an accidental release occur, the radioactive gases and aerosols in the plume would be transported by the prevailing wind while dispersing in the atmosphere. The environment would be contaminated by radioactive materials deposited from the plume, and the population would be exposed to radiation. The objectives of a MACCS calculation are to estimate the range and probability of the health effects induced by the radiation exposures not avoided by protective actions.

In order to understand MACCS, one must understand its two essential elements: the time scale after an accident is divided into various "phases" and the region surrounding the facility is divided into a polar-coordinate grid.

The time scale after the accident is divided into three phases: emergency phase, intermediate phase, and long-term phase. The emergency phase begins immediately after the accident and could last up to seven days following the accident. In this period, the exposure of population to both radioactive clouds and contaminated ground is modeled. Various protective measures can be specified for this phase, including evacuation, sheltering, and dose-dependent relocation.

The intermediate phase can be used to represent a period in which evaluations are performed and decisions are made regarding the type of protective measure actions that need to be taken. In this period, the radioactive clouds are assumed to be gone, and the only exposure pathways are those from the contaminated ground. The only protective measure that can be taken during this period is temporary relocation.

The long-term phase represents all time subsequent to the intermediate phase. The only exposure pathways considered here are those resulting from the contaminated ground. A variety of protective measures can be taken in the long-term phase in order to reduce doses to acceptable levels:

decontamination, interdiction, and condemnation of property.

The spatial grid used to represent the region is centered on the facility itself. The user specifies the number of radial divisions as well as their endpoint distances. Up to 35 of these divisions may be defined, extending out to a maximum distance of 9,999 km (6,213 mi). The angular divisions used to define the spatial grid correspond to the sixteen directions of the compass.

Since the emergency phase calculations use highly nonlinear dose-response models for early fatality and early injury, it is necessary for those calculations to be performed on a finer grid than the calculations of the intermediate and long-term phases. For this reason, the 16 compass sectors are divided into 3, 5, or 7 user-specified subdivisions in the calculations of the emergency phase.

The increased likelihood (probability) of cancer fatality to a member of the public is taken as $5.0x10^{-4}$ times the dose in person-rem for values of dose less than 20 rem. For larger doses, when the rate of exposure is greater than 10 rads per hour, the increased likelihood of cancer fatality is doubled. The MACCS code was applied in a probabilistic manner using a weather bin sampling technique. Centerline doses as a function of distance were calculated for each of 150 meteorological sequence samples; the mean value of these doses and increased likelihoods of cancer fatality for the distance corresponding to the location of the maximum offsite individual at each site were reported for that individual. Doses to noninvolved workers were calculated similarly, except that these workers will experience an increased likelihood of cancer fatality of $4.0x10^{-4}$ times the dose in person-rem for doses less than 20 rem or exposure rates less than 10 rads per hour. For larger doses, when the rate of exposure is greater than 10 rads per hour, the increased likelihood of cancer fatality is doubled.

The hypothetical worker was placed at 1,000 meters (m) (3,281 feet [ft]) or at the site boundary, whichever is less. It should be noted that since the doses and cancer fatalities for the maximum offsite individual and the workers reported in the high-consequence/low-probability accident tables are mean values based on approximately 100 meteorological sequence samples, there is no direct correlation between the mean value of dose and the mean value of cancer fatalities.

Offsite population doses and latent cancer fatalities are calculated by MACCS using a methodology similar to that described for the maximum offsite individual. In the case of the population, each of the sampled meteorological sequences was applied to each of the 16 sectors (accounting for the frequency of occurrence of the wind blowing in that direction). Population doses are the sum of the individual doses in each sector. Once again, the mean value of the calculated population doses and latent cancer fatalities for each of the trials are reported.

F.2 Stockpile Management

F.2.1 Weapons Assembly/Disassembly

Studies of evaluation basis accidents (EBA) and beyond evaluation basis accidents (BEBA) have been performed for the downsized weapons assembly/disassembly (A/D) operations. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of an operating facility.

The accident analyses in this PEIS have been closely coordinated with the Pantex Site-Wide EIS to ensure consistency. The Pantex Site-Wide EIS is a more detailed evaluation of the Pantex Plant (Pantex) operations than this PEIS. Consequently, if there are any differences between the two documents, this PEIS defers to the Pantex Site-Wide EIS as the more accurate analysis of potential impacts from accidents.

F.2.1.1 Accident Scenarios and Source Terms

A range of hazardous conditions and potential accidents were reviewed as candidates for estimating the risks to workers and the public from operating this facility. Through a screening process, several evaluation basis and beyond evaluation basis accidents were selected for further definition and analysis. A brief description of each of the six accident scenarios and source terms is presented below. Table F.2.1.1-1 presents a summary of each accident scenario and source term. Further detail can be found in a topical report (HNUS 1996a).

Scenario 1: Aircraft impact and release

Pantex Plant. Pantex is located approximately 13.6 km (8.5 mi) from the northeast-southwest runway at Amarillo International Airport. The scenario involving aircraft impact considers an impact into a cell or bay, possibly causing a fire and subsequent detonation of high explosive (HE) with burning plutonium, or pit damage from debris. An assessment of the probability of aircraft impact into Pantex structures has been prepared for the Draft Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapons Components (DOE/EIS-0225D, March 1996). Based on existing information, aircraft impact into an assembly cell or bay buildings and the release of hazardous material is considered a credible but extremely unlikely event with an estimated probability in the range of $1x10^{-7}$ to $5x10^{-6}$/yr. For calculation purposes a value of $8x10^{-7}$/yr is assumed. A high-speed military aircraft or a large commercial aircraft crashing into a single facility could cause sufficient damage to release plutonium. The degree of damage incurred and any subsequent release of radioactive materials depends on the size and speed of the aircraft involved, among other factors. The impacts of an aircraft crash into a stockpile stewardship and management weapons A/D Facility are based on an analysis performed for the Pantex Site-Wide EIS of an aircraft crash into Zone 4 and Zone 12 facilities. Since stockpile stewardship and management facilities are only in Zone 12, the Pantex Site-Wide EIS impacts were scaled to 28 percent of the public risk, and 61 percent of the maximum offsite individual risk. For the noninvolved worker, the Pantex Site-Wide EIS estimates that a worker at 100 m (328 ft) will not survive the aircraft crash effects. For the *Stockpile Stewardship and Management PEIS* , the noninvolved worker is assumed to be at 1,000 m (3,281 ft) and survives the crash. The accident consequences and risks to the noninvolved worker and the maximally exposed individual are discussed in section F.2.1.2.

Table F.2.1.1-1.-- Accident Scenarios for Downsized Weapons Assembly/Disassembly Operations

Accident Scenario	Site	Accident Frequency (Per Year)	Total Material Released to Environment
1. Aircraft impact and release	Pantex	8x10-7	[1]
	NTS	<1x10^{-7}	Not applicable
2. Explosive dispersal of plutonium from high explosives detonation in cell or bay	Pantex	5.7x10^{-6}	62 g to 5,000 g plutonium[2] metal
	NTS	5.7x10^{-6}	96 g to 5,000 g plutonium[2]metal
3. Mechanical release due to pit drop or impact of forklift breaching pit cladding	Pantex	7.8x10^{-3}	6x10^{-5} g plutonium metal
	NTS	7.8x10^{-3}	6x10^{-5} g plutonium metal
4. Inadvertent activation of explosive squib on tritium reservoir	Pantex	0.02	1.8 g of tritium oxide and 18.2 g of elemental tritium
	NTS	0.02	1.8 g of tritium oxide and 18.2 g of elemental tritium
5. Operational fire-induced plutonium release	Pantex	1x10^{-5}	20 g plutonium oxide
	NTS	1x10^{-5}	20 g plutonium oxide
6. Fire-induced release from tritium reservoirs in staging vault	Pantex	4x10^{-7}	600 g tritium oxide[2]
	NTS	4x10^{-7}	600 g tritium oxide[2]

Nevada Test Site. The probability of an aircraft impact into the downsized weapons A/D facilities is estimated at less than 10^{-7} /yr and, in accordance with NEPA guidelines, does not have to be considered further.

Scenario 2: Explosive dispersal of plutonium from HE detonation in cell or bay. The combined probability of an explosive dispersal of plutonium in a bay ($7x10^{-7}$/yr) or cell ($5x10^{-6}$/yr) is $5.7x10^{-6}$ / yr. This value is conservatively based on 2,000 weapons operations per year. The anticipated number of weapons operations per year is 300 for the downsize A/D mission at Pantex.

Scenario 2.1: Explosive dispersal of plutonium from high explosives detonation in an assembly bay. Explosive dispersal of a plutonium pit would be the greatest when HE is in direct contact with the pit during an explosion or fire. The explosion would blow off the roof and doors of the bay; thus, no material would be retained inside the structure. As a result, it is assumed that all of the respirable plutonium would be released into the environment.

Pantex Plant. For the purposes of this analysis, the release of respirable plutonium from a Pantex assembly bay is assumed to be 5,000 grams (g) (176 ounces [oz]). The probability of this accident is $7x10^{-7}$/yr.

Nevada Test Site. For the purposes of this analysis, the release of respirable plutonium from a Nevada Test Site (NTS) assembly bay is assumed to be 5,000 g (176 oz). The probability of this accident is $7x10^{-7}$ /yr.

Scenario 2.2: Explosive dispersal of plutonium from high explosives detonation in an assembly cell assuming no roof collapse. A detonation of less than 45 kilograms (kg) (100 pounds [lb]) (130 lb trinitrotoluene [TNT] equivalent) of HE is estimated to be the amount of HE that would not cause the roof of a gravel gertie cell at Pantex or NTS to at least partially collapse. The explosion, which would cause greater than atmospheric pressures, would exist in the cell for approximately 1 minute. Since the roof does not collapse, a large fraction of the plutonium would be retained by the intact structures. In the case of large detonations causing the cell roof to collapse, the estimated release and consequences are bounded by the case in which the roof does not collapse.

Pantex Plant. The calculated respirable release from a Pantex assembly cell for this scenario is estimated to be 62 g (2.2 oz) of plutonium. The probability of this accident is $5x10^{-6}$/yr.

Nevada Test Site. The total respirable release from the NTS assembly cell for this scenario is estimated to be 96 g (3.4 oz) of plutonium. The probability of this accident is $5x10^{-6}$/yr.

Scenario 3: Mechanical release due to dropping a pit and breaching the cladding. For the purposes of this analysis, a pit is generically defined as a 6.5-kg (14-lb) spherical shell clad in thin metal alloy. Operational scenarios that have the potential to release small quantities of plutonium include dropping a pit onto the floor, cracking the external cladding because of disassembly stress, hitting a pit with other equipment, pulling out a pit tube during A/D, and breaching a container and pit with a forklift. A pit drop accident is used to characterize the category of events leading to violation of pit integrity.

An event of this nature has occurred at Pantex, where a weapon cladding was cracked, resulting in localized contamination around the pit. In this instance, the airborne contamination was insufficient to actuate the radiation alarm, and the worker dose was less than 0.1 rem.

Pantex Plant. The probability of a pit drop or forklift impact accident with a small plutonium release to a cell or bay at Pantex is 7.8x10 $^{-3}$ /yr. The total release to the environment is estimated to be 6x10^{-5} g of plutonium. *Nevada Test Site.* The probability of a pit drop or forklift impact accident with a small plutonium release to a cell or bay at NTS is 7.8x10 $^{-3}$ /yr. The total release to the environment is estimated to be 6x10 $^{-5}$ g of plutonium.

Scenario 4: Inadvertent activation of explosive squib on tritium reservoir. During assembly or disassembly of a nuclear explosive, conditions could be encountered in which an electro-explosive device is accidentally fired and releases tritium from a reservoir. There have been two events (one at a weapons complex and one at a military installation) in which a squib was inadvertently actuated, releasing tritium from a reservoir. Since the events occurred, added precautions have been implemented. For this scenario, the squib valve must fire, releasing tritium from the reservoir, and the stem tube must be breached or disconnected from the pit (the latter is a normal step of disassembly).

For the purposes of this analysis, a reservoir is assumed to contain 20 g (0.7 oz) of elemental tritium. The entire amount of this tritium is assumed to be released in gaseous form. (Only hydrogen tritide is considered in assessing of worker dose, because only about 1 percent of hydrogen tritide is converted to tritium oxide after 1 hour.) All elemental tritium is 100 percent respirable. The amount of tritium which becomes airborne in the cell or bay is thus 20 g (0.7 oz). Upon detecting tritium, the exhaust fans will continue to operate and exhaust tritium to the atmosphere. The potential offsite doses from the tritium release would depend on the extent of tritium oxidation, which is estimated to be 9 percent as a bounding limit.

Pantex Plant. The probability of inadvertent squib activation during operations in an assembly cell or bay is 0.02/yr. The total release is estimated to be 1.8 g (0.06 oz) of tritium oxide and 18.2 g (0.6 oz) of elemental tritium.

Nevada Test Site. The probability of inadvertent squib activation during operations in an assembly cell or bay is estimated to be the same as at Pantex with the same total release of 1.8 g (0.06 oz) of tritium oxide and 18.2 g (0.6 oz) of elemental tritium.

Scenario 5: Operational fire-induced plutonium dispersal. The metal-clad plutonium pits are designed to maintain their integrity for certain temperature levels but are not intended to function as barriers against release. The facilities (assembly cells or bays) that can have plutonium pits outside of their containers would likely remain intact in a fire not associated with an explosion. A bounding scenario for fire-induced plutonium dispersal assumes the radioactive material limit in a cell or bay is dispersed by fire with no containment.

Pantex Site. The probability of an operational fire-induced plutonium dispersal is 1x10 $^{-5}$ /yr. The total material released is 20 g (0.7 oz) of plutonium oxide.

Nevada Test Site. The operational fire at Pantex is assumed to occur at NTS with the same frequency and release as at Pantex.

Scenario 6: Fire-induced release from tritium reservoirs in staging vault. In this scenario, an earthquake is assumed to cause a fire in the vault where in-process tritium reservoirs are stored. The fire causes 100 percent of the tritium reservoirs in the vault to fail, releasing its entire contents. In addition, it is assumed that the elemental tritium is completely oxidized by the fire.

Pantex Plant. The probability of a release of tritium from the Pantex A/D staging area is 4x10^{-7} /yr. For the purposes of this analysis, the release is assumed to be 600 g (21 oz) of tritium oxide.

Nevada Test Site. It is assumed that this scenario at Pantex would be applicable at NTS. Therefore, the accident probability is 4x10^{-7} /yr. For the purposes of this analysis, the release is assumed to be 600 g (21 oz) of tritium oxide.

F.2.1.2 Accident Consequences and Risk

Tables F.2.1.2-1 and F.2.1.2-2 list the set of accidents selected to represent consequences and risks to workers and the public from accidental releases of radioactive materials during operations at Pantex and NTS, respectively. For each accident, the table identifies the frequency of occurrence and the consequences to a hypothetical worker located 1,000 m (3,281 ft) from the accident, a hypothetical individual located at the nearest site boundary, and the public out to a distance of 80 km (50 mi). The risks of cancer fatality for the worker, the individual at the site boundary, and the public for the composite set of accidents are also shown.

Table F.2.1.2-1.-- Downsized Weapons Assembly/Disassembly Operations at Pantex Plant, Impacts of Accidents

	Noninvolved Worker at 1,000 Meters			**Maximum Offsite Individual**			**Population to 80 Kilometers**		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality**[3]		**Dose (rem)**	**Probability of Cancer Fatalitya**		**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Aircraft impact and release [4]	23	9.2x10-3		23	0.012		2.8x10^{3}	1.4	8.0x10^{-7}

2. Explosive dispersal of plutonium in cell or bay	16.9	$6.8x10^{-3}$		12.9	$6.5x10^{-3}$		$3.8x10^{3}$	1.9	$5.7x10^{-6}$
3. Mechanical release from impact breach of pit cladding	$3.2x10^{-6}$	$1.3x10^{-9}$		$2.4x10^{-6}$	$1.2x10^{-9}$		$6.5x10^{-4}$	$3.2x10^{-7}$	$7.8x10^{-3}$
4. Inadvertent activation of explosive squib on tritium reservoir	$9.7x10^{-4}$	$3.9x10^{-7}$		$7.4x10^{-4}$	$3.7x10^{-7}$		0.20	$9.9x10^{-5}$	0.02
5. Operational fire-induced plutonium release	0.52	$2.1x10^{-4}$		0.40	$2.0x10^{-4}$		107	0.054	$1.0x10^{-5}$
6. Fire-induced release from tritium reservoirs in staging vault[4]	0.31	$1.2x10^{-4}$		0.24	$1.2x10^{-4}$		66	0.033	$4.0x10^{-7}$
Impacts for Composite Set of EBAs and BEBAs[5]									
Expected consequences[6]		2.0x10-6			$2.0x10^{-6}$			$5.2x10^{-4}$	
Expected risk (per year)		$5.6x10^{-8}$			$5.6x10^{-8}$			$1.5x10^{-5}$	
Impacts for Composite Set of EBAs									
Expected consequences[6]		$1.7x10^{-6}$			$1.7x10^{-6}$			$4.8x10^{-4}$	
Expected risk (per year)		$4.8x10^{-8}$			$4.6x10^{-8}$			$1.3x10^{-5}$	
Impacts for Composite Set of BEBAs									
Expected consequences[6]		6.2x10-3			8.0x10-3			0.94	

Expected risk (per year)		7.4x10^{-9}			9.7x10^{-9}			1.1x10^{-6}	

Table F.2.1.2-2.-- Downsized Weapons Assembly/Disassembly Operations at Nevada Test Site, Impacts of Accidents

	Noninvolved Worker at 1,000 Meters			**Maximum Offsite Individual**			**Population to 80 Kilometers**		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality**[7]		**Dose (rem)**	**Probability of Cancer Fatality**		**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Aircraft impact and release	[8]	[8]		[8]	[8]		[8]	[8]	[8]
2. Explosive dispersal of plutonium in cell or bay	26.1	0.01		2.3	1.1x10^{-3}		361	0.18	5.7x10^{-6}
3. Mechanical release from impact breach of pit cladding	4.7x10^{-6}	1.9x10^{-9}		4.0x10^{-7}	2.0x10^{-10}		5.4x10^{-5}	2.7x10^{-8}	7.8x10^{-3}
4. Inadvertent activation of explosive squib on tritium reservoir	1.4x10^{-3}	5.7x10^{-7}		1.2x10^{-4}	6.2x10^{-8}		0.016	8.1x10^{-6}	0.02
5. Operational fire-induced plutonium release	0.77	3.1x10^{-4}		0.066	3.3x10^{-5}		8.9	4.4x10^{-3}	1.0x10^{-5}
6. Fire-induced release from tritium reservoirs in staging vault[9]	0.42	1.7x10^{-4}		0.038	1.9x10^{-5}		5.6	2.8x10^{-3}	4.0x10^{-7}
Impacts of Composite Set of EBAs and BEBAs[10]									

Expected consequences[11]		2.7x10^{-6}			2.9x10^{-7}			4.4x10^{-5}	
Expected risk (per year)		7.4x10^{-8}			8.1x10^{-9}			1.2x10^{-6}	
Impacts for Composite Set of EBAs									
Expected consequences[11]		2.7x10-6			2.9x10^{-7}			4.4x10^{-5}	
Expected risk (per year)		7.4x10^{-8}			8.1x10^{-9}			1.2x10^{-6}	
Impacts for Composite Set of BEBAs									
Expected consequences[11]		1.7x10^{-4}			1.9x10^{-5}			2.8x10^{-3}	
Expected risk (per year)		6.7x10-^{11}			7.7x10^{-12}			1.1x10^{-9}	

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1 For the aircraft crash accident, the Stockpile Stewardship and Management PEIS impacts are based on a percentage of the risks described in the Pantex Site-Wide Draft EIS. See the discussion under Scenario 1 in this section for additional details.

2 The maximum amount of material is a hypothetical amount chosen for the purposes of this analysis. HNUS 1996a.

3 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located at 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

4 A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

5 For the offsite population of 285,409, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is 1.8x10^{-9}/5.3x10^{-11}.

6 Result of exposure to the indicated dose if the accident occurs. All values are mean values. Model results.

7 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or to a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

8 Not applicable. The probability of an aircraft crash is estimated to be lower than 10^{-7} /yr.

9 A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

10 For the offsite population of 18,517, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is 2.4×10^{-9}/6.5×10^{-11}.

11 Result of exposure to the indicated dose if the accident occurs. All values are mean values. Model results.

APPENDIX F: FACILITY ACCIDENTS

F.2.2 Secondary and Case Fabrication

Evaluation basis accidents and beyond evaluation basis accidents have been studied for the secondary and case fabrication operations. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public that can be expected from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations.

F.2.2.1 Accident Scenarios and Source Terms

A range of hazardous conditions and potential accidents were reviewed as candidates to represent the risks of the facility's operation to workers and the public. Through a screening process, several evaluation basis accidents and beyond evaluation basis accidents were selected for further definition and analysis. A brief description of each of the 12 accident scenarios and source terms is presented below. Table F.2.2.1-1 presents a summary of each accident scenario and source term. Further detail can be found in a topical report (HNUS 1996a).

Scenario 1: Nuclear criticality. Criticality accidents are postulated at nearly all locations where highly enriched uranium (HEU) is handled. Potential causes include operator error and loss of safe geometry resulting from fire damage to aluminum birdcage containers or structural damage from an earthquake. Both ground-level and elevated fission product releases to the atmosphere are postulated. The postulated criticality is based on the characteristics of a solution as specified by the U.S. Nuclear Regulatory Commission.

For the accidental criticality evaluated, it is assumed that 1x1019 fissions occur before reaching a stable, subcritical condition. This total is comprised of an initial burst of 1x1018 fissions followed by repeated bursts of 1x1017 fissions over an 8-hour period as liquid is assumed to be boiled from a solution system. 100 percent of the xenon and krypton formed is released; 25 percent of the iodine is released.

Oak Ridge Reservation. The criticality accident frequency is assumed to be extremely unlikely (1x10-6 to 1x10-4/yr).

Los Alamos National Laboratory. The criticality accident frequency is assumed to be extremely unlikely (1x10-6 to 1x10-4/yr).

Lawrence Livermore National Laboratory. The criticality accident frequency is assumed to be extremely unlikely (1x10-6 to 1x10-4/yr).

Scenario 2: Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fire. The postulated accident assumes that a beyond evaluation basis earthquake causes the uranium process, component fabrication, and storage facilities to collapse. Ruptured gas lines and/or hydraulic lines cause fires in the process and component fabrication facilities.

Oak Ridge Reservation. The frequency of this accident is beyond evaluation basis (1x10-7 to 1x10-6). The total HEU source term released in oxide form is estimated to be 17 kg (37 lb) and 1.5 kg (3.3 lb) of depleted uranium.

Los Alamos National Laboratory. The accident defined for Oak Ridge Reservation (ORR) is assumed to be valid at Los Alamos National Laboratory (LANL). The frequency is assumed to be in the range of 1x10-7 to 1x10-6/yr. The total release is 17 kg (37 lb) of HEU and 1.5 kg (3.3 lb) of depleted uranium. The location of the release is the Chemistry and Metallurgy Research Building.

Table F.2.2.1-1.-- Accident Scenarios for Secondary and Case Fabrication

Accident Scenario	Site	Accident Frequency (per year)	Total Material Released to Environment
1. Nuclear criticality	ORR	1x10-6 to 1x10-4	1x1019 fissions
	LANL	1x10-6 to 1x10-4	1x1019 fissions
	LLNL	1x10-6 to 1x10-4	1x1019 fissions
2. Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fire	ORR	1x10-7 to 1x10-6	17 kg of HEU and 1.5 kg of depleted uranium
	LANL	1x10-7 to 1x10-6	17 kg of HEU and 1.5 kg of depleted uranium
	LLNL	1x10-7 to 1x10-6	17 kg of HEU and 1.5 kg of depleted uranium
3. Dry criticality resulting from vehicle accident	ORR	1x10-6 to 1x10-4	1x1018 fissions
	LANL	1x10-6 to 1x10-4	1x1018 fissions
	LLNL	1x10-6 to 1x10-4	1x1018 fissions
4. Fire-induced release of highly enriched uranium from solvent fire	ORR	1x10-6 to 1x10-4	4 kg of HEU
	LANL	1x10-6 to 1x10-4	4 kg of HEU
	LLNL	1x10-6 to 1x10-4	4 kg of HEU
5. Fire-induced release of highly enriched uranium from metallurgical operations	ORR	1x10-6 to 1x10-4	3.75 kg of HEU
	LANL	1x10-6 to 1x10-4	3.75 kg of HEU
	LLNL	1x10-6 to 1x10-4	3.75 kg of HEU
	ORR	1x10-6 to 1x10-4	2,800 kg Li2O

6. Fire-induced release of lithium	LANL	1x10-6 to 1x10-4	2,800 kg Li2O
	LLNL	1x10-6 to 1x10-4	2,800 kg Li2O
7. Fire-induced release of highly enriched uranium on loading dock	ORR	1x10-6 to 1x10-4	0.8 kg of HEU
	LANL	1x10-6 to 1x10-4	0.8 kg of HEU
	LLNL	1x10-6 to 1x10-4	0.8 kg of HEU
8. Filter failure-induced release of highly enriched uranium	ORR	1x10-6 to 1x10-4	1.6 kg of HEU
	LANL	1x10-6 to 1x10-4	1.6 kg of HEU
	LLNL	1x10-6 to 1x10-4	1.6 kg of HEU
9. Mechanical release of hydrogen fluoride	ORR	1x10-6 to 1x10-4	386 kg of hydrogen fluoride
	LANL	1x10-6 to 1x10-4	386 kg of hydrogen fluoride
	LLNL	1x10-6 to 1x10-4	386 kg of hydrogen fluoride
10. Fire-induced release of hydrogen cyanide	ORR	1x10-6 to 1x10-4	300 kg of acetonitrile solvent
	LANL	1x10-6 to 1x10-4	300 kg of acetonitrile solvent
	LLNL	1x10-6 to 1x10-4	300 kg of acetonitrile solvent
HNUS 1996a.			

Lawrence Livermore National Laboratory. The accident defined for ORR is assumed to be valid at Lawrence Livermore National Laboratory (LLNL). The frequency is assumed to be in the range of 1x10-7 to 1x10-6/yr. The total release is 17 kg (37 lb) of HEU and 1.5 kg (3.3 lb) of depleted uranium.

Scenario 3: Dry criticality resulting from vehicle accident. A vehicle accident is postulated in which the contents are dislodged and possibly mixed with moderating materials, creating a criticality. HEU oxide powder is spilled and collected in the vehicle's low point. The accidental criticality could be initiated by an error in strapping or by wheels falling off a bottle dolly. The postulated criticality results in 1x10 *18* fissions for the dry criticality.

Oak Ridge Reservation. The accident frequency is assumed to be in the range of extremely unlikely (1x10-6 to 1x10-4/yr).

Los Alamos National Laboratory. The accident is assumed to occur at LANL with a frequency of 1x10-6 to 1x10-4/yr.

Lawrence Livermore National Laboratory. The accident is assumed to occur at LLNL with a frequency of 1x10-6 to 1x10-4/yr.

Scenario 4: Fire-induced release of highly enriched uranium from a solvent fire. A fire releasing uranium aerosols is postulated to occur. The types of fires include contaminated trash, solvents containing uranium solutions, uranium chips, and larger uranium metal shapes. A solvent fire releasing uranium-laden combustion gases at ground level is assumed. In this scenario, the entire contents of an extraction column would be released via a pipe break or other failure and are ignited by an electrical fault. Complete combustion would occur.

Oak Ridge Reservation. The release at ORR is estimated to be 4 kg (8.8 lb) of HEU with a frequency in the range of 1x10-6 to 1x10-4/yr.

Los Alamos National Laboratory. The accident is assumed to occur at LANL with a frequency in the range of 1x10-6 to 1x10-4/yr and a release of 4 kg (8.8 lb) of HEU.

Lawrence Livermore National Laboratory. The accident is assumed to occur at LLNL with a frequency in the range of 1x10-6 to 1x10-4/yr and a release of 4 kg (8.8 lb) of HEU.

Scenario 5: Fire-induced release of highly enriched uranium. A uranium fire accident is postulated to occur during metallurgical operations when a 4-liter (L) (1-gallon [gal]) container of briquettes ignites while check weighing before being loaded into a crucible. The total material at risk is estimated to be 15 kg (33 lb) of HEU.

Oak Ridge Reservation. The accident is assumed to occur with a frequency in the range of 1x10-6 to 1x10-4 /yr and a release of 3.75 kg (8.31 lb) of HEU.

Los Alamos National Laboratory. The accident is assumed to occur with a frequency in the range of 1x10-6 to 1x10-4 /yr and a release of 3.75 kg (8.3 lb) of HEU.

Lawrence Livermore National Laboratory. The accident is assumed to occur with a frequency in the range of 1x10-6 to 1x10-4/yr and a release of 3.75 kg (8.31 lb) of HEU.

Scenario 6: Fire-induced release of lithium. A lithium fire is postulated to occur when burning lithium produces hazardous lithium oxide.

Oak Ridge Reservation. The probability of the accident is assumed to be in the range of 1x10-6 to 1x10-4/yr and to release 2,800 kg (6,170 lb) of lithium oxide.

Los Alamos National Laboratory. The probability of the accident is assumed to be in the range of 1x10-6 to 1x10-4/yr and to release 2,800 kg (6,170 lb) of lithium oxide.

Lawrence Livermore National Laboratory. The probability of the accident is assumed to be in the range of 1x10-6 to 1x10-4/yr and to the release 2,800 kg (6,170 lb) of lithium oxide.

Scenario 7: Fire-induced release of highly enriched uranium on loading dock. A uranium metal fire at the loading dock is postulated to occur and results in a release of heated uranium aerosols at ground level. The fire is assumed to burn for 30 minutes and, during that time, completely oxidate the uranium metal in the transport vehicle. The effective release height is estimated to be 30 m (98 ft) because of thermal buoyancy.

Oak Ridge Reservation. The amount of HEU released to the atmosphere is 0.8 kg (1.8 lb) with an assumed frequency in the range of 1x10-6 to 1x10-4/yr.

Los Alamos National Laboratory. The accident is assumed to occur at LANL with a frequency in the range of 1x10-6 to 1x10-4/yr. The release is estimated to be 0.8 kg (1.8 lb) of HEU with a release height of 30 m (98 ft).

Lawrence Livermore National Laboratory. The accident is assumed to occur at LLNL with a frequency in the range of 1x10-6 to 1x10-4/yr. The release is estimated to be 0.8 kg (1.8 lb) of HEU with a release height of 30 m (98 ft).

Scenario 8: Filter failure release of highly enriched uranium. Mechanical upsets are events such as spills, forklift punctures, loss of filtration, and piping failures. The mechanical upset would result in small releases to the atmosphere, unless the off-gas filters in the fluid bed system fail. The bounding accident scenario postulates that both the primary and secondary filters rupture internally, allowing the contained charge of uranium oxide and uranium fluoride particles to be released to the atmosphere via the exhaust stack.

Oak Ridge Reservation. The release to the atmosphere is 1.6 kg (3.5 lb) of HEU from the filter. The assumed accident frequency is in the range of 1x10-6 to 1x10-4/yr.

Los Alamos National Laboratory. The release to the atmosphere is 1.6 kg (3.5 lb) of HEU from the filter. The assumed accident frequency is in the range of 1x10-6 to 1x10-4/yr.

Lawrence Livermore National Laboratory. The release to the atmosphere is 1.6 kg (3.5 lb) of HEU from the filter. The assumed accident frequency is in the range of 1x10-6 to 1x10-4/yr.

Scenario 9: Mechanical release of hydrogen fluoride. This accident is postulated as a large spill of hydrogen fluoride that would generate a dense cloud of hydrogen fluoride that can exceed Level of Concern limits. It is assumed that the entire contents of a tank containing 386 kg (850 lb) of hydrogen fluoride would leak from a 2.54-centimeter (cm) (1-inch [in]) hole, emptying the tank in 12 minutes.

Oak Ridge Reservation. The accident frequency is assumed to range from 1x10-6 to 1x10-4/yr. The release is the tank's entire contents of 386 kg (850 lb) of hydrogen fluoride.

Los Alamos National Laboratory. The accident frequency is assumed to range from 1x10-6 to 1x10-4/yr. The release is the tank's entire contents of 386 kg (850 lb) of hydrogen fluoride.

Lawrence Livermore National Laboratory. The accident frequency is assumed to range from 1x10-6 to 1x10-4/yr. The release is the tank's entire contents of 386 kg (850 lb) of hydrogen fluoride.

Scenario 10: Fire-induced release of hydrogen cyanide during a vehicle impact. A vehicular traffic accident is postulated to occur and cause a rupture in one or more drums containing acetonitrile solvent waste. The spill is ignited by a spark, and the resulting fire spreads to other drums in the area. The fire produces hydrogen cyanide.

Oak Ridge Reservation. The accident frequency is assumed to be in the range of 1x10-6 to 1x10-4/yr. The release involves 300 kg (660 lb) of solvent waste.

Los Alamos National Laboratory. The accident frequency is assumed to be in the range of 1x10-6 to 1x10-4/yr. The release involves 300 kg (660 lb) of solvent waste.

Lawrence Livermore National Laboratory. The accident frequency is assumed to be in the range of 1x10-6 to 1x10-4/yr. The release involves 300 kg (660 lb) of solvent waste.

F.2.2.2 Accident Consequences and Risk

Tables F.2.2.2-1, F.2.2.2-2 , and F.2.2.2-3 list the set of accidents selected to represent consequences and risks to workers and the public from accidental releases of radioactive materials during operations at ORR, LANL, and LLNL, respectively. For each accident, the table identifies the frequency of occurrence and the consequences to a hypothetical worker at a specified distance from the accident, a hypothetical individual located at the nearest site boundary, and the public out to a distance of 80 km (50 mi). The risks of cancer fatality for the worker, the individual at the site boundary, and the public for the composite set of accidents are also shown.

Table F.2.2.2-1.-- Secondary and Case Fabrication at Oak Ridge Reservation, Impacts of Accidents

	Noninvolved Worker at 619 Meters			**Maximum Offsite Individual**			**Population to 80 Kilometers**		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality 12**		**Dose (rem)**	**Probability of Cancer Fatalitya**		**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Nuclear criticality	0.051	2.0x10 -5		0.051	2.5x10 -5		3.1	1.5x10 -3	1.0x10 -5

2. Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fires [13]	2.4	9.6x10^{-4}		2.4	1.2x10^{-3}		363	0.18	5.0x10^{-7}
3. Dry criticality resulting from vehicle accident	5.1x10^{-3}	2.0x10^{-6}		5.1x10^{-3}	2.5x10^{-6}		0.31	1.5x10^{-4}	1.0x10^{-5}
4. Fire-induced release of highly enriched uranium from solvent fire	0.57	2.3x10^{-4}		0.57	2.9x10^{-4}		86	0.04	1.0x10^{-5}
5. Fire-induced release of highly enriched uranium from metallurgical operations	0.54	2.2x10^{-4}		0.54	2.7x10^{-4}		80.6	0.04	1.0x10^{-5}
7. Fire-induced release of highly enriched uranium on loading dock	0.083	3.3x10^{-5}		0.083	4.2x10^{-5}		17.6	8.8x10^{-3}	1.0x10^{-5}
8. Filter failure-induced release of highly enriched uranium	0.23	9.2x10^{-5}		0.23	1.1x10^{-4}		34.3	0.017	1.0x10^{-5}
Impacts for Composite Set of EBAs and BEBAs [14]									
Expected consequences [15]		*1.1x10-4*			1.3x10^{-4}			0.02	
Expected risk (per year)		6.4x10^{-9}			8.0x10^{-9}			1.2x10^{-6}	
Impacts for Composite Set of EBAs									

Expected consequences [15]		*1.0x10-4*			1.2x10-4			0.018	
Expected risk (per year)		5.9x10 *-9*			7.4x10-9			1.1x10 *-6*	
Impacts for Composite Set of BEBAs									
Expected consequences[15]		*9.7x10-4*			$1.2x10^{-3}$			0.18	
Expected risk (per year)		4.9x10-10			6.0x10-10			9.1x10-8	

Table F.2.2.2-2.-- Secondary and Case Fabrication at Los Alamos National Laboratory, Impacts of Accidents

	Noninvolved Worker at 862 Meters			**Maximum Offsite Individual**			**Population to 80 Kilometers**		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality [16]**		**Dose (rem)**	**Probability of Cancer Fatalitya**		**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Nuclear criticality	0.034	1.4x10 *-5*		0.034	1.7x10 *-5*		4.9	2.4x10 *-3*	1.0x10 *-5*
2. Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fire [17]	1.6	6.2x10 *-4*		1.6	7.7x10 *-4*		360	0.18	5.0x10 *-7*
3. Dry criticality resulting from vehicle accident	3.4x10 *-3*	1.4x10 *-6*		3.4x10 *-3*	1.7x10 *-6*		0.49	2.4x10 *-4*	1.0x10 *-5*
4. Fire-induced release of highly enriched uranium from solvent fire	0.36	1.5x10 *-4*		0.36	1.8x10 *-4*		84.5	0.042	1.0x10 *-5*

5. Fire-induced release of highly enriched uranium from metallurgical operations	0.34	1.4x10 *-4*		0.34	1.7x10 *-4*		79.4	0.04	1.0x10 *-5*
7. Fire-induced release of highly enriched uranium on loading dock	0.053	2.1x10 *-5*		0.053	2.6x10 *-5*		15.0	7.5x10 *-3*	1.0x10 *-5*
8. Filter failure-induced release of highly enriched uranium	0.15	5.8x10 *-5*		0.15	7.3x10 *-5*		33.8	0.017	1.0x10 *-5*
Impacts for Composite Set of EBAs and BEBAs[18]									
Expected consequences *[19]*		6.8x10 *-5*			8.4x10 *-5*			0.02	
Expected risk (per year)		4.1x10 *-9*			5.1x10 *-9*			1.2x10 *-6*	
Impacts for Composite Set of EBAs									
Expected consequences[19]		*6.3x10-5*			7.9x10-5			0.018	
Expected risk (per year)		3.8x10 *-9*			4.7x10 *-9*			1.1x10 *-6*	
Impacts for Composite Set of BEBAs									
Expected consequences*[19]*		*6.2x10-4*			*7.7x10-4*			0.18	
Expected risk (per year)		3.1x10-10			3.9x10-10			8.9x10-8	

Table F.2.2.2-3.-- Secondary and Case Fabrication at Lawrence Livermore National Laboratory, Impacts of Accidents

	Noninvolved Worker at 247 Meters			Maximum Offsite Individual			Population to 80 Kilometers		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality**[20]		**Dose (rem)**	**Probability of Cancer Fatality**		**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Nuclear criticality	0.07	2.8x10 -5		0.07	3.5x10 -5		9.9	5.0x10 -3	1.0x10 -5
2. Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fire[21]	3.4	1.4x10 -3		3.4	1.7x10 -3		1.2x10 3	0.58	5.0x10 -7
3. Dry criticality resulting from vehicle accident	7.0x10 -3	2.8x10 -6		7.0x10 -3	3.5x10 -6		0.99	5.0x10 -4	1.0x10 -5
4. Fire-induced release of highly enriched uranium from solvent fire	0.8	3.2x10 -4		0.80	4.0x10 -4		273	0.14	1.0x10 -5
5. Fire-induced release of highly enriched uranium from metallurgical operations	0.75	3.0x10 -4		0.75	3.8x10 -4		257	0.13	1.0x10 -5
7. Fire-induced release of highly enriched uranium on loading dock	0.11	4.2x10 -5		0.11	5.3x10 -5		53.2	0.027	1.0x10 -5
8. Filter failure-induced release of highly enriched uranium	0.32	1.3x10 -4		0.32	1.6x10 -4		109	0.055	1.0x10 -5

Impacts for Composite Set of EBAs and BEBAs[22]									
Expected consequences [23]		1.5x10 -*4*			1.8x10 -*4*			0.063	
Expected risk (per year)		8.9x10 -*9*			1.1x10 -*8*			3.8x10 -*6*	
Impacts for Composite Set of EBAs									
Expected consequences[23]		*1.4x10-4*			1.7x10-4			0.06	
Expected risk (per year)		8.2x10 -*9*			1.0x10 -*8*			3.5x10-6	
Impacts for Composite Set of BEBAs									
Expected consequences[23]		*1.4x10-3*			*1.7x10-3*			0.6	
Expected risk (per year)		6.8x10-10			8.5x10-10			2.9x10-7	

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12 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located at the indicated distance from the accident as a result of exposure to the indicated dose if the accident were to occur.

13 A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

14 For the offsite population of 1,096,144, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is 1.8x10-8/1.1x10-12.

15 Result of exposure to the indicated dose if the accident occurs. All values are mean values. Model results.

16 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located at the indicated distance from the accident as a result of

exposure to the indicated dose if the accident occurred.

17 A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

18 For the offsite population of 281,812, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is 7.1x10-8/4.3x10-12.

19 Result of exposure to the indicated dose if the accident occurs. All values are mean values. Model results.

20 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 247 m (810 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

21 A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

22 For the offsite population of 7,843,061, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is 8.0x10-9/4.8x10-13.

23 Result of exposure to the indicated dose if the accident occurs. All values are mean values.

APPENDIX F: FACILITY ACCIDENTS

F.2.3 Pit Fabrication and Intrusive Modification Pit Reuse

Studies of evaluation basis accidents and beyond evaluation basis accidents have been performed for the pit fabrication and intrusive modification pit reuse operations. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public that can be expected from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations.

F.2.3.1 Accident Scenarios and Source Terms

A range of hazardous conditions and potential accidents were reviewed as candidates to represent the risks to workers and the public of the replacement pit fabrication and intrusive modification operations at Savannah River Site (SRS) and LANL, respectively. Through a screening process, several evaluation basis accidents and beyond evaluation basis accidents were selected for further definition and analysis. Descriptive information on these accidents is provided in table F.2.3.1-1.

Table F.2.3.1-1.-- Accident Scenarios for Pit Fabrication and Intrusive Modification Pit Reuse

Accident Scenario	Site	Accident Frequency (per year)	Total Material Released to Environment
1. Fire-induced release of plutonium from a glove box	LANL	1x10-4 to 0.01	0.24 g plutonium oxide
	SRS	1x10-4 to 0.01	0.24 g plutonium oxide
2. Operational release of tritium	LANL	1x10-6 to 1x10-4	21,000 Ci of tritium oxide [24]
	SRS	1x10-6 to 1x10-4	21,000 Ci of tritium oxide [24]
3. Mechanical release of nitric acid into confined area	LANL	1x10-6 to 1x10-4	6,100 gal of 80-percent nitric acid in bermed area
	SRS	1x10-6 to 1x10-4	6,100 gal of 80-percent nitric acid in bermed area
4. Earthquake-induced mechanical release of nitric acid	LANL	1x10-7 to 1x10-6	6,100 gal of 80-percent nitric acid in bermed area
	SRS	1x10-7 to 1x10-6	6,100 gal of 80-percent nitric acid in bermed area
5. Earthquake-induced	LANL	1x10-6 to 1x10-4	0.61 g of plutonium metal

release of plutonium	SRS	1x10-6 to 1x10-4	0.61 g of plutonium metal
6. Earthquake-induced release of plutonium	LANL	1x10-7 to 1x10-6	0.63 g of plutonium metal
	SRS	1x10-7 to 1x10-6	0.63 g of plutonium metal
7. Wet criticality	LANL	1x10-7 to 1x10-6	5x1017 fissions
	SRS	1x10-7 to 1x10-6	5x1017 fissions
8. Mechanical-induced release of plutonium	LANL	0.01 to 1x10-1	7.2x10-12 g of plutonium oxide
	SRS	0.01 to 1x10-1	7.2x10-12 g of plutonium oxide
9. Explosive-induced release of plutonium	LANL	1x10-4 to 0.01	0.05 g of plutonium metal
	SRS	$1x10^{-4}$ to 0.01	0.05 g of plutonium metal
10. Fire-induced release of plutonium on loading dock	LANL	$1x10^{-6}$ to $1x10^{-4}$	0.8 g plutonium oxide
	SRS	$1x10^{-6}$ to $1x10^{-4}$	0.8 g plutonium oxide

Scenario 1: Fire-induced release of plutonium from a glove box. A fire is postulated within a laboratory which involves cleaning liquid such as acetone or isopropyl alcohol and burns the gloves in a glove box. The fire releases the plutonium contamination from the outer surface of the gloves that are in the glove box. Fire suppression and ventilation systems are assumed to be inoperable.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of $1x10^{-4}$ to 0.01/yr. The estimated release is 0.24 g ($8.47x10^{-3}$ oz) of plutonium oxide.

Savannah River Site. The accident frequency is estimated to be in the range of $1x10^{-4}$ to 0.01/yr. The estimated release is 0.24 g ($8.47x10^{-3}$ oz) of plutonium oxide.

Scenario 2: Operational release of tritium from special recovery line. This postulated accident is initiated by the loss of the inert atmosphere in the disassembly glove box in the special recovery line. As a result of the loss of inert atmosphere, a fire is assumed to start. As the tritium storage container is heated, tritium is released. It is assumed that released tritium bypasses the tritium collection system.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. For the purposes of this analysis, the release is assumed to be 21,000 curies (Ci) of tritium oxide.

Savannah River Site. The accident is assumed to be applicable at SRS with an estimated frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. For the purposes of this analysis, the release is assumed to be 21,000 Ci of tritium oxide.

Scenario 3. Mechanical release of nitric acid into confined bermed area. A mechanical failure in a tank, valve, or piping is postulated that releases the entire contents of an 80-percent nitric acid storage tank. The tank is located outdoors within a bermed area. The inventory is confined to the berm surrounding the tank.

Los Alamos National Laboratory. The nitric acid tank contains 23,090 L (6,100 gal) of 80-percent nitric acid. The bermed area is 27 square meters (m^{2}) (288 square feet [ft^{2}]). The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Savannah River Site. The same nitric acid tank and bermed area are assumed to located at SRS. The tank contains 23,090 L (6,100 gal) of 80-percent nitric acid. The bermed area is 27 m^{2} (288 ft^{2}). The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Scenario 4: Beyond evaluation basis earthquake-induced release of nitric acid. A mechanical failure in a tank, valve, or piping is postulated that releases the entire contents of an 80-percent nitric acid storage tank. The tank is located outdoors within a bermed area; however, a beyond evaluation basis earthquake ruptures the berm. The inventory is not confined to the berm surrounding the tank.

Los Alamos National Laboratory. The nitric acid tank contains 23,090 L (6,100 gal) of 80-percent nitric acid. The accident frequency is estimated to be in the range of 1x10-7 to 1x10-6/yr.

Savannah River Site. The same nitric acid tank and bermed area are assumed to be located at SRS. The tank contains 23,090 L (6,100 gal) of 80-percent nitric acid. The accident frequency is estimated to be in the range of 1x10-7 to 1x10-6/yr.

Scenario 5: Evaluation basis earthquake-induced release of plutonium. The forces from the seismic event are applied to the facility and confinement systems within the facility. For the source term analysis, both anchorage failures and support stand failures are assumed to cause enclosures to fall over. On impact with the floor, glove box windows may break or fall out, connecting rings and connections to exhaust ductwork may separate, and solution transfer lines may break. The enclosures may also fail structurally. For the source term analysis, if the seismic margins assessment shows that an enclosure will fail, it is assumed that the enclosure will be breached, and material that becomes airborne will be released to the laboratory. The building structure, high-efficiency particulate air (HEPA) filter plenums, and ductwork from the plenums to the structure will remain a functional confinement barrier following an earthquake.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of 1x10-6 to 1x10-4/yr. The release is calculated to be 0.61 g (0.02 oz) of plutonium metal.

Savannah River Site. This accident is also assumed to occur at SRS. The accident frequency is estimated to be in the range of 1x10-6 to 1x10-4/yr. The release is calculated to be 0.61 g (0.02 oz) of plutonium metal.

Scenario 6. Beyond evaluation basis earthquake-induced release of plutonium. The forces from the seismic event are applied to the facility and confinement systems within the facility. For the source term analysis, both anchorage failures and support stand failures are assumed to cause enclosures to fall over. On impact with the floor, glove box windows may break or fall out, connecting rings and connections to exhaust ductwork may separate, and solution transfer lines may break. The enclosures may also fail structurally. For the source term analysis, if the seismic margins assessment shows that an enclosure will fail, it is assumed that the enclosure will be breached, and material that becomes airborne will be released to the laboratory. For the beyond evaluation basis earthquake, the building structure, HEPA filter plenums, and ductwork from the plenums to the structure are assumed not to be functional confinement barriers.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr. The release is calculated to be 0.63 g (0.02 oz) of plutonium metal.

Savannah River Site. This accident is also assumed to occur at SRS. The accident frequency is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr. The release is calculated to be 0.63 g (0.02 oz) of plutonium metal.

Scenario 7: Wet criticality. The wet criticality accident occurs in a glove box where the plutonium in solution exceeds the critical mass.

Los Alamos National Laboratory. The wet criticality accident that is postulated results in 5x1017 fissions. The frequency of occurrence of a criticality is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr.

Savannah River Site. The wet criticality is also assumed to occur at SRS. The accident results in 5x1017 fissions. The frequency of occurrence of a criticality is estimated to be in the range of 1x10-7 to 1x10-6/yr.

Scenario 8: Mechanical-induced release of plutonium from a degraded storage container. This postulated scenario assumes a package is dropped and the oxide contents spill onto the room floor. The material at risk is assumed to be 4.5 kg (9.9 lb) of plutonium oxide. No credit is taken for the inner metal container (assumed to have been ruptured by the plutonium oxidation reaction), the inner plastic bag (assumed to have deteriorated), or the outer package (assumed to be a slip-lid can with a degraded seal).

Los Alamos National Laboratory. The accident frequency is in the range of 0.01 to 0.1/yr. The release is estimated to be $7.2x10^{-12}$ g ($2.5x10^{-13}$ oz) of plutonium oxide.

Savannah River Site. The accident frequency is in the range of 0.01 to 0.1/yr. The release is estimated to be $7.2x10^{-12}$ g ($2.5x10^{-13}$ oz) of plutonium oxide.

Scenario 9: Explosion-induced release of plutonium. This postulated accident is the result of a chemical explosion in an ion-exchange column. The explosion causes a breach of the glove box containing the ion exchange column. It is assumed that the normal ventilation system is inoperable.

Los Alamos National Laboratory. The accident frequency is in the range of 1x10^{-4} to 0.01/yr. The release of plutonium metal is estimated to be 0.05 g (1.76x10^{-3} oz).

Savannah River Site. The accident frequency is in the range of 1x10^{-4} to 0.01/yr. The release of plutonium metal is estimated to be 0.05 g (1.76x10^{-3} oz).

Scenario 10: Fire-induced release of plutonium on loading dock. This postulated scenario involves a fire on the loading dock involving a combustible plutonium contaminated waste drum. This scenario also assumes that the loading dock is open to the atmosphere at the time of the fire.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of 1x10^{-6} to 1x10^{-4}/yr. The release is calculated to be 0.8 g (0.03 oz) of plutonium oxide.

Savannah River Site. The accident frequency is estimated to be in the range of 1x10^{-6} to 1x10^{-4} /yr. The release is calculated to be 0.8 g (0.03 oz) of plutonium oxide.

F.2.3.2 Accident Consequences and Risk

Tables F.2.3.2-1 and F.2.3.2-2 list the set of accidents selected to represent consequences and risks to workers and the public from accidental releases of radioactive materials during operations. For each accident, the table identifies the frequency of occurrence and the consequences to a hypothetical worker located at 1,000 m (3,281 ft) from the accident, a hypothetical individual located at the nearest site boundary, and the public out to a distance of 80 km (50 mi). The risks of cancer fatality for the worker, the individual at the site boundary, and the public for the composite set of accidents are also shown.

Table F.2.3.2-1.-- Pit Fabrication and Intrusive Modification Pit Reuse at Savannah River Site, Impacts of Accidents

	Noninvolved Worker at 1,000 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality[25]**	**Dose (rem)**	**Probability of Cancer Fatality[25]**	**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Fire-induced plutonium release from a glove box	0.035	1.4x10^{-5}	5.8x10^{-4}	2.9x10^{-7}	4.3	2.2x10^{-3}	1.0x10^{-3}

2. Operational release of tritium	6.5x10^{-3}	2.6x10^{-6}		1.1x10^{-4}	5.5x10^{-8}		0.79	4.0x10^{-4}	1.0x10^{-5}
5. Earthquake-induced release of plutonium - evaluation basis earthquake	0.099	4.0x10^{-5}		1.7x10^{-3}	8.4x10^{-7}		12.3	6.2x10^{-3}	1.0x10^{-5}
6. Earthquake-induced release of plutonium - beyond evaluation basis earthquake[26]	0.10	4.1x10^{-5}		1.7x10^{-3}	8.6x10^{-7}		12.8	6.4x10^{-3}	5.0x10^{-7}
7. Wet criticality[26]	8.5x10^{-4}	3.4x10^{-7}		1.4x10^{-5}	7.0x10^{-9}		0.019	9.5x10^{-6}	5.0x10^{-7}
8. Mechanical-induced release of plutonium	1.2x10^{-12}	4.7x10^{-16}		2.0x10^{-14}	9.9x10^{-18}		1.5x10^{-10}	7.3x10^{-14}	0.05
9. Explosion-induced release of plutonium	8.1x10^{-3}	3.3x10^{-6}		1.4x10^{-4}	6.9x10^{-8}		1.0	5.1x10^{-4}	1.0x10^{-3}
10. Fire-induced release of plutonium on loading dock	0.11	4.6x10^{-5}		1.9x10^{-3}	9.7x10^{-7}		14.3	7.2x10^{-3}	1.0x10^{-5}
Impacts for Composite Set of EBAs and BEBAs[27]									
Expected consequences[28]		3.5x10^{-7}			7.3x10^{-9}			5.4x10^{-5}	
Expected risk (per year)		1.8x10^{-8}			3.8x10^{-10}			2.8x10^{-6}	
Impacts for Composite Set of EBAs									
Expected consequences[28]		3.4x10^{-7}			7.3x10^{-9}			5.3x10^{-5}	
Expected risk (per year)		1.8x10^{-8}			3.8x10^{-10}			2.8x10^{-6}	

Impacts for Composite Set of BEBAs									
Expected consequences[28]		3.3x10^{-5}			4.4x10^{-7}			3.2x10^{-3}	
Expected risk (per year)		3.3x10^{-11}			4.4x10^{-13}			3.2x10^{-9}	

Table F.2.3.2-2.-- Pit Fabrication and Intrusive Modification Pit Reuse at Los Alamos National Laboratory, Impacts of Accidents

	Noninvolved Worker at 1,000 Meters			**Maximum Offsite Individual**			**Population to 80 Kilometers**		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality[29]**		**Dose (rem)**	**Probability of Cancer Fatality[29]**		**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Fire-induced plutonium release from a glove box	0.064	2.6x10^{-5}		0.035	1.7x10^{-5}		9.5	4.7x10^{-3}	1.0x10^{-3}
2. Operational release of tritium	0.012	4.8x10^{-6}		6.6x10^{-3}	3.3x10^{-6}		1.8	8.8x10^{-4}	1.0x10^{-5}
5. Earthquake-induced release of plutonium - evaluation basis earthquake	0.18	7.4x10^{-5}		0.099	5.0x10^{-5}		27.2	0.014	1.0x10^{-5}
6. Earthquake-induced release of plutonium - beyond evaluation basis earthquake[30]	0.19	7.6x10^{-5}		0.10	5.1x10^{-5}		28.1	0.014	5.0x10^{-7}
7. Wet criticality[30]	1.5x10^{-3}	6.1x10^{-7}		8.7x10^{-4}	4.4x10^{-7}		0.12	6.2x10^{-5}	5.0x10^{-7}

8. Mechanical-induced release of plutonium	2.2x10^{-12}	8.7x10^{-16}		1.2x10^{-14}	5.9x10^{-16}		3.2x10^{-10}	1.6x10^{-13}	0.05
9. Explosion-induced release of plutonium	0.015	6.1x10^{-6}		8.2x10^{-3}	4.1x10^{-6}		2.2	1.1x10^{-3}	1.0x10^{-3}
10. Fire-induced release of plutonium on loading dock	0.21	8.5x10^{-5}		0.12	5.7x10^{-5}		31.5	0.016	1.0x10^{-5}
Impacts for Composite Set of EBAs and BEBAs[31]									
Expected consequences[32]		6.4x10^{-7}			4.3x10^{-7}			1.2x10^{-4}	
Expected risk (per year)		3.3x10^{-8}			2.2x10^{-8}			6.2x10^{-6}	
Impacts for Composite Set of EBAs									
Expected consequences[32]		6.4x10^{-7}			4.3x10^{-7}			1.2x10^{-4}	
Expected risk (per year)		3.3x10^{-8}			2.2x10^{-8}			6.2x10^{-6}	
Impacts for Composite Set of BEBAs									
Expected consequences[32]		3.8x10^{-5}			2.6x10^{-5}			7.1x10^{-3}	
Expected risk (per year)		3.8x10^{-11}			2.6x10^{-11}			7.1x10^{-9}	

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24 The maximum amount of material is a hypothetical amount chosen for the purpose of this analysis. **HNUS 1996a.**

25 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

26 A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

27 For the offsite population of 747,836, the average probability of cancer fatality/risk of cancer

fatality (per year) for the composite set of accidents is 7.2x10-11/3.7x10-12.

28 Result of exposure to the indicated dose if the accident occurs. **All values are mean values. Model results.**

29 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

30 A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

31 For the offsite population of 287,977, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is 4.2x10-10/2.2x10-11.

32 Result of exposure to the indicated dose if the accident occurs. All values are mean values. Model results.

APPENDIX F: FACILITY ACCIDENTS

F.2.4 Nonintrusive Modification Pit Reuse

A set of potential accidents can be postulated for the nonintrusive modification pit reuse for which there may be releases of hazardous materials that may impact onsite workers and the public. Any such impacts, however, are expected to be bounded by the impacts associated with weapons A/D or pit fabrication.

F.2.5 High Explosives Fabrication

Evaluation basis accidents and beyond evaluation basis accidents have been studied for the HE fabrication operations. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations.

F.2.5.1 Accident Scenarios and Consequences

A range of hazardous conditions and potential accidents were reviewed as candidates to represent the risks to workers and the public of the HE fabrication operations. The physical releases (of chemicals and energy) from postulated accidents at the existing HE fabrication facilities at Pantex were used as an analog for potential releases at LANL and LLNL. A range of accidents was considered, from the release of particulates and dust through processing techniques, to the release of explosives from a fire or explosion, to the effects of blast pressure and fragment and debris scatter from an explosion.

The release of particulates and dust through processing operations would be contained where those operations occur. There is a probability in the range of 0.01 to 0.1/yr that the filtration systems fail during these operations. If there is filter failure, the operations would be halted. The releases from such accidents would have marginal effects (may cause minor occupational illnesses).

A release of chemical HE to the environment during a fire is estimated to occur with a probability in the range of $1x10^{-4}$ to 0.01/yr. Such a release would range up to 79 kg (175 lb) of explosives (released over a 10 minute period). The resulting environmental concentrations from a release, either triaminotrinitrobenzene (TATB) or TNT, of this magnitude were simulated. The TATB (which is representative of other explosives such as cyclotrimethylenetrinitramine [RDX] and cyclotetramethylenetetranitramine [HMX]) concentrations in the path of the plume would exceed the threshold limit value-time weighted average (TLV-TWA) of 1.5 mg/m^3 for distances up to 1,500, 2,200; and 2,400 m (5,000; 7,100; and 8,000 ft) from the release for Pantex, LLNL, and LANL, respectively. If the explosive were TNT, the plume concentrations would exceed the TLV-TWA limit of 0.5 milligrams (mg)/cubic meter (m^3) for distances up to 3,100; 4,500; and 5,000 m (10,200; 14,700; and 16,600 ft) from the release for Pantex, LLNL, and LANL, respectively. Concentrations of

HE at each of the site boundaries would be 0.9, 54, and 50 mg/m ^{3} , respectively. Concentrations of HE at 1,000 m (3,281 ft) from the fire (typical for a noninvolved worker) at each of the sites would be 3.0, 5.2, and 6.2 mg/m ^{3} , respectively.

A release of chemical HE from the various processing facilities caused by an accidental explosion has a probability in the range of 1x10 $^{-4}$ to 1x10 $^{-6}$ /yr. Such a release would range up to 79 kg (175 lb) of TATB (or HMX or RDX) or up to 29 kg (64 lb) of TNT. The explosive force from such an accident would result in elevating the HE to a height of 68 m (223 ft) before its downwind transport. The maximum concentration to those who could be exposed would be 6.7 mg/m ^{3} for TATB or 2.5 mg/m ^{3} for TNT, at a distance of 800 m (2,600 ft) from the release; this distance is offsite for LANL and LLNL but onsite for Pantex. The maximum offsite concentration at Pantex would be 3.2 mg/m ^{3} or 1.2 mg/m ^{3} for TATB or TNT, respectively. The TLV-TWA limits for TATB would be exceeded between 180 and 3,500 m (580 and 11,600 ft) from the release; these limits for TNT would be exceeded in the interval from 170 to 3,700 m (550 to 12,300 ft) from the release. The noninvolved worker (1,000 m [3,281 ft] from the explosion) could be exposed to TATB or TNT concentrations of 6.4 or 2.4 mg/m ^{3} , respectively, essentially the maximum concentration found near the ground.

It should be noted that the TLV-TWA represents a TWA limit to a worker for a 40-hour workweek. The toxic exposures considered here are of a much shorter duration, on the order of minutes.

F.2.6 Storage of Plutonium Strategic Reserves

Evaluation basis accidents and beyond evaluation basis accidents have been studied for the storage of plutonium strategic reserves. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public that can be expected from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations.

F.2.6.1 Accident Scenarios and Source Terms

A range of hazardous conditions and potential accidents were reviewed as candidates to represent the risks to workers and the public from operating this facility. Through a screening process, several evaluation basis and beyond evaluation basis accidents were selected for further definition and analysis. A brief description of each of the accident scenarios and source terms is presented below. Table F.2.6.1-1 presents a summary of each accident scenario and source term. Further detail can be found in a topical report *(HNUS 1996a).*

Scenario 1: Fire-induced release of plutonium from storage vault.

The combustible material within the vault mostly consists of tags and paperwork. Further, the design and configuration of the vault preclude the introduction of combustible materials in sufficient quantities to significantly alter the thermal environment. Therefore, the only proposed method to initiate a fire in the vault is by the introducing and initiating large amounts of gasoline, jet fuel, or other high-energy-density fuel. Additionally, because of vault, storage container, and pit designs, not all of the pits stored in the vault would be affected by the fire.

For an internal fire to cause some storage containers to fail through would take a sustained (more than 30-minute) exposure to a fire. Even if the storage container containing the pit fails, it is assumed that the material encapsulating the pit retains enough of its integrity so that no plutonium is released, or so that the contribution from pits is insignificant.

Table F.2.6.1-1.-- Accident Scenarios for Storage of Plutonium Strategic Reserves

Accident Scenario	Site	Accident Frequency (per year)	Total Material Release to Environment
1. Fire-induced release of plutonium from storage vaults	Pantex	$5x10^{-8}$	11.4 g plutonium oxide
	NTS	Not applicable	Not applicable
2. Mechanical release of plutonium on loading dock	Pantex	$6x10^{-4}$	0.04 g plutonium oxide
	NTS	$6x10^{-4}$	0.04 g plutonium oxide
HNUS 1996a.			

Pantex Plant. The accident frequency is estimated at $5x10^{-8}$ /yr. The release is estimated to be 11.4 g (0.4 oz) of plutonium oxide.

Nevada Test Site. The vault fire accident is not considered to be a credible scenario because there is no conceivable way to get enough flammable material inside the underground vaults to make this accident possible.

Scenario 2: Mechanical release of plutonium on loading dock

. In this postulated event, a forklift driver attempting to pick up a pallet containing pit storage containers in the shipping and receiving area punctures two of the storage containers. It is assumed that both storage containers contain pits, that the storage containers fall on the floor, and that any loose material in the form of powder is shaken out of the storage container onto the floor.

Pantex Plant. The accident frequency is $6x10^{-4}$ /yr. The release is estimated to be 0.04 g ($1.41x10^{-3}$ oz) of plutonium oxide.

Nevada Test Site. This accident is assumed to occur at NTS at a frequency of $6x10^{-4}$ /yr and release 0.04 g ($1.41x10^{-3}$ oz) of plutonium oxide.

F.2.6.2 Accident Consequences and Risk

Tables F.2.6.2-1 and F.2.6.2-2 list the set of accidents selected to represent consequences and risks to workers and the public from accidental releases of radioactive materials during operations at Pantex and NTS, respectively. For each accident, the table identifies the frequency of occurrence and the consequences to a hypothetical worker located at 1,000 m (3,281 ft) from the accident, a hypothetical individual located at the nearest site boundary, and the public out to a distance of 80 km (50 mi). The risks of cancer fatality for the worker, the individual at the site boundary, and the public for the composite set of accidents are also shown.

Table F.2.6.2-1.-- Storage of Plutonium Strategic Reserves at Pantex Plant, Impacts of Accidents

	Maximum Worker at 1,000 Meters		**Maximum Offsite Individual**		**Population to 80 Kilometers**		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality**[33]	**Dose (rem)**	**Probability of Cancer Fatality**[33]	**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Fire-induced release of plutonium from storage vaults[34]	1.6	$6.4x10^{-4}$	0.51	$2.6x10^{-4}$	59	0.03	$5.0x10^{-8}$
2. Mechanical release of plutonium from loading dock	$5.6x10^{-3}$	$2.3x10^{-6}$	$1.8x10^{-3}$	$9.0x10^{-7}$	0.21	$1.0x10^{-4}$	$6.0x10^{-4}$
Impacts for Composite Set of EBAs and BEBAs[35]							
Expected consequences[36]		$2.3x10^{-6}$		$9.2x10^{-7}$		$1.1x10^{-4}$	
Expected risk (per year)		$1.4x10^{-9}$		$5.5x10^{-10}$		$6.4x10^{-8}$	
Impacts for Composite Set of EBAs							
Expected consequences[36]		2.3x10-6		9.0x10-7		$1.0x10^{-4}$	

Expected risk (per year)		$1.4x10^{-9}$			$5.4x10^{-10}$			$6.2x10^{-8}$	
Impacts for Composite Set of BEBAs									
Expected consequences[36]		< $6.4x10^{-4}$			$2.6x10^{-4}$			0.03	
Expected risk (per year)		$3.2x10^{-11}$			$1.3x10^{-11}$			$1.5x10^{-9}$	

Table F.2.6.2-2.-- Storage of Plutonium Strategic Reserves at Nevada Test Site, Impacts of Accidents

	Noninvolved Worker at 1,000 Meters			**Maximum Offsite Individual**			**Population to 80 Kilometers**		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality[37]**		**Dose (rem)**	**Probability of Cancer Fatality[37]**		**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Fire-induced release of plutonium from storage vaults [38]	[39]	[39]		[39]	[39]		[39]	[39]	[39]
2. Mechanical release of plutonium from loading dock	$9.6x10^{-3}$	$3.8x10^{-6}$		$1.8x10^{-4}$	$8.9x10^{-8}$		0.013	$6.5x10^{-6}$	$6.0x10^{-4}$
Impacts for Composite Set of EBAs and BEBAs									
Expected consequences[40]		[41]			[41]			[41]	
Expected risk (per year)		[41]			[41]			[41]	
Impacts for Composite Set of EBAs[38]									
Expected consequences[40]		$3.8x10^{-6}$			$8.9x10^{-8}$			$6.5x10^{-6}$	
Expected risk (per year)		$2.3x10^{-9}$			$5.3x10^{-11}$			$3.9x10^{-9}$	

Impacts for Composite Set of BEBAs									
Expected consequences[40]		41			41			41	
Expected risk (per year)		41			41			41	

F.2.7 Storage of Uranium Strategic Reserves

Studies of evaluation basis accidents and beyond evaluation basis accidents have been performed for the storage of uranium strategic reserves. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public that can be expected from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations. In this manner, no other credible accidents with an expected frequency of occurrence larger than 10-7/yr are anticipated that will have consequences and risks larger than those described in this section.

F.2.7.1 Accident Scenarios and Source Terms

A range of hazardous conditions and potential accidents were reviewed as candidates to represent the risks to workers and the public from facility operation. Through a screening process, several evaluation basis accidents and beyond evaluation basis accidents were selected for further definition and analysis. A brief description of each of the five accident scenarios and source terms is presented below. Table F.2.7.1-1 presents a summary of each accident scenario and source term. Further detail can be found in a topical report (HNUS 1996a).

Scenario 1: Criticality

. Criticality accidents were considered for routine handling in storage areas. Hypothetical scenarios were analyzed in the tube vault involving loading and unloading activities that might result in criticality. A facility worker could accidentally overdraw and drop a loaded tube tray, allowing the cans to fall and tumble into a critical pile. A criticality accident could also result from overloading the tube vault (spacing between slots on tube trays physically prevents overloading). A forklift could accidentally crush or jam a sufficient number of cans together to cause a criticality accident (spacing between the slots also makes it physically impossible for a forklift to accidentally crush or jam a sufficient number of cans together to cause a criticality accident).

Oak Ridge Reservation. The probability of a criticality in the vault area is assumed to be in the range of 1x10^{-6} to 1x10$^{-4/yr}$. A single pulse of 1x10^{17} fissions is produced before the solid matrix disassembles.

Pantex Plant. The probability of a criticality in the vault area is assumed to be in the range of 1x10^{-6}

to $1x10^{-4/yr}$. A single pulse of $1x10^{17}$ fissions is produced before the solid matrix disassembles.

Nevada Test Site. The probability of a criticality in the vault area is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$ /yr. A single pulse of $1x10^{17}$ fissions is produced before the solid matrix disassembles.

Scenario 2: Fire-induced release of highly enriched uranium from aircraft crash.

An aircraft crash into the vault area, followed by a large fire, bounds the potential consequences associated with the facility. The concern then rises that the multiple barriers of some of the stored HEU could be breached solely because of the crash itself. It is estimated that an engine block penetrating the facility might impact 15 percent of the available containers. Therefore, it is assumed that the impacted 15 percent would be subject to release in the first ten minutes of the fire. Because of the insulated shipping containers, after one hour it is assumed that 1 percent of the total inventory would be available for release. To assume that any impact results in a complete release of the encased materials is a conservative assumption and is used for the purposes of this bounding study.

Table F.2.7.1-1.-- Accident Scenarios for Storage of Uranium Strategic Reserves

Accident Scenario	Site	Accident Frequency (per year)	Total Material Release to Environment
1. Criticality	ORR	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{17}$ fissions
	Pantex	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{17}$ fissions
	NTS	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{17}$ fissions
2. Fire-induced release of HEU from aircraft crash	ORR	not applicable	
	Pantex	$1x10^{-7}$	270 grams of HEU
	NTS	not applicable	
3. Fire-induced release of lithium hydride from aircraft crash	ORR	not applicable	
	Pantex	$1x10^{-7}$	2.5 g/s to 2.8 g/s
	NTS	not applicable	
4. Fire-induced release of HEU from vault	ORR	$1x10^{-6}$ to $1x10^{-4}$	37.64 kg HEU
	Pantex	$1x10^{-6}$ to $1x10^{-4}$	37.64 kg HEU
	NTS	$1x10^{-6}$ to $1x10^{-4}$	37.64 kg HEU
5. Explosive release of HEU from vault	ORR	$1x10^{-6}$ to $1x10^{-4}$	540 grams of HEU
	Pantex	$1x10^{-6}$ to $1x10^{-4}$	540 grams of HEU
	NTS	$1x10^{-6}$ to $1x10^{-4}$	540 grams of HEU

HNUS 1996a.

Oak Ridge Reservation. This accident is not applicable to ORR because the probability of an aircraft crash into a facility is much less than 10^{-7}/yr.

Pantex Plant. This accident is considered a beyond evaluation basis accident ($1x10^{-7}$ /yr). The release for radiological impacts is 270 g (9.5 oz) of HEU. For chemical toxicity impacts, the release is 1.5 g/seconds (s) for 10 minutes then 1.7 g/s for the second hour of the accident.

Nevada Test Site. This accident is not applicable to NTS because the probability of an aircraft crash into a facility is much less than 10^{-7}/yr.

Scenario 3: Fire-induced release of lithium from an aircraft crash.

Of the chemical accident scenarios, no mechanisms were identified that could potentially release a significant amount of lithium hydride or uranium to the environment, other than the potential jet fuel-fed fires following an aircraft crash. A large aircraft crash with significant secondary fuel fire is therefore assumed to be the bounding hazardous chemical accident. The release scenario is similar to scenario 2.

Oak Ridge Reservation. This accident is not applicable to ORR because the probability of an aircraft crash into a facility is much less than 10^{-7}/yr.

Pantex Plant. This accident is considered a beyond evaluation basis accident ($1x10^{-7}$ /yr). For chemical toxicity impacts, the release is 2.5 g/s for 10 minutes then 2.8 g/s for the second hour of the accident.

Nevada Test Site. This accident is not applicable to NTS because the probability of an aircraft crash into a facility is much less than 10^{-7}/yr.

Scenario 4: Fire-induced release of highly enriched uranium.

It is assumed that 3,785 L (1,000 gal) of fuel are inserted into the vault area and that a pool 0.64-cm (1/4-in) deep develops. The area covered by that pool will be approximately 595 m^2 (6,400 ft^2). It is assumed that only in the innermost 20 percent of the fire will temperatures be sufficient to ignite uranium, and that only the topmost of the three drums will reach those temperatures, the lower ones being cooled through conduction to the vault base and the fuel. Of the drums reaching those temperatures, half are assumed to fail and, of those, half fail at the bottom, releasing some or all of their contents. The drum density in the new vault areas is approximately one set of three per 0.9 to 1.0 m^2 (10 to 11 ft^2). Thus, 1,920 drums will be within the fire, and 128 of them will reach high enough temperatures to ignite the uranium, of which 32 will fail at the bottom and expel their contents.

Oak Ridge Reservation. The frequency of this accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr . The amount estimated to be released will be 37,640 g (1,328 oz).

Pantex Plant. The frequency of this accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$ /yr. The amount estimated to be released will be 37,640 g (1,328 oz).

Nevada Test Site. The frequency of this accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$ / yr. The amount estimated to be released will be 37,640 g (1,328 oz).

Scenario 5: Explosion-induced release of highly enriched uranium from vault.

In an explosion, it is assumed that the drums and cans will provide sufficient protection to prevent the uranium from igniting. Consequently, even though there may be significant damage to the drums and/ or cans, since the metal contents have not oxidized or vaporized, there is assumed to be no release. For those cans containing powders, the situation is different, in that the powder may spill from the drum and then be released. It is assumed that the storage arrangement will protect all but the "front row" of cans.

Considering a 5x4 arrangement in the pallet, and using the side with five cans, about 25 percent of the cans will feel the blast. Thus, about 250 cans may be damaged. However, it is assumed that only 100 cans, representing the faces of the four closest stacks of pallets, are sufficiently damaged to spill their contents.

Oak Ridge Reservation. Assuming that half the contents of each of the 100 cans spill, 540 g (19 oz) will be released. The estimated probability is in the range of $1x10^{-6}$ to $1x10^{-4}$ /yr.

Pantex Plant. Assuming that half the contents of each of the 100 cans spill, 540 g (19 oz) will be released. The estimated probability is in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Nevada Test Site. Assuming that half the contents of each of the 100 cans spill, 540 g (19 oz) will be released. The estimated probability is in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

F.2.7.2 Accident Consequences and Risk

Table F.2.7.2-1 lists the set of accidents selected to represent consequences and risks to workers and the public from accident releases of radioactive materials and other hazardous effects during operations at ORR. For each accident, the table identifies the frequency of occurrence, and the consequences to a hypothetical worker at a specified distance from the accident, a hypothetical individual located at the nearest site boundary, and the public out to a distance of 80 km (50 mi). The risks of cancer fatality for the worker, the individual at the site boundary, and the public for the composite set of accidents are also shown.

Table F.2.7.2-1.-- Storage of Uranium Strategic Reserves at Oak Ridge Reservation, Impacts of Accidents

	Noninvolved Worker at 619 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
Accident Scenario	**Dose (rem)**	**Probability of Cancer Fatality[42]**	**Dose (rem)**	**Probability of Cancer Fatality[42]**	**Dose (person-rem)**	**Cancer Fatalities**	**Accident Frequency (per year)**
1. Criticality	5.1x10^{-4}	2.0x10^{-7}	5.1x10^{-4}	2.5x10^{-7}	0.031	1.5x10^{-5}	1.0x10^{-5}
4. Fire-induced release of highly enriched uranium from vault	5.4	2.2x10^{-3}	5.4	2.7x10^{-3}	806	0.40	1.0x10^{-5}
5. Explosive release of highly enriched uranium from vault	0.077	3.1x10^{-5}	0.077	3.9x10^{-5}	11.6	5.8x10^{-3}	1.0x10^{-5}
Impacts for Composite Set of EBAs and BEBAs[43]							
Expected consequences[44]		7.3x10^{-4}		9.1x10^{-4}		0.14	
Expected risk (per year)		2.2x10^{-8}		2.7x10^{-8}		4.1x10^{-6}	
Impacts for Composite Set of EBAs							
Expected consequences[44]		[45]		[45]		[45]	
Expected risk (per year)		[45]		[45]		[45]	
Impacts for Composite Set of BEBAs							
Expected consequences[44]		[46]		[46]		[46]	
Expected risk (per year)		[46]		[46]		[46]	

F.3 Comparison of the No Action Alternative to Proposed

Alternatives at Pantex Plant and Oak Ridge Reservation

F.3.1 Pantex Plant

Existing operations at Pantex that have the potential for risks to workers and the public are weapons A/D and storage of plutonium. Under the No Action alternative storage would continue in Zone 4 and weapons A/D would continue in Zones 4 and 12. The risks of accidents to workers and the public are addressed in applicable SARs and would not be expected to change if they were continued. Under the proposed actions, weapons A/D operations would be entirely relocated to Zone 12.

Through relocation, the A/D operations would be performed in existing, modern facilities resulting in a decrease in the facility footprint in Zone 12 compared to the footprint in Zone 4. Although the risks of accidents due to internal initiators like fires and explosions are not expected to decrease significantly, risks would be reduced through the engineered safety features of a modern facility. More importantly, all Zone 4 operations have a higher probability of an externally initiated accident caused by an aircraft crash because Zone 4 is closer to the nearby commercial airport and traffic patterns than Zone 12. The probability of an aircraft crash into a Zone 12 facility is also decreased as a result of a reduction in the size of the facility compared to the existing facilities in Zone 4.

F.3.2 Oak Ridge Reservation

Existing operations at ORR that have the potential for risks to workers and the public are secondary and case fabrication and storage of HEU. Under the No Action alternative, these operations would continue to be performed in the facilities where they presently exist. The risks of accidents to workers and the public are addressed in applicable SARs and would not be expected to change if they were to be continued.

Under the proposed actions, secondary and case fabrication and HEU storage would be downsized into fewer existing buildings in the same vicinity as buildings associated with the No Action alternative. The risks of accidents to workers and the public from internal causes such as fires and criticality are not expected to change. However, all of the buildings that would perform the downsized operations would be upgraded to meet natural phenomena requirements. These upgrades are expected to reduce risks, which would not happen under the No Action alternative.

F.4 Secondary Impacts of Accidents

The primary impacts of accidents are measured in terms of public and worker exposures to radiation and toxic chemicals. The secondary impacts of accidents include all elements of the environment. For example, if an accident occurred, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be lowered; recreational areas may be closed; industrial parks may suffer economic losses during shutdown for decontamination; historical sites may have to be closed to visitors; and the endangered species may move closer to extinction.

This section addresses the secondary impacts of a high consequence EBA and BEBA in the region of a radiological release. The accidents were selected to illustrate the effects of accidents evaluated for each of the technologies. The levels of radioactivity that have a potential for secondary effects are based on analysis using the MACCS computer code with 50 percent meteorology conditions for each site.

The region of secondary effects extends out from the point of release in a pattern formed by dispersion parameters such as meteorology. The level of exposure is generally decreasing with increasing distance from the release point. Figures F.4.1.-1 through F.4.6-2 show the shapes of patterns for each site at a distance at which the level of radioactivity from the accidental release would be higher than the level of radioactivity from natural background at each site.

These results are useful for comparing the environmental sensitivity of sites with respect to the secondary impacts for an accidental radiological release. In reviewing the results, it is useful to note whether the impacted area extends beyond the site boundary where the economic impacts would be larger than if the area were contained within the site boundary. It is also useful to note the size of the contaminated area in which the level of radioactivity exceeds exposures from natural background.

F.4.1 Oak Ridge Reservation

In the region of ORR, the natural background level of radiation (excluding radon) is 95 millirems (mrem)/yr, plus an additional 200 mrem from radon. The results shown in figures F.4.1-1 and F.4.1-2 indicate the radiation levels at various distances from the accident. Section 4.2 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the ORR environment that may receive secondary impacts from accidents.

F.4.2 Savannah River Site

In the region of SRS, the natural background level of radiation (excluding radon) is 98 mrem/yr, plus an additional 200 mrem from radon. The results shown in figure F.4.2-1 indicate the radiation levels at various distances from the accident. Section 4.3 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the SRS environment that may receive secondary impacts from accidents.

F.4.3 Pantex Plant

In the region of Pantex, the natural background level of radiation (excluding radon) is 134 mrem /yr, plus an additional 200 mrem from radon. The results shown in figures F.4.3-1 and F.4.3-2 indicate the radiation levels at various distances from the accident. Section 4.5 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the Pantex environment that may receive secondary impacts from accidents.

F.4.4 Los Alamos National Laboratory

In the region of LANL, the natural background level of radiation (excluding radon) is 140 mrem/yr, plus an additional 200 mrem from radon. The results shown in figures F.4.4-1 and F.4.4-2 indicate the radiation levels at various distances from the accident. Section 4.6 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the LANL environment that may receive secondary impacts from accidents.

F.4.5 Lawrence Livermore National Laboratory

In the region of LLNL, the natural background level of radiation (excluding radon) is 100 mrem per/yr, plus an additional 200 mrem from radon. The results shown in figure F.4.5-1 indicate the radiation levels at various distances from the accident. Section 4.7 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the LLNL environment that may receive secondary impacts from accidents.

F.4.6 Nevada Test Site

In the region of NTS, the natural background level of radiation (excluding radon) is 113 mrem per/yr, plus an additional 200 mrem from radon. The results shown in figures F.4.6-1 and F.4.6-2 indicate the radiation levels at various distances from the accident. Section 4.9 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the NTS environment that may receive secondary impacts from accidents.

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33 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

34 A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

35 For the offsite population of 285,409, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $3.0\times10^{-10}/2.2\times10^{-13}$.

36 Result of exposure to the indicated dose if the accident occurs. All values are mean values. Model results.

37 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located

at the site boundary or a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

38 For the offsite population of 18,517, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is 3.5×10^{-10} /2.1×10^{-13} .

39 The accident is not possible at NTS.

40 Result of exposure to the indicated dose if the accident occurs.

41 No beyond evaluation basis accidents were identified for NTS. The impacts for the composite set of EBAs and BEBAs is the same as the impacts for the composite set of EBAs. All values are mean values. Model results.

42 Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or to a worker located 619 m from the accident as a result of exposure to the indicated dose if the accident occurred.

43 For the offsite population of 1,096,144, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is 1.3×10^{-7}/$3.7\times10^{-12.}$

44 Result of exposure to the indicated dose if the accident occurs.

45 The impacts of evaluation basis accidents (EBA) are identical to the data shown in this table.

46 All accidents are in the frequency range of 10^{-6} to 10^{-4} per year and are grouped together as EBAs. As a result, there are no impacts shown for beyond evaluation basis accidents (BEBA). All values are mean values. Model results.

APPENDIX G: INTERSITE TRANSPORTATION

G.1 Transportation Risk Analysis Methodology

The transportation risk assessment estimates the health effects, in terms of annual fatalities, from the transportation of plutonium and highly enriched uranium (HEU) for each programmatic environmental impact statement (PEIS) alternative. For this assessment, the PEIS alternatives can be described as combinations of pit fabrication, secondary and case fabrication, and assembly/disassembly (A/D) sites. The potential sites for these functions are:

- A/D--Nevada Test Site (NTS) or Pantex Plant (Pantex)
- Pit Fabrication--Los Alamos National Laboratory (LANL) or Savannah River Site (SRS)
- Secondary and Case Fabrication--LANL, Lawrence Livermore National Laboratory (LLNL), or Oak Ridge Reservation (ORR)

In addition, the sites considered for the storage of the strategic reserve of plutonium and HEU and the tritium recycling site were considered in the analysis for estimating risk. The strategic reserve of plutonium and HEU could be located at six potential sites: Hanford, Idaho National Engineering Laboratory (INEL), NTS, ORR, Pantex, or SRS. Two of these sites, NTS and Pantex, are considered by the Stockpile Stewardship and Management PEIS due to the assumption that storage of the strategic reserve in the form of pits and secondaries would be collocated at the weapons A/D sites. The other four sites are being considered by the *Storage and Disposition of Weapons-Usable Fissile Materials Draft Programmatic Environmental Impact Statement* (DOE/EIS-0229-D, February 1996) for consolidated storage of all plutonium and uranium. Tritium recycling would remain at SRS. All of the alternatives are shown in table G.1-1.

For each of the special nuclear materials and radioactive materials involved, the radiological risk calculations were performed using the RADTRAN Version 4 computer code, developed and maintained by Sandia National Laboratories (SNL) at Albuquerque, NM (RADTRAN 4: *Volume 3 User Guide [SAND89-2370, January 1992]).*

The RADTRAN code combines user-determined demographic, transportation, packaging, and material factors with health physics data to calculate the expected radiological consequences of accident-free and accident risk from transporting radioactive material.

For performing the calculations, plutonium and HEU would be transported via Department of Energy's (DOE) safe secure trailers. Tritium would be transported by DOE's contract air carrier. The packaging types and the number of packages per shipment would be in accordance with regulatory requirements.

For this analysis, the isotopic composition was assumed to be 93 percent uranium-235 for HEU shipments and 100 percent tritium for tritium shipments. Plutonium was assumed to be weapons-grade material.

The transport index is a regulatory characteristic of a package and is equal to the radiation dose rate in millirem per hour at a distance of 1 meter (m) (3.3 feet [ft]) from the outside of the package. The transport index values were estimated to be the maximum allowed by regulatory checks incorporated in RADTRAN.

These regulatory checks limit the product of the number of packages and the transport index of each package to a value of about 16. The quantity of material per package, number of packages per truckload, and number of truckloads per year were estimated.

Table G.1-1.-- Annual Health Impact from Transportation of Materials for Each Alternative

						Health Effects[1]		
Alternative	**Pit Fabrication Site**	**Secondary and Case Fabrication Site**	**Plutonium Storage Site**	**HEU Storage Site**	**Tritium Recycling Site**	**Accident**	**Accident-Free**	**Total**
No Action	LANL (limited)	ORR	Pantex	ORR	SRS	2.57x10^{-3}	7.64x10^{-4}	3.33x10^{-3}
Assembly/ Disassembly at NTS	LANL	ORR	NTS	ORR	SRS	4.78x10^{-3}	1.34x10^{-3}	6.12x10^{-3}
	LANL	ORR	Pantex	Pantex	SRS	6.47x10^{-3}	1.87x10^{-3}	8.34x10^{-3}
	LANL	ORR	ORR	ORR	SRS	5.30x10^{-3}	1.51x10^{-3}	6.81x10^{-3}
	LANL	ORR	NTS	NTS	SRS	8.44x10^{-3}	2.39x10^{-3}	0.0108
	LANL	ORR	SRS	SRS	SRS	6.00x10^{-3}	1.76x10^{-3}	7.76x10^{-3}
	LANL	ORR	INEL	INEL	SRS	8.76x10^{-3}	2.52x10^{-3}	0.0113
	LANL	ORR	Hanford	Hanford	SRS	9.88x10^{-3}	2.84x10^{-3}	0.0127
	SRS	ORR	NTS	ORR	SRS	7.03x10^{-3}	2.03x10^{-3}	9.06x10^{-3}
	SRS	ORR	Pantex	Pantex	SRS	8.26x10^{-3}	2.44x10^{-3}	0.0107
	SRS	ORR	ORR	ORR	SRS	5.55x10^{-3}	1.61x10^{-3}	7.16x10^{-3}
	SRS	ORR	NTS	NTS	SRS	1.07x10^{-2}	3.07x10^{-3}	0.0138
	SRS	ORR	SRS	SRS	SRS	5.87x10^{-3}	1.70x10^{-3}	7.57x10^{-3}

	SRS	ORR	INEL	INEL	SRS	1.08×10^{-2}	3.15×10^{-3}	0.0139
	SRS	ORR	Hanford	Hanford	SRS	1.19×10^{-2}	3.49×10^{-3}	0.0154
	LANL	LANL	NTS	NTS	SRS	3.87×10^{-3}	1.02×10^{-3}	4.89×10^{-3}
	LANL	LANL	Pantex	Pantex	SRS	3.06×10^{-3}	8.06×10^{-4}	3.87×10^{-3}
	LANL	LANL	ORR	ORR	SRS	5.67×10^{-3}	1.61×10^{-3}	7.28×10^{-3}
	LANL	LANL	SRS	SRS	SRS	6.39×10^{-3}	1.85×10^{-3}	8.24×10^{-3}
	LANL	LANL	INEL	INEL	SRS	4.80×10^{-3}	1.25×10^{-3}	6.05×10^{-3}
	LANL	LANL	Hanford	Hanford	SRS	5.91×10^{-3}	1.59×10^{-3}	7.50×10^{-3}
	SRS	LANL	NTS	NTS	SRS	6.13×10^{-3}	1.70×10^{-3}	7.83×10^{-3}
	SRS	LANL	Pantex	Pantex	SRS	4.84×10^{-3}	1.37×10^{-3}	6.21×10^{-3}
	SRS	LANL	ORR	ORR	SRS	5.93×10^{-3}	1.71×10^{-3}	7.64×10^{-3}
	SRS	LANL	SRS	SRS	SRS	6.23×10^{-3}	1.81×10^{-3}	8.04×10^{-3}
	SRS	LANL	INEL	INEL	SRS	6.80×10^{-3}	1.90×10^{-3}	8.70×10^{-3}
	SRS	LANL	Hanford	Hanford	SRS	7.92×10^{-3}	2.23×10^{-3}	0.0102
	LANL	LLNL	NTS	NTS	SRS	3.58×10^{-3}	1.08×10^{-3}	4.66×10^{-3}
Assembly/ Disassembly at NTS (Continued)	LANL	LLNL	Pantex	Pantex	SRS	4.76×10^{-3}	1.39×10^{-3}	6.15×10^{-3}
	LANL	LLNL	ORR	ORR	SRS	7.43×10^{-3}	2.21×10^{-3}	9.64×10^{-3}
	LANL	LLNL	SRS	SRS	SRS	8.16×10^{-3}	2.44×10^{-3}	0.0106

	LANL	LLNL	INEL	INEL	SRS	4.40x10-3	1.25x10-3	5.65x10-3
	LANL	LLNL	Hanford	Hanford	SRS	4.52x10-3	1.38x10-3	5.90x10-3
	SRS	LLNL	NTS	NTS	SRS	5.83x10-3	1.77x10-3	7.60x10-3
	SRS	LLNL	Pantex	Pantex	SRS	6.54x10-3	1.96x10-3	8.50x10-3
	SRS	LLNL	ORR	ORR	SRS	7.68x10-3	2.32x10-3	0.0100
	SRS	LLNL	SRS	SRS	SRS	8.00x10-3	2.39x10-3	0.0104
	SRS	LLNL	INEL	INEL	SRS	6.40x10-3	1.89x10-3	8.29x10-3
	SRS	LLNL	Hanford	Hanford	SRS	6.53x10-3	2.02x10-3	8.55x10-3
Assembly/ Disassembly at Pantex	LANL	ORR	Pantex	ORR	SRS	2.57x10-3	7.64x10-4	3.33x10-3
	LANL	ORR	Pantex	Pantex	SRS	4.49x10-3	1.36x10-3	5.85x10-3
	LANL	ORR	ORR	ORR	SRS	3.32x10-3	9.94x10-4	4.31x10-3
	LANL	ORR	NTS	NTS	SRS	6.47x10-3	1.88x10-3	8.34x10-3
	LANL	ORR	SRS	SRS	SRS	4.03x10-3	1.23x10-3	5.26x10-3
	LANL	ORR	INEL	INEL	SRS	6.78x10-3	2.00x10-3	8.78x10-3
	LANL	ORR	Hanford	Hanford	SRS	7.90x10-3	2.28x10-3	0.0102
	SRS	ORR	Pantex	ORR	SRS	3.89x10-3	1.20x10-3	5.09x10-3
	SRS	ORR	Pantex	Pantex	SRS	5.80x10-3	1.80x10-3	7.60x10-3
	SRS	ORR	ORR	ORR	SRS	3.10x10-3	9.67x10-4	4.07x10-3

	SRS	ORR	NTS	NTS	SRS	8.26x10-3	2.44x10-3	0.0107
	SRS	ORR	SRS	SRS	SRS	3.41x10-3	1.07x10-3	4.48x10-3
	SRS	ORR	INEL	INEL	SRS	8.32x10-3	2.52x10-3	0.0108
	SRS	ORR	Hanford	Hanford	SRS	9.44x10-3	2.85x10-3	0.0123
	LANL	LANL	Pantex	Pantex	SRS	2.25x10-3	5.96x10-4	2.85x10-3
Assembly/ Disassembly at Pantex (Continued)	LANL	LANL	ORR	ORR	SRS	4.86x10-3	1.40x10-3	6.26x10-3
	LANL	LANL	NTS	NTS	SRS	3.06x10-3	8.06x10-4	3.87x10-3
	LANL	LANL	SRS	SRS	SRS	5.58x10-3	1.64x10-3	7.22x10-3
	LANL	LANL	INEL	INEL	SRS	3.98x10-3	1.05x10-3	5.03x10-3
	LANL	LANL	Hanford	Hanford	SRS	5.10x10-3	1.38x10-3	6.48x10-3
	SRS	LANL	Pantex	Pantex	SRS	3.57x10-3	1.03x10-3	4.60x10-3
	SRS	LANL	ORR	ORR	SRS	4.65x10-3	1.38x10-3	6.03x10-3
	SRS	LANL	NTS	NTS	SRS	4.84x10-3	1.37x10-3	6.21x10-3
	SRS	LANL	SRS	SRS	SRS	4.95x10-3	1.48x10-3	6.43x10-3
	SRS	LANL	INEL	INEL	SRS	5.52x10-3	1.57x10-3	7.09x10-3
	SRS	LANL	Hanford	Hanford	SRS	6.64x10-3	1.90x10-3	8.54x10-3
	LANL	LLNL	Pantex	Pantex	SRS	5.92x10-3	1.71x10-3	7.63x10-3
	LANL	LLNL	ORR	ORR	SRS	8.59x10-3	2.54x10-3	0.0111

	LANL	LLNL	NTS	NTS	SRS	4.76×10^{-3}	1.39×10^{-3}	6.15×10^{-3}
	LANL	LLNL	SRS	SRS	SRS	9.33×10^{-3}	2.74×10^{-3}	0.0121
	LANL	LLNL	INEL	INEL	SRS	5.57×10^{-3}	1.56×10^{-3}	7.13×10^{-3}
	LANL	LLNL	Hanford	Hanford	SRS	5.69×10^{-3}	1.70×10^{-3}	7.39×10^{-3}
	SRS	LLNL	Pantex	Pantex	SRS	7.24×10^{-3}	2.15×10^{-3}	9.39×10^{-3}
	SRS	LLNL	ORR	ORR	SRS	8.39×10^{-3}	2.51×10^{-3}	0.0109
	SRS	LLNL	NTS	NTS	SRS	6.54×10^{-3}	1.96×10^{-3}	8.50×10^{-3}
	SRS	LLNL	SRS	SRS	SRS	8.71×10^{-3}	2.59×10^{-3}	0.0113
	SRS	LLNL	INEL	INEL	SRS	7.10×10^{-3}	2.09×10^{-3}	9.19×10^{-3}
	SRS	LLNL	Hanford	Hanford	SRS	7.23×10^{-3}	2.22×10^{-3}	9.45×10^{-3}

The transportation accident model in RADTRAN assigns accident probabilities to a set of accident categories. For the truck and air analysis, the eight accident-severity categories defined in the Nuclear Regulatory Commission's (NRC) Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes (NUREG 0170, December 1977) were used. The least severe accident category (Category I) represents low magnitudes of crush force, accident-impact velocity, fire duration, or puncture-impact speed. The most severe category (Category VIII) represents a large crush force, high-impact velocity, high puncture-impact speed, an 88-kilometer [km] per hour (54.6-mile [mi] per hour) collision into the side of the vehicle and a 982-degree Celsius (°C) (1,800-degree Fahrenheit [°F]) fire lasting 1.5 hours to produce a release of the material (plutonium, HEU, or tritium). The release fractions for Category VIII accidents were conservatively estimated to be 0.1 for all types of materials analyzed.

To perform the risk calculations, distance and distance fractions for rural, suburban, and urban populations for each intersite route were estimated using the INTERSTAT routing code. INTERSTAT is part of the RADTRAN model. Although the distance fractions in the rural, suburban, and urban populations are slightly different for each route, among the routes considered, the average distance fractions for population distribution for rural, suburban, and urban were 78, 20, and 2 percent, respectively. Also included are nonradiological impacts due to air pollution and highway accidents. Fatalities from potential air pollution were estimated using 1.0×10^{-7} *cancer fatalities per urban kilometer. Highway accident fatalities were estimated from national statistics using* 1.5×10^{-8} *rural,* 3.7×10^{-9} *suburban, and* 2.1×10^{-9} *urban for occupational risks per kilometer, and* 5.3×10^{-8} *rural,* 1.3×10^{-8} *suburban, and* 7.5×10^{-9} *for nonoccupational risks per kilometer (SNL 1986a:167).*

To estimate accident and accident-free impacts, the radiation dose from each shipment was converted to a risk factor by multiplying the occupational accident-free and accident dose by $4.0x10^{-4}$ cancers per person-rem and the public accident-free and accident dose by $5.0x10^{-4}$ cancers per person-rem (ICRP 1991a:22). The resultant annual health risks are presented as potential fatalities. The combined resultant health risks are presented as potential fatalities.

The estimated annual impacts for each alternative were derived by summing the health effects from individual routes. The potential sites for each alternative and the corresponding annual impacts are presented in table G.1-1.

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1 Estimated fatalities per year. Source: RADTRAN model results.

APPENDIX G: INTERSITE TRANSPORTATION

G.2 Packaging

Packaging refers to a container and all accompanying components or materials necessary to perform its containment function. Packagings used by DOE for hazardous materials shipments are either certified to meet specific performance requirements or built to specifications described in Department of Transportation (DOT) hazardous materials regulations (49 Code of Federal Regulations [CFR] Subchapter C). For relatively low-level radioactive materials, DOT Specification Type A packagings are used. These packagings are designed to retain their contents under normal transportation conditions. More sensitive radioactive materials shipments require use of highly sophisticated Type B packaging, designed and tested to prevent the release of contents under all credible transportation accident conditions.

Plutonium, HEU, and components containing tritium are DOE-unique hazardous materials that require special protection. In addition to meeting the stringent Type B containment and confinement requirements of NRC's 10 CFR 71 and DOT's 49 CFR, packaging for nuclear weapons and components must be certified separately by DOE. DOE employs a closed, Government-owned and -operated Transportation Safeguards System for the intersite transport of nuclear weapons and components, including plutonium and HEU. Specially designed safe secure trailers are utilized to ensure high levels of safety and physical protection. Limited-life components are transported almost exclusively by DOE's contract air carrier.

As a representation of a typical Type B packaging used to transport weapons components, the testing sequence for the 6M, Type B packaging used for the shipment of HEU is described below. Plutonium and tritium packaging requires a similar, high level of protection. Most other radioactive and hazardous materials, such as low-level waste, would be transported by commercial truck. Historical summaries of the hazardous and nonhazardous materials shipped to and from each of the candidate sites are presented in tables G.3-1, G.3-2, and G.3-3.

In addition to meeting standards demonstrating it can withstand normal conditions of transport without loss or dispersal of its radioactive contents, the model 6M, Type B packaging used for DOE shipments must survive certain severe hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and water submersion. Test conditions do not duplicate accident environments but, rather, produce damage equivalent to extreme and unlikely accidents. The 6M, Type B packaging is judged as surviving extreme sequential testing if it retains all of its contents except for minuscule allowable releases, and if the dose rate outside the packaging does not exceed 1 rem/hour at a distance of 1 m from the package surface. Drum sizes (outer package) can vary from 38 to 420 liters (10 to 110 gallons).

The complete sequence of tests is listed below:

- **Drop Test.** A 9-m (30-ft) drop onto a flat, essentially unyielding, horizontal surface, striking the surface in a position at which maximum damage is expected
- **Puncture Test:** A 1-m (40-inch [in]) drop onto the upper end of a 15-centimeter (cm) (6-in) diameter solid, vertical, cylindrical, mild steel bar mounted on an essentially unyielding, horizontal surface
- **Thermal Test:** An exposure for not less than 30 minutes to a heat flux not less than that of a radiation environment of 800 °C (1,475 °F) with an emissivity coefficient of at least 0.9
- **Water-Immersion Test:** A subjection to water pressure equivalent to immersion under a head of water of at least 15 m (50 ft) for not less than 8 hours

The regulatory test conditions for the 6M, Type B packaging and other similar packagings are much more demanding than they might appear. For example, an impact on a very hard surface (desert caliche) at over 32 km (200 mi) per hour is not as likely to deform the packaging as would a drop of 9 m (30 ft) onto an unyielding target.

The 6M, Type B packaging is made up of several component parts each playing an integral engineered role in containment and confinement of the radioactive material being shipped. The applicable DOE Safety Analysis Report for Packaging provides additional detail that shows that the package provides a high level of public safety regardless of the accidental conditions it might encounter during transportation. A typical 6M, Type B packaging approved for use by DOE is covered by a Certificate of Compliance. Although 6M, Type B packagings have been involved in severe accidents, the integrity of the packaging has never been compromised. A representative 6M packaging is shown in figure G.2-1.

Source: RADTRAN model results.

APPENDIX G: INTERSITE TRANSPORTATION

G.3 Intersite Shipment Data

Table G.3-1 presents a 5-year (1990 through 1994) summary of the nonhazardous and hazardous cargo shipped by commercial carriers to and from each of the candidate sites.

Table G.3-2 presents a summary, by chemical name, of hazardous materials shipped to and from Kansas City Plant (KCP), LANL, LLNL, and NTS for 1994. Table G.3-3 presents a summary, by chemical name, of hazardous materials shipped to and from ORR, Pantex, SNL, and SRS in 1994. All references to SNL refer to the Albuquerque location.

Table G.3-1.-- Five-Year Summary of Cargo Shipments by Commercial Carrier to and from Candidate Sites

	1990		1991		1992		1993		1994	
Site	**Shipments (number)**	**Weight (kg)**	**Shipments (number)**	**Weight (kg)**	**Shipments (number)**	**Weight (kg)**	**Shipments (number)**	**Weight (kg)**	**Shipments (number)**	**Weight (kg)**
Kansas City Plant										
Hazardous	800	363,943	350	142,510	455	142,155	668	170,716	389	120,481
Nonhazardous	18,774	1,933,747	13,680	1,704,409	14,530	1,169,727	13,354	1,040,980	9,998	877,005
All cargo	19,574	2,297,690	14,030	1,846,919	14,985	1,311,882	14,022	1,211,696	10,387	997,486
Los Alamos National Laboratory										
Hazardous	851	544,668	680	316,974	1,089	363,818	1,133	345,403	692	214,510
Nonhazardous	28,266	4,129,802	28,757	3,943,075	36,805	1,855,129	46,663	2,617,906	49,453	3,327,743
All cargo	29,117	4,674,470	29,437	4,260,049	37,894	2,218,947	47,796	2,963,309	50,145	3,542,253
Lawrence Livermore National Laboratory										
Hazardous	987	931,582	453	277,618	2,264	3,329,414	4,510	11,785,251	5,089	15,944,718
Nonhazardous	5,080	729,180	78	455,632	39,818	3,161,580	50,902	4,397,530	56,037	4,243,668
All cargo	6,067	1,660,762	531	733,250	42,082	6,490,994	55,412	16,182,781	61,126	20,188,386
Nevada Test Site										
Hazardous	1,742	20,627,008	1,325	15,777,433	1,432	17,834,469	1,143	15,845,750	1,324	22,384,272
Nonhazardous	23,107	38,455,253	21,898	36,197,342	19,938	31,944,034	16,568	10,622,714	14,839	21,567,339
All cargo	24,849	59,082,261	23,223	51,974,775	21,370	49,778,503	17,711	26,468,464	16,163	43,951,611
Oak Ridge Reservation										
Hazardous	2,141	3,592,513	1,433	2,254,290	3,896	8,546,187	3,130	11,765,312	3,169	6,438,748
Nonhazardous	55,921	8,176,837	57,217	6,905,370	69,771	7,448,941	74,479	5,409,370	75,684	7,409,628
All cargo	58,062	11,769,350	58,650	9,159,660	73,667	15,995,128	77,609	17,174,682	78,853	13,848,376
Pantex Plant										
Hazardous	1,869	407,622	1,339	462,842	1,124	601,087	1,080	597,720	612	328,329
Nonhazardous	8,494	1,262,617	10,085	1,314,989	10,191	1,317,023	11,135	1,733,062	11,760	1,732,379
All cargo	10,363	1,670,239	11,424	1,777,831	11,315	1,918,110	12,215	2,330,782	12,372	2,060,708
Sandia National Laboratories										
Hazardous	454	114,870	482	120,977	554	124,924	456	45,101	695	414,554
Nonhazardous	20,653	2,944,455	20,018	2,254,413	26,986	2,850,913	34,136	3,159,762	39,315	3,624,333
All cargo	21,107	3,059,325	20,500	2,375,390	27,540	2,975,837	34,592	3,204,863	40,010	4,038,887
Savannah River Site										
Hazardous	1,151	4,049,534	643	3,192,682	1,462	2,625,821	1,386	2,508,277	1,147	2,754,435
Nonhazardous	36,012	227,513,797	33,870	151,211,460	34,348	136,905,940	34,816	224,005,944	25,915	241,279,894
All cargo	37,163	231,563,331	34,513	154,404,142	35,810	139,531,761	36,202	226,514,221	27,062	244,034,329

Gross weights, which include the weight of the package.
SAIC 1995a:1.

Source: RADTRAN model results.

APPENDIX G: INTERSITE TRANSPORTATION

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Table G.3-3.-- Summary of Hazardous Materials Shipped to and from Oak Ridge Reservation, Pantex Plant, Sandia National Laboratories, and Savannah River Site, 1994

	ORR		**Pantex**		**SNL**		**SRS**	
Commodity	**Shipments (number)**	**Weight (kg)**	**Shipments (number)**	**Weight (kg)**	**Shipments (number)**	**Weight (kg)**	**Shipments (number)**	**Weight (kg)**
Acetylene gas	13	8,101					17	3,372
Aluminum nitrate	1	5					2	53
Aluminum sulfate, solid	1	378					2	6,277
Ammonia, anhydrous	3	686			1	7	4	587
Ammonium fluoride	1	1						
Ammonium hydroxide			1	34				
Ammonium sulfate								
Argon	199	430,223	8	1,250	1	6	33	82,713
Asbestos articles	33	37,544						
Asphalt			1	540				
Beryllium metal								
Beryllium metal or powder	1	6,638						
Cadmium nitrate	1	489						
Cadmium sulfate								
Calcium nitrate	1	1	1	2				
Chlorine	35	63,200	4	1,780				
Class A poison	2	10			7	1,919		
Class B poison	2	3,680	2	1,343	2	60		
Combustible liquid, n.o.s.	28	2,237	7	1,142	1	4	3	119

Corrosive material, n.o.s.	183	213,634	60	15,996	94	26,185	120	290,507
Dry ice	153	45,406			2	511		
Empty haz containers (non-radiological)	210	576,434			1	752		
Enriched boric acid								
Environmentally hazardous substance (marine pollutant)	3	80					1	20
Environmentally hazardous substance	10	4,934						
Etiologic agent, n.o.s.	1	144						
Explosives, n.o. s. (Class 1.1)			27	25,058	26	41,891		
Explosives, n.o. s. (Class 1.2)			1	40	5	29,821		
Explosives, n.o. s. (Class 1.3)			2	2,650	27	259,008		
Explosives, n.o. s. (Class 1.4)	7	3,870	93	14,008	28	2,064	8	4,859
Ferrous sulfamate	1	2,749	1	21				
Ferrous sulfate	2	2,041						
Flammable gas, n.o.s.	42	24,301	13	1,734	9	372	25	57,028
Flammable liquid, n.o.s.	140	54,056	54	6,947	48	3,352	33	28,406
Flammable solid, n.o.s.	35	360	58	6,068	9	1,222	1	7
Fluoboric acid	1	1						
Fuel oil (diesel, 1-6)	109	366,209					3	2,188
Gasoline	166	624,837					10	4,790
Hazardous waste (nonradiological)	3	12	1	19			8	1,438

Helium	33	42,913	11	640	157	33,864	21	27,444
Hydrocarbon gas, compressed or liquefied								
Hydrochloric acid	16	95	6	20			25	43,606
Hydrofluoric acid	2	59					7	6,885
Hydrofluoric acid solution, spent	1	4					1	27
Hydrogen gas	11	39,032	3	217			13	2,620
Hydrogen peroxide	8	1,911	1	2			9	3,870
Irritant, n.o.s.								
Isobutane, compressed or liquefied	2	1						
Lithium metal	24	3,290	9	845	2	10		
Lubricating oil	13	1,589	14	3,766			22	8,391
Magnesium, powder, metal strip	10	6					1	39
Mercuric nitrate								
Methanol, liquid	1	1					1	123
Methyl isobutylketone								
Misc. hazardous material	19	653	1	13	1	114	1	75
N-dodecane								
Natural gas, compressed or liquefied							1	373
Nitric acid fuming	14	20,827	3	59			22	6,270
Nitric acid (over 40 percent)	1	18					4	306
Nitric acid, fuming	1	2					3	1,143
Nitrogen	58	269,550	2	384	1	8	32	69,318

Nonflammable gas, n.o.s.	141	103,053	29	6,310	18	2,649	205	1,477,767
Organic peroxide, n.o.s.	2	2					2	11
Orm A, n.o.s.	2	7,874						
Orm B, n.o.s.								
Orm D, consumer commodity							10	4,619
Orm E, n.o.s.	5	11,544						
Other regulated material, liquid	3	79					1	626
Other regulated material, solid	1	159						
Oxidizer, n.o.s.	47	1,486	2	35	2	49	4	15,321
Oxygen	24	4,811	2	258			20	26,036
Poison, liquid, n. o.s.	47	5,880	4	124	10	231	1	1
Poison, solid, n. o.s.	50	258			19	47	1	1
Propane, compressed or liquefied	5	227					1	68
RAM, empty packages	68	313,080	88	159,735			17	24,540
RAM, fissile, <20 percent uranium-235	3	6,275						
RAM, fissile, >20 percent uranium-235	15	2,318						
RAM, fissile, HRCQ								
RAM, fissile, HRCQ, IR, PINS							17	212,305
RAM fissile, HRCQ, UNIR, PINS								
RAM, fissile, n. o.s.	10	36,770	1	1,659	1	195	2	220

RAM, fissile, UNIR, PINS								
RAM, fissile, waste			1	7,254				
RAM, HRCQ, special	2	4,364						
RAM, instr. and articles	9	5,875	5	91				
RAM, LSA, n.o. s.	454	1,120,758	9	465				
66	1,270,833							
RAM, LSA, waste	6	111,223						
RAM, ltd. quant., n.o.s.	209	197,911	48	57,469	107	8,176	239	64,891
RAM, medical isotopes	107	390						
RAM, n.o.s.	135	124,546	23	3,903	107	302	32	69,099
RAM, n.o.s., HRCQ	1	13,744						
RAM, n.o.s., special	58	38,376	6	89			6	216
RAM, n.o.s., waste	1	109						
RAM, U-metal, pyrop	3	529			1	11		
RAM, UOx, n.o. s.	1	2						
Small arms ammunition	1	1,013	4	4,913	2	1,237		
Sodium hydroxide (caustic soda)	27	70,840			1	134	52	39.585
Sodium metal, (non-RAM)	3	65			1	136		
Sodium nitrate	3	233	1	2			3	169
Spontaneously combustible material	1	3			1	6		
Sulfuric acid	13	103,875			3	211	13	81,353

Toxic gas, inhalation hazard	16	340	1	653			7	1,675
Trichloroethane 1.1.1	8	247	2	108				
Wet cell batteries	21	27,448	2	684			81	83,084
Total	3,169	6,438,748	612	328,329	695	414,553	1,147	2,754,435
Gross weights, which include the weight of the package. n.o.s. - not otherwise specified; RAM - radioactive material. SAIC 1995a:2.								

G.4 Highway Distance

Table G.4-1 presents highway distances between sites being evaluated.

Table G.4-1.-- Highway Distances Between Selected Sites in Kilometers (Miles)

Site	SRS	SNL	Pantex	ORR	NTS	LANL	LLNL
KCP	1,599 (993)	1,259 (782)	869 (540)	1,153 (716)	2,330 (1,447)	1,293 (803)	2,919 (1,832)
LLNL	4,249 (2,639)	1,713 (1,064)	2,178 (1,353)	3,911 (2,429)	958 (595)	1,860 (1,155)	
LANL	2,605 (1,618)	166 (103)	535 (332)	2,267 (1,408)	1,220 (758)		
NTS	3,610 (2,242)	1,074 (667)	1,539 (956)	3,272 (2,032)			
ORR	531 (330)	2,145 (1,369)	1,732 (1,076)				
Pantex	2,070 (1,286)	472 (293)					
SNL	2,542 (1,579)						
DOE 1991j; DOE 1992o:3; McNally 1990a.							

Source: RADTRAN model results.

APPENDIX H: ENVIRONMENTAL MANAGEMENT

H.1 Overview

This appendix provides a general overview of the Department of Energy (DOE) Environmental Restoration and Waste Management Program, including the categories of waste streams managed by DOE; the applicable Federal statutes and DOE orders; waste minimization and pollution prevention; waste treatment, storage, and disposal; transportation of wastes; and facility transition management. Site-specific discussions of current waste management activities will follow in section H.2. Stockpile management project-specific waste management activities are addressed in appendix section A.3. Stockpile stewardship project-specific waste management activities are addressed in appendix I (National Ignition Facility [NIF]), appendix J (Contained Firing Facility [CFF]), and appendix K (Atlas Facility).

H.1.1 Waste Categories

Wastes are generated in gaseous, liquid, and solid forms and are categorized by their health hazard and handling requirements. The categories are listed in table H.1.1-1.

Table H.1.1-1.-- Waste Categories

Category	Characterization
Spent nuclear fuel	Nuclear reactor fuel that has been irradiated to the extent that it has undergone significant isotopic change to the point that fission-product poisons have reached an uneconomic threshold. DOE is no longer reprocessing spent nuclear fuel solely to recover fissile and fertile material. Although spent nuclear fuel is not categorized as a nuclear waste, the definition is provided here since it is radioactive material that must be stored, managed, and handled.
High-level	Highly radioactive material that results from the reprocessing of spent nuclear fuel including liquid waste produced directly in reprocessing, and any solid waste derived from the liquid that contains fission products in sufficient concentrations and other highly radioactive material that the NRC, consistent with existing law, determines to require permanent isolation.

Transuranic	Radioactive waste contaminated with alpha-emitting elements with an atomic number greater than uranium, half-life greater than 20 years, and in concentrations greater than 100 nanocuries per gram (nCi/g). Such wastes result primarily from fuel reprocessing, and from the fabrication of plutonium weapons components and plutonium-bearing reactor fuel. Generally, little or no shielding is required ("contact-handled" transuranic waste), but energetic gamma and neutron emissions from certain transuranic nuclides and fission-product contaminants may require shielding or remote handling ("remote-handled" transuranic waste).
Low-level	Radioactive waste that is not spent nuclear fuel, high-level waste (HLW), transuranic (TRU) waste, or byproduct material as defined by DOE Order 5820.2A, *Radioactive Waste Management.* Includes research and development (R&D) fissionable test specimens with TRU less than 100 nCi/g. The radiation level from this waste may sometimes be high enough to require shielding for handling and transport. In 10 CFR 61, NRC defines four disposal categories of low-level waste (LLW) that require differing degrees of confinement and/or monitoring: classes A, B, C, and Greater-Than-Class C.
Hazardous	Nonradioactive waste that has characteristics identified by either or both of the following Federal statutes: *The Resource Conservation and Recovery Act* (RCRA) (40 CFR 261) as amended or the *Toxic Substances Control Act* (TSCA). These toxic, corrosive, reactive, or ignitable substances and RCRA-listed wastes have been identified as posing health or environmental risks. Hazardous waste includes chemicals (such as chlorinated and nonchlorinated hydrocarbons), explosives, leaded oil, paint solvents, sludges, acids, organic solvents, heavy metals, and pesticides.
Mixed	Waste containing both hazardous and radioactive constituents.
Nonhazardous (Sanitary)	Solid sanitary waste that includes garbage, is routinely generated by normal housekeeping activities and does not have a defined health risk (neither radioactive nor hazardous). Solid sanitary waste is regulated under RCRA, Subtitle D. Liquid sanitary waste includes sewage and industrial waste, and is treated in a wastewater process before discharge to a publicly owned treatment works or surface waters. The management of liquid sanitary waste is regulated by the *Clean Water Act* (CWA) and the National Pollutant Discharge Elimination System (NPDES).
Nonhazardous (Other)	Other wastes that do not have a defined health risk, such as process wastewater.

H.1.2 Applicable Federal Statutes and Department of Energy Orders

Most of the regulations that impact the storage, treatment, and disposal of wastes were promulgated since the original Nuclear Weapons Complex (Complex) was established. In many cases, the technology available at the time the Complex was constructed does not meet current requirements for full compliance and, as a result, interim agreements have been made with the regulatory agencies. Through continuous upgrade programs, processes have been improved or added to meet the requirements of any new regulations. Operations continue on the basis of using "best available technology" for facilities that were in operation before the regulation came into effect. In the siting and construction of any new facilities, the intent is to meet current regulations and to reach the goal of maximum recycling, minimal waste generation, no liquid discharges to the surface, and treatment and stabilization of unavoidable wastes sufficient for long-term storage or permanent disposal either on or offsite.

In order to operate at most of its facilities, DOE has entered into numerous agreements with states and the Environmental Protection Agency (EPA) to address compliance issues concerning certain aspects of environmental regulatory requirements that have arisen due either to the age of DOE facilities or the uniqueness of DOE operations. For the most part, DOE facilities are in compliance with the major portion of all environmental regulatory requirements, and these compliance agreements address specific situations. At the same time, most of these compliance agreements include a commitment from DOE to achieve compliance with each specific requirement by a specified date, including a schedule and milestones for achieving that compliance. These schedules and milestones are renegotiated on an ongoing basis as a result of changing budgets, additional environmental findings, and other factors. These agreements guide DOE activities at the sites under applicable environmental laws, regulations, and other standards. Compliance with the terms of these negotiated agreements is one of the highest DOE priorities. Site operations would be conducted in accordance with commitments DOE has made and would make in these agreements. DOE would work with the regulators to amend existing agreements and to develop new agreements to ensure continued compliance. Under no circumstances would DOE's performance pursuant to any existing compliance agreement be compromised or diminished as a result of the proposed action.

The following section summarizes the applicable Federal statutes and DOE orders:

Atomic Energy Act. The *Atomic Energy Act* gives DOE the authority to manage and regulate nuclear materials handled and generated at its facilities; however, DOE seeks to make its internal guidelines consistent with standards applied to commercial nuclear facilities regulated by the U.S. Nuclear Regulatory Commission (NRC). Pursuant to the *Atomic Energy Act* , DOE is committed to the practice of as low as reasonably achievable exposure to radiation from its operations, whereby exposures and resultant doses are maintained as low as social, economic, technical, and practical considerations permit.

Resource Conservation and Recovery Act. The *Resource Conservation and Recovery Act* (RCRA) was passed in 1976 as an amendment to the *Solid Waste Disposal Act* of 1965. RCRA regulates the "cradle to grave" management (generation, accumulation, storage, treatment, recycling, transport, and disposal) of hazardous waste, nonhazardous waste, underground storage tanks containing petroleum products and hazardous substances, and medical waste. Subtitle C of RCRA mandates that hazardous wastes be treated, stored, and disposed of in a manner that will minimize the threat to human health and the environment. To carry out this mandate, RCRA requires that owners and operators of hazardous waste treatment, storage, and disposal facilities obtain operating or post-closure care permits for certain waste management activities. RCRA defines the requirements for treatment, storage, and disposal facilities. Subtitle D of the law addresses the management of nonhazardous solid waste. Title 40 of the *Code of Federal Regulations* (CFR) implements the statutory provisions of RCRA. RCRA is a program which may be delegated to the states and for most states where DOE facilities are located, such delegation has occurred.

Land Disposal Restrictions. The *Hazardous and Solid Waste Amendments* to RCRA enacted in 1984 required the EPA to evaluate all listed and characteristic hazardous wastes according to a strict schedule and to develop requirements by which disposal of these wastes would be protective of human health and the environment. The implementing regulations for accomplishing this statutory reatment that substantially reduce the waste's toxicity or the likelihood that the waste's hazardous constituents will migrate. After the land disposal restriction's effective date, restricted wastes that do not meet treatment standards are prohibited from land disposal unless they qualify for certain variances or exemptions. EPA has promulgated standards for each of the five statutorily designated categories (40 CFR 268.31-40 CFR 268.35).

In addition to prohibiting disposal before appropriate treatment, land disposal restrictions prohibit any storage of land-disposal-restricted hazardous wastes (including mixed waste) except "for the purpose of the accumulation of such quantities of hazardous waste as are necessary to facilitate proper recovery, treatment, or disposal" (40 CFR 268.50). EPA has determined that storage of a hazardous waste pending development of treatment capacity does not constitute storage to accumulate sufficient quantities to "facilitate proper recovery, treatment, or disposal."

Underground Storage Tank Provisions. The requirements for the facilities that use tank systems for storing or treating hazardous waste are outlined in 40 CFR 264, Subpart J. These requirements include assessment of the existing tank system's integrity, design, and installation of new tank systems or components, and secondary containment. Hazardous wastes or treatment reagents are not placed in a tank system if they could cause the tank, its ancillary equipment, or the containment system to rupture, leak, corrode, or otherwise fail. Controls and practices to prevent spills and overflows from tank or containment systems are also required. Inspection requirements, procedures for response to leaks or spills, the disposition of leaking or unfit-for-use tanks, and closure and post-closure care requirements are also outlined in 40 CFR 264, Subpart J. Ignitable or reactive and incompatible hazardous wastes have special requirements.

Resource Conservation and Recovery Act Corrective Action Program. Hazardous waste permits require sites to institute corrective action programs for investigating and remediating Solid Waste Management Units. This program applies to all operating, closed, or closing RCRA facilities.

Federal Facility Compliance Act. The *Federal Facility Compliance Act* was passed in 1992. It waived sovereign immunity for Federal facilities and included provisions concerning DOE compliance with RCRA hazardous waste treatment for mixed waste. The *Federal Facility Compliance Act* required DOE to have approved site-specific mixed waste treatment plans and related orders in place 3 years (October 1995) from the date of enactment in order to avoid the imposition of fines and penalties (except for sites already subject to a permit, agreement, or order addressing compliance with the RCRA land disposal restrictions storage prohibition).

In an April 6, 1993, *Federal Register* notice (58 FR 17875), DOE published its schedule for submitting plans for treating mixed wastes for each facility at which DOE generates or stores mixed waste. Two interim versions of the plans were used to facilitate discussions among states and other interested parties. A subsequent consent order signed by the regulatory agency requires implementation of the final site treatment plan. For mixed waste for which identified treatment technologies exist, the plans provide a schedule for submitting permit applications, entering into contracts, initiating construction, conducting systems testing, starting operation, and processing mixed wastes. For mixed waste without an identified treatment technology, the plans include a schedule for identifying and developing technologies, identifying the funding requirements for research and development (R&D), submitting treatability study exemptions, and submitting R&D permit applications. In cases where DOE proposes radionuclide separation, the plans also provide an estimate of the volume of waste that would exist without such separation as well as cost estimates and underlying assumptions. DOE also prepared summary documents of the final plans to provide a national picture of DOE's technology needs and possible options for treatment of its mixed waste. The summaries were provided to all states and made available to other interested parties.

Comprehensive Environmental Response, Compensation, and Liability Act. The *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act* (SARA) of 1986, provides liability, compensation, cleanup, and emergency response for hazardous substances (including radionuclides) released to the environment. The cleanup of inactive waste disposal sites is one of the major requirements of CERCLA. It provides for prioritization of cleanup actions (National Priorities List [NPL] or Superfund List) and directs that a Federal Facility Compliance Agreement be negotiated with EPA and the state to coordinate CERCLA and RCRA compliance activities in one comprehensive strategy for each Federal facility. CERCLA also requires public participation in the selection of remediation alternatives, and this involvement or participation usually addresses the requirements of CERCLA, RCRA, and the *National Environmental Policy Act* (NEPA). Title III of CERCLA further requires that the National Response Center (operated by the U.S. Coast Guard) be notified in the event that a nonpermitted release of a reportable quantity of hazardous substance or radionuclides occurs. In the case of such a release, the National Response Center alerts the appropriate Federal emergency personnel who assess the event, formulate a response, and notify cognizant local emergency agencies. SARA requires industries to report the hazardous substances used at their facilities to include reporting inventories of these substances.

National Contingency Plan. The National Contingency Plan is an implementation regulation that sets forth requirements necessary to comply with CERCLA and SARA. For every site that is targeted for remedial response action under Section 104 of CERCLA, the National Contingency Plan requires that a detailed remedial investigation/feasibility study be conducted. The remedial investigation emphasizes data collection and site characterization. Its purpose is to define the nature, extent, and significance of contamination at a site in order to evaluate, select, and design a cost-effective remedial action. The feasibility study emphasizes analysis of data and decision making; it uses results from the remedial investigation to develop response objectives and alternative remedial responses. These alternatives are then evaluated in terms of their engineering feasibility, public health protection, environmental impacts, and costs. The remedial investigation/feasibility study leads to a decision that sets forth the method selected for remedial action to clean up the NPL site. Under the provisions of CERCLA, Federal facilities have the lead for CERCLA actions.

Toxic Substances Control Act. *The Toxic Substances Control Act* (TSCA) was enacted in 1976 to ensure that the manufacture, sale, storage, and disposal of toxic chemical substances do not present an unreasonable risk of injury to human health or the environment. Its applicability to DOE sites deals principally with the management and disposal of polychlorinated biphenyls (PCBs), asbestos, and dioxin. The problem created by dioxin is that currently there is a limited capability to treat these materials. Radioactively contaminated PCBs and PCB-contaminated materials generated by DOE are destroyed annually by the K-1435 TSCA Incinerator at K-25 at Oak Ridge Reservation (ORR).

Clean Air Act. The original *Clean Air Act* (CAA) was passed in 1955. It was wholly replaced by the *Air Quality Act* of 1967, but the name *Clean Air Act, which was reauthorized in 1990* , is still used. The CAA establishes air quality requirements and pollutant emission limits. The National Emissions Standards of Hazardous Air Pollutants (NESHAP) is a section of CAA that sets air quality standards for air emissions such as radionuclides, benzene, beryllium, and asbestos. NESHAP regulations require the use of EPA-approved monitoring instrumentation, sampling methodology, calculations, and modeling for each Federal facility.

Clean Water Act. The *Federal Water Pollution Control Act* , as amended by the *Clean Water Act* (CWA) of 1977, establishes a Federal/state scheme for controlling the introduction of pollutants into the Nation's water. The CWA created the National Pollutant Discharge Elimination System (NPDES) program. This program regulates nonradiological effluent discharges to ensure that surface water bodies meet applicable water quality standards. Each discharge point (outfall) is permitted through the NPDES program. New NPDES permit regulations for stormwater discharges require DOE to also characterize surface runoff during rain events.

Safe Drinking Water Act. The *Safe Drinking Water Act* (SDWA) was enacted in 1975 and is designed to protect drinking water resources. Primary drinking water standards set by SDWA apply to drinking water "at the tap" as delivered by public water systems. Of equal significance is that drinking water standards are used to determine groundwater protection regulations under a number of other statutes. The SDWA requires DOE to obtain permits and to complete sample analyses and site inspections of public/industrial water supplies and sources of drinking water. It also imposes requirements on the installation and maintenance of drinking water wells.

Department of Energy Orders. The primary DOE orders governing waste management are as follows:

- DOE Order 5400.1, General Environmental Protection Program. Establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for assuring compliance with applicable Federal, state, and local environmental protection laws and regulations, Executive orders, and internal department policies. Requires the preparation of waste minimization plans that describe how waste minimization activities will be promoted and implemented.
- DOE Order 460.1, (Packaging and Transportation Safety). Establishes the requirements for the packaging and transportation of hazardous materials, hazardous substances, and hazardous wastes.
- DOE Order 5820.2A, Radioactive Waste Management. Establishes policies and guidelines by which DOE manages its radioactive waste, waste byproducts, and radioactively contaminated surplus facilities.

H.1.3 Waste Minimization and Pollution Prevention

Waste minimization is the reduction, to the extent feasible, of radioactive and hazardous waste before treatment, storage, or disposal of the waste. Pollution prevention fully utilizes source reduction techniques in order to reduce risks to public health, safety, welfare, and the environment, as well as utilizing environmentally sound recycling to achieve these same goals. Each DOE site is required to have a Waste Minimization and Pollution Prevention Awareness Plan. To report their progress towards their goals in the plan, each site prepares an Annual Report on Waste Generation and Waste Minimization Progress. When planning for facilities to be constructed by 2005, it will be necessary to consider currently available technology while providing modular, flexible designs that can incorporate process improvements as they become available. In accordance with Executive Orders 12856, 12873, and DOE policy, the facilities that would support the Stockpile Stewardship and Management Program would be designed for waste minimization with an overall operating philosophy of pollution prevention. This waste minimization program would contribute to decreases in waste treatment, storage, and disposal costs and lower health risks to workers and the public. Technical approaches are being sought to optimize the number of production operations required, to increase the use of nonhazardous chemicals and environmentally benign waste-producing chemicals, to increase the use of recyclable chemicals and materials, and implement the new design or redesign of existing processes and products. Some criteria useful in determining successful technologies include improved processing yield, reduced quantities of scrap, reduced waste and processing of byproducts, reduced use of hazardous chemicals, positive return on investment, and continued product quality.

H.1.4 Waste Treatment, Storage, and Disposal

Waste management activities that would support the Stockpile Stewardship and Management Program are assumed to be current per site and are contingent upon decisions to be made through the Waste Management PEIS. Any future waste management facilities that may be required to support the Stockpile Stewardship and Management Program would be coordinated with any decisions resulting from the Waste Management PEIS and any respective site-specific NEPA documentation.

Treated waste is waste that, following generation, has been altered chemically or physically to reduce its toxicity or prepare it for storage or disposal. Waste treatment can include volume reduction activities, such as incineration or compaction, that may be performed on waste prior to either storage or disposal or both. Stored waste is waste that, following generation (and usually some treatment), is being temporarily retained in a retrievable manner and monitored pending disposal. Disposed waste is waste that has been put in final emplacement to ensure its isolation from the environment, with no intention of retrieval. Deliberate action is required to regain access to the waste. Disposed wastes include materials placed in geologic repositories or buried in landfills.

Waste that is staged for processing would be stored according to its characterization and form. The disposal of waste is managed by the DOE Office of the Assistant Secretary for Environmental Management (EM). A facility near Carlsbad, NM, for disposal of retrievable and newly generated transuranic (TRU) waste, is planned. All surface facilities at the Waste Isolation Pilot Plant (WIPP) have been completed. To date, only underground excavations for the test phase have been done, and the remaining excavation would be completed once the facility is operational. The original planned test phase has been abandoned, and in its place an experimental program at Idaho National Engineering Laboratory is being conducted to develop the technical data to support the permit application under 40 CFR 191 and 40 CFR 268. Once operational, WIPP would become a permanent disposal site. The total projected capacity of WIPP is 175,543 cubic meters ($m^{3)}$ (229,602 cubic yards [yd^3]), of which 7,080 m^3 (9,260 yd^3) could be remote-handled.

A supplemental environmental impact statement (EIS) is being prepared for the proposed phased development of WIPP for disposal of TRU waste. This supplemental EIS will analyze the impacts of waste storage, characterization, certification, processing or treatment, and loading at the generator sites. It will also discuss the impacts of transportation of TRU waste between generator sites and WIPP. The impacts of waste disposal operations at WIPP will also be analyzed, including the impacts of waste receipt, waste package inspection, monitoring, emplacement, and subsequent activities associated with eventual closure, decommissioning, and institutional control of WIPP once disposal operations have been completed. Options for the interim storage of TRU waste are evaluated in the Draft Waste Management Programmatic Environmental Impact Statement (DOE/EIS-0200-D). Yucca Mountain, NV, is a site being studied to determine its suitability for the disposal of commercial spent nuclear fuel and Department of Defense high-level waste (HLW). To date, no decisions to utilize either the Yucca Mountain repository or WIPP have been made. The remainder of this section discusses some of the treatment, storage, and disposal options that may be utilized with the various waste streams from stockpile stewardship and management facilities.

Gaseous Waste. Gaseous wastes can be nonhazardous (e.g., inert gases and air), hazardous (e.g., chlorinated hydrocarbon vapor and polyaromatic hydrocarbon vapor), or radioactive (e.g., tritium and xenon). Most hazardous gaseous wastes that are combustible may be incinerated to destroy the hazardous constituents by converting the combustibles into carbon dioxide and water vapor, while capturing any particulates that may result. When a particulate (ash) is contaminated with heavy metals, the end product must be stabilized into an approved solid form suitable for disposal.

Gaseous radioactive wastes are held for interim storage in tanks; adsorbed on surfaces in filters, molecular sieves, or active beds; refrigerated and liquefied or solidified; or reacted to form an aqueous solution. Gaseous waste may be oxidized, mixed with other liquid wastes, or solidified in a stable form for long-term disposal. Reactive gases such as tritium are captured on reactive beds, in molecular sieves, or in cryogenic traps for recycling back to the process. Inert radioactive gases such as xenon and argon can be separated by cryogenic capture and held in storage tanks until they decay sufficiently to permit release. Gases that decay to metals can be captured on activated charcoal beds and held until they can be stabilized, packaged, and disposed of as solid waste. When sufficiently decayed, gases may be released to the atmosphere.

Liquid Waste. Liquid waste includes both wastewaters and nonwastewaters. Wastewaters are a mixture of water and organic, inorganic, or radioactive contaminants. Liquid radioactive wastes are processed according to their chemical nature and radiological sources and activities. Liquid wastes that meet release criteria in applicable regulations can be released at permitted discharge points. Where conditions permit, liquids can be processed and recycled to replace virgin feedstocks. Waste processing removes the hazardous or radioactive contaminants from the releasable or recyclable liquids. The largest volume of liquid radioactive waste is low-level waste (LLW), typically in aqueous solution from process operations. Some of this waste is contaminated with hazardous compounds such as solvents or resins, and the result is a liquid mixed waste. Liquid HLW would not be generated in stockpile stewardship and management facilities, but is part of the reference conditions at candidate sites where spent fuel or target processing was conducted. The desired final waste form for liquid wastes is a stable solid that is resistant to stresses from heat generation and from internal and external physical loads. The form must remain stable while stored and the radioactive constituents must not be allowed to migrate to the surroundings.

Mixed waste often has combustible constituents. These are most readily decomposed in thermal treatment (incineration) or chemical reaction resulting in the creation of an ash. The resulting material would be granular and suitable for stabilization in a cemented form in which the hazardous constituents (radionuclides and heavy metals) are bound in compounds that have an affinity for heavy metals and radionuclides. These processes have been utilized in various forms, and their retention properties have been credibly demonstrated.

Liquid LLW is normally processed to reclaim or remove the excess water, leaving a saturated salt solution. This can be accomplished by clarification processes normal to water treatment or by evaporation. This usually results in the greatest volume reduction for liquid waste. The subsequent stabilization and solidification of the concentrated solution results in a waste form that does not leach its active constituents for a time sufficient to allow the radioactive constituents to decay.

Liquid radioactive and hazardous wastes are usually stored in tanks, where they are staged for further processing. Processes are employed to concentrate the hazardous constituents. These processes result in significant volume reductions, with the reclaimed water processed to a purity sufficient for permitted discharge or recycle.

Liquid hazardous waste concentrates may contain combustive hydrocarbons and heavy metal contaminants. These can be treated by incineration to produce a dry waste. If this waste is still hazardous after treatment, it can then be processed into a stabilized solid that would not leach its hazardous constituents while in storage or in a disposal facility. Liquid low-level and noncombustible hazardous waste can also be processed into a stabilized solid form for storage and disposal.

Solid Waste. Solid radioactive waste typically consists of contaminated materials (e.g., filters, clothing, storage vessels, cleaning materials, and tools) that have been used in, or contaminated by, nuclear materials processing. The term is also applied to those stabilized forms resulting from gaseous or liquid waste processing. In solid waste handling, forms and materials would be segregated, combustibles could be incinerated, and the resultant materials would be reduced in volume, stabilized if necessary, and packaged in specified containers for storage or disposal.

The only HLW stored at sites considered for the Stockpile Stewardship and Management Program is liquid HLW in tanks at Savannah River Site (SRS). It would be processed to a borosilicate glass, stored in an engineered facility onsite, and eventually shipped to a Federal repository.

Dry LLW that consists of protective clothing, containers, process materials, and equipment is stored in specified containers designed to retain the waste constituents for a time sufficient to permit decay of the radioactive constituents.

Solid hazardous waste may contain combustible hydrocarbon compounds or mixtures with heavy metal contamination. These wastes are usually shipped offsite to RCRA-permitted commercial facilities where they are treated, if required, and disposed of. Wastes that retain their hazardous constituents after processing must be packaged into forms that would retain the hazardous constituents safely within the waste form. For LLW or hazardous waste that results from liquid waste processing or incineration, the accepted form is solidification with a cement-like bonding agent.

Some mixed waste can be processed to remove its hazardous constituents and can be disposed of as LLW. Otherwise, it can be processed into stabilized forms and packaged for storage in an engineered facility until a licensed facility is available for permanent disposal. Solid nonhazardous wastes from process wastewater evaporation ponds or from sanitary waste treatment plants are usually deposited as sludge in a landfill.

Sites under consideration for stockpile stewardship and management facilities that do not have or have planned an onsite LLW disposal facility would ship their LLW offsite to one of DOE's LLW disposal facilities. As shown in table H.1.4-1, data from the DOE Integrated Database were used to calculate LLW disposal land usage factors from 1990 to 1993 for Los Alamos National Laboratory (LANL), Nevada Test Site (NTS), and SRS. ORR (Oak Ridge National Laboratory [ORNL]) is not listed because it only accepts ORNL-generated LLW. To determine a usage factor for the waste management impact analysis, an average value was calculated and then rounded down to the nearest hundred cubic meters. For the proposed Class II LLW disposal facility at ORR, a 3,300-m3/hectares (ha) (1,700-yd$^{3/acre)}$ usage factor was assumed (OR DOE 1995e:1).

Table H.1.4-1.-- Low-Level Waste Disposal Land Usage Factors for Department of Energy Sites

Site	Total Cumulative Volume (m^3)	Estimated Area Utilized (ha)	Land Usage Factor (m^3/ ha)
1993			
LANL	220,700	17.4	12,684
NTS	458,435	174.2	2,632
SRS	665,239	67.9	9,797
1992			
LANL	218,000	17.2	12,674
NTS	439,700	55.0	7,995
SRS	649,700	78.2	8,308
1991			
LANL	215,700	17.2	12,541
NTS	419,600	55.0	7,629
SRS	636,700	78.2	8,142
1990			
LANL	209,900	17.0	12,347
NTS	408,400	No Data	No Data
SRS	612,800	72.1	8,499
Average			
LANL	NA	NA	12,562
NTS	NA	NA	6,085
SRS	NA	NA	8,687
NA - not applicable. DOE 1991h; DOE 1992f; DOE 1994c; DOE 1994d.			

H.1.5 Transportation

DOE complies with applicable Department of Transportation (DOT) regulations (10 CFR 71 and 49 CFR) when shipping hazardous materials over public roads. Transportation, especially for radioactive material, is highly regulated by Federal, state, and local laws. The stringent packaging requirements, combined with strict regulations and procedures governing the shipment of hazardous and radioactive materials, ensure that transport is a safe activity. Federal DOT regulations require the use of appropriate warning placards on vehicles and labels on packages to alert workers, officials, and the public to the hazardous nature of the shipped material. The use of placards on vehicles and warning labels on packages is a joint responsibility of the carrier and the shipper. The labels and placards are familiar to emergency response personnel and are valuable in determining content and hazard information.

Shipments of hazardous materials, including radioactive materials, must be accompanied by properly completed shipping papers such as bills of lading and cargo manifests that contain detailed information on the material being transported. These papers must be kept in the vehicle transporting the material and must be available for inspection by responsible officials at any time. The shipper must certify on the shipping papers that the hazardous material offered for transport is properly classified, packaged, marked, labeled, and made ready for transport according to all DOT regulations.

Radioactive material is shipped in secure packages. Type A packages contain small amounts of radioactive material and are designed to withstand normal conditions of transport. Type A packages are subjected to rigorous water spray, free-fall compression, and penetration tests carried out in sequence to ensure that radioactive materials are contained. Type B packaging is designed to contain more hazardous, and larger amounts of, radioactive waste. It can withstand severe accident conditions and contain radioactive materials under any credible circumstance.

If WIPP is determined to be a suitable disposal facility for TRU and mixed TRU wastes pursuant to the requirements of 40 CFR 191 and 40 CFR 268, TRU wastes would be shipped in TRUPACT-II (contact-handled) and RH-72B (remote-handled) containers. No remote-handled waste is expected to be generated in any of the stockpile stewardship and management facilities. To determine the number of TRU waste shipments required, 8.7 m3 (11.5 yd ^{3}) of waste per truck shipment, 17.5 m ^{3} (23 yd ^{3}) of waste per regular train shipment, and 52.4 m3 (69 yd ^{3}) of waste per dedicated train shipment was assumed (*DOE 1994v:* B-4).

The additional shipments of LLW from stockpile stewardship and management sites without onsite LLW disposal were estimated. All LLW would be transported in a solid form. A typical shipment would consist of 80 208-liter (L) (55-gallon [gal]) drums loaded into an enclosed semi-trailer type truck. Each drum is assumed to be fully loaded, resulting in a total shipment volume of 17 m^3 (21.7 yd ^{3}). The truck is assumed to operate as an "exclusive-use" vehicle.

H.1.6 Facility Transition Management

Any transition activities of facilities from a production mode to a cleanup mode that are part of the baseline for this PEIS are discussed as appropriate in the impacts sections of chapter 4 and in section H.2 of this appendix. Decontamination and decommissioning (D&D) considerations of stockpile stewardship and management facilities would be planned for in the design.

The DOE Office of the Assistant Secretary for Defense Programs (DP) is responsible for the safe operation, shutdown, and ultimate disposition of facilities used to support the nuclear weapons program. EM is responsible for final facility disposition, which may include D&D of inactive facilities or refurbishment of them for further economic development. Transition activities would require appropriate NEPA evaluation and would proceed consistent with programs within EM, DP, and Materials Disposition. Depending on the site, facility transition activities are in different stages of planning. The dominant time-intensive activities are building characterizations of the environmental hazards related to the building and the deactivation of the facility.

At the end of their useful lives, all potential facilities would require decommissioning. The transition process begins when DOE management decides to stop operating the production facility and ends when responsibility for the facility is formally turned over to EM. Transition plans would be required for all facility transfers to EM. These plans define the actions necessary to bring the identified facilities into a condition acceptable for transfer to EM. Some facility transition issues that would be considered in the facilities design process are:

- Land-use criteria defined for the period after cleanup
- Interim storage of mixed waste
- Disposal facilities for hazardous and LLW

The cleanup of proposed stockpile stewardship and management facilities would be significantly less difficult because consideration for waste minimization and ease of decontamination would be included in the facility design. The surfaces that come in contact with potential contaminants would be easier to decontaminate. In-process decontamination (to reduce operational exposures) would significantly reduce the cleanup required at the end of the facilities' life.

In spite of the best design and process practices, many of the proposed stockpile stewardship and management facilities would require decontamination efforts at the end of their life. Because of the necessity of working inside contaminated areas during the cleanup phase, the potential for exposure for cleanup workers is higher than during the operation phase. All D&D workers would wear protective clothing and would be supplied breathing air, as appropriate, to minimize their exposure.

Technologies for cleanup are established and are improving as experience in working with nuclear facilities increases. The use of robotics, improved task planning, and new materials to prevent the spread of contamination have already improved current cleanup activities. By the time the proposed stockpile stewardship and management facilities are decommissioned, DOE will have gained considerable cleanup experience; thus, further improvements should be expected.

DOE 1993h; DOE 1994k; DOE 1994n; DOE 1995gg; OR DOE 1995g; OR MMES 1993f; OR MMES 1995c.

H.2 Waste Management Activities

H.2.1 Oak Ridge Reservation

ORR consists of three operating industrial complexes in and around the city of Oak Ridge. The Energy Systems Waste Management Organization provides the waste management oversight for ORR. It also provides guidance to each of the operating facility waste management divisions that are responsible for operating and managing their respective waste management facilities and activities. Because there is no spent nuclear fuel, HLW, or TRU waste associated with the fabrication of secondaries and cases, there will be no further discussion of these wastes at ORR in this appendix.

Y-12 Plant. Laboratory, maintenance, construction, demolition, and cleanup activities; machining operations; and waste produced in the purification of uranium for recycle are the primary waste generation activities at the Y-12 Plant (Y-12). In addition, metal-plating operations generate plating waste solutions while various laboratory activities generate reactive wastes and waste laboratory chemicals. Liquid process waste and the sludge resulting from the treatment of these process wastes are generated throughout the plant. Waste oils and solvents are generated from machining and cleaning operations. Daily operations such as janitorial services and floor sweepings generate both noncontaminated and uranium-contaminated industrial trash.

Pollution Prevention. The Y-12 Pollution Prevention Awareness Program Plan describes the overall program in detail. The program is designed to maintain the flow of information pertaining to waste minimization and pollution prevention and to facilitate activities to implement real reductions in waste generation. A summary description of the four key elements of the Waste Minimization and Pollution Prevention Program includes a promotional campaign, information exchange, a waste tracking system, and waste assessment performance.

One goal of the program is to sustain an effective pollution prevention effort by improving the awareness of the employees of waste minimization opportunities and activities. Improved awareness is accomplished in many ways including training, posters, publications, seminars, promotional campaigns, and recognition of individuals and teams for activities that reduce waste generation. Waste minimization activities at other ORR sites and other weapons sites provide useful input to the program. Using ideas developed by others is an important aspect that can save time and resources.

Tracking waste generation in a manner that lends itself to waste minimization reporting is a prerequisite to documenting successes or failures in waste minimization efforts. Y-12 is improving its ability to record and track waste shipments. Process waste assessments are being conducted as part of the ongoing program to identify, screen, and analyze options to reduce the generation of waste. This determines the amount of material in a workplace that is disposed of as waste during work operations. The assessment provides a summary of hazardous materials usage and waste production and identifies those processes and operations that need to be improved or replaced to promote waste minimization.

Low-Level Waste. Machining operations that use stock materials including steel, stainless steel, aluminum, depleted uranium, and other materials produce machine turnings and fines as waste products. Waste treatment provides controlled conversion of waste streams generated from operations to an environmentally acceptable, or to a more efficiently handled or stored, form. This activity includes continuing operation and maintenance of facilities that treat wastewaters and solid waste generated from production and production support activities. Waste minimization and planned treatment facilities are expected to reduce the magnitude of these wastes. In 1993, Y-12 treated approximately 1,030,000 L (272,000 gal) of liquid LLW and 4,730 m3 (6,200 yd ^{3}) of solid LLW (ORiting approval from the state.

The Waste Coolant Processing Facility is a biodegradation and storage facility for waste coolants that may be LLW and utilizes the following equipment for coolant treatment:

- Three storage tanks
- Feed tank
- Waste processing reactor/clarifier
- Sludge holding tank
- Two sludge blenders/dryers
- Effluent holding tank
- Transfer pumps

Microorganisms biodegrade approximately 114,000 L (30,000 gal) of waste coolant per month into harmless products. Each batch of coolant takes approximately 30 days to treat. After treatment, the clarifier separates the wastes into three process streams: floating oily solids, liquid effluent, and settled biological solids. Floating solids are dewatered in the dryer/ribbon blender and are transferred to drums. Liquid effluent is sent to the Central Pollution Control Facility or West End Treatment Facility/West Tank Farm for final treatment prior to NPDES discharge. Biological solids are further treated in the aeration tank and are then recycled or sent through the blender for dewatering. Nonrecycled solids are currently pumped into tankers for storage. This practice will continue until adequate treatment and disposal methods are established.

Long-term storage options include storage in warehouses, tanks, and vaults, as well as storage of Y-12 wastes in buildings at K-25. The major Y-12 LLW storage facilities, described below, are summarized in table H.2.1-2. As of June 1994, approximately 7,930 m3 (10,400 yd ^{3}) of LLW and 4,740 m3 (6,210 yd ^{3}) of uranium-contaminated scrap metal were stored at Y-12 (OR MMES 1995c5-25). The Classified Waste Storage Facility (located in Building 9720-25) will provide for the permitted storage of solid LLW and mixed LLW, which is classified for national securtiy purposes under provisions of the Atomic Energy Act. These wastes are currently being stored by the waste generators. The facility will meet plant security requirements for classified waste management and guildlines for the management of LLW and mixed LLW.

Containerized waste storage units in Buildings 9206 and 9212 provide for the storage of cans of ash resulting in the combustion of uranium-contaminated solid wastes. Combustile solid waste contaminated with enriched uranium are turned into ash by oxidation during the uranium recovery process. The resulting cans of ash are stroed in contanerized storage units in Buildings 9206 and 9212 until uranium accountability results have been obtained and the material can be returned to the uranium recovery process for further processing to recover the enriched uranium.

The Depleted Uranium Oxide Storage Vaults I and II are located on the Chestnut Ridge northeast of Building 9213. The vaults are constructed of reinforced concrete and provide a retreivable storage repository for uranium oxide, uranium metal, and a blended mixture of uranium sawfines and oxide. The vaults contain a negative pressure exhaust system that operates during material entry. The exhaust is filtered and monitored prior to its release to the atmoaphere. The facility utilizes forklift trucks, electric hoists, and a motorized drum dumper during operation. Depleted uranium oxide and blended sawfines are delivered in sealed 208-L (30- and 55-gal) drums. The containers have a weight limit of 386 kilograms (kg) (850 pounds [lb]).

The Old Salvage Yard contains both low-level uranium-contaminated and nonradioactive scrap metal. Most scrap currently sent to this facility is contaminated. The Contaminated Scrap Metal Storage is an area within the Old Salvage Yard that is used to store uranium-contaminated scrap metal. Contaminated scrap is being placed in approved containers and eventually will be transferred to the aboveground storage pads. Noncontaminated scrap is sold when offsite shipments are allowed. This facility is located at the west end of Y-12.

Y-12 has no current onsite LLW disposal capability. All disposal activities at the Bear Creek Burial Ground were terminated on June 30, 1991. This landfill was used to dispose of radiologically contaminated solid waste. These wastes are currently containerized and stored at Y-12 in aboveground storage pads or are shipped offsite for incineration. In 1993, approximately 187 m3 (245 yd^3) of solid nonmetallic LLW were sent offsite to be compacted or incinerated with the ash returned to Y-12 for storage (OR MMM 1995c:5-15). Also, 745m (976yd) of contaminated scrap were sent to be smelted offsite. The proposed LLW disposal facilities project would provide new disposal facilities at a new centralized location of ORR. The proposed LLW disposal facilities would utilize state-of-the-art disposal technologies, invcluding lined trenches with leahate collection treatment capabilities and tumulus confinement disposal units. The Class-II Facility, for wastes contaminated with very low concentrations of short (less than 30 years) half-lite radionuclides, is expected to be operational in 2002. DOE has indefinately postponed consturction of the Class-I Facility, for wastes contaminated with very low cncentrations of predonminately long (greater than 30 years) half-lite radionuclides.

Mixed Low-Level Waste. Mixed LLW is generated from the development, metal preparation, fabrication, and assembly/industrial engineering functions at Y-12. Mixed LLW is hazardous waste such as solvents, degreasers, biodegradable coolants, organic and inorganic acids, biodenitrification sludge, and wastewater that is contaminated with enriched and/or depleted uranium. There is no disposal of mixed waste at Y-12; however, future plans include disposal of mixed wastes at a permitted offsite commercial facility. Mixed wastes are put in storage awaiting treatment or disposal, treated at Y-12, or sent to another ORR facility for treatment and disposal. Table H.2.1-3 presents the inventory of mixed LLW at Y-12 as of December 31, 1994, along with a 5-year projection. In 1993, approximately 2,410,000 L (636,000 gal) of liquid mixed LLW was treated at Y-12 (OR MMES 1995c-7-9). The Y-12 Waste Management Division operates several mixed LLW treatment facilities which are described below and summarized in the table H.2.1-1.

The Groundwater Treatment Facility treats wastewatere from the Liquid Storage Facility at Y-12 and seepwater collected at K-25 to remove volatile and nonvolatile organic compounds and iron. It is part of the Disposal Area Remedial Action program to collect and treat contaminated groundwater from the Beer Creek Burial Grounds. The Groundwater Treatment Facility is located at the far west end of Y-12, adjacent to the West End Treatment Facility. This facility utilizes an air stripping operation to remove volatie organics. In addition, carbon adsorption eliminates nonvolatile organics and PCBs. Iron removal equipement is also operational After treatment, wastewater is sampled and recycled if additionla processing is required. Wastewater that meets discharge specifications is pumped into East Fork Poplar Creek through an NPDES monitoring station. The GroundWater Treatment Facility treated and discharged approximately 2,780,000L (735,000gal) during 1992 (DOE 1994n).

The West End Treatment Facility/West Tank Farm treats the following nitrate-bearing wastes generated by Y-12 production operations: nitric acid wastes, nitrate-bearing rinsewaters, mixed acid wastes, waste coolants, mop water, caustic wastes, and biodenitrification sludges. Treatment operations consist of biological denitrification, biological oxidation, metals precipitation, coagulation, flocculation, clarification, filtration, hydrogen-ion concentration adjustment, degassification, and carbon adsorption. Wastes are received at the West End Treatment Facility/West Tank Farm in 18,900-L (5,000-gal) tankers, 2,270-L (600-gal) polytanks, and in smaller, approved waste transportation containers such as drums, bottles, and carboys. Detailed waste analysis documentation is used to determine the treatment scheme and temporary storage location of each shipment. The West End Treatment Facility effluent polishing system facilitates the removal of uranium, trace metals, and suspended solids. The treated wastewater is then discharged to East Fork Poplar Creek through an NPDES monitoring station. Sludges, spent carbon, and spent filter material generated during the treatment processes are currently stored in 1,890,000-L (500,000-gal) tanks. A major modification to the West End Treatment Facility/West Tank Farm is currently in the design phase. This modification will remove all heavy metals up front, thus separating the hazardous sludge from the nonhazardous sludge. Approximately two-thirds of the current sludge volume generated can then be disposed of as nonhazardous wastes.

The Y-12 Cyanide Treatment Unit provides storage and treatment of waste solutions containing metallic cyanide compounds from spent plating baths and precious metal recovery operations or other areas. The cyanide reduction process performed within the unit is currently performed in 208-L (55-gal) containers. After waste is treated at the Cyanide Treatment Unit, it is transferred to the West End Treatment Facility for further treatment then discharged to the East Fork Poplar Creek.

As of June 1994, approximately 16,600 m3 (21,700 yd ^{3}) of mixed LLW were stored at Y-12 (OR MMES 1995c7-32). Table H.2.1-2 summarizes the mixed LLW storage facilities at Y-12 that are described below.

The Containerized Waste Storage Area consists of three concrete pads covering apporoximately

2,320 square meters (m) (24,800 square feet [ft]). These pads provide storage for LLW, RCRA hazardous, and mixed LLW. An impermeable dike surrounds each pad to porovide spill containment. Fire protection at this facility will be upgraded, contingent on funds.

The Building 9811-1 RCRA Storage Facility (OD7 and OD8) contains a diked storage area for tanks (OD7) and an enclosed storage area for containers (OD8) with a capacity of 1,000drums. The OD7 contains four 114,000-L (30,000-gal) tanks, two 37,9000-L (10,000-gal) tanks, and associated piping and pumps. RCRA waste oil/solvent mixtures containing various concentrations of chlorinated and nonchlorinated hydrocarbon solvents, uranium, trace PCBs, and water for specific chemical constituents are stored at OD8 in 208-L(55-gal) drums and 1,140-L (300-gal) Tuff-tanks to await sampling and analytical results. Wastes deemed compatible with OD7 materials are pumped into those tanks. Noncompatible wastes are transported to different facilities.

The Waste Oil/Solvent Storage Facility (OD9) is a permitted RCRA TSCA hazardous waste storage facility. It consists of a diked area supporting five 151,000-L (40,000 Gal) tanks, a tanker transfer station with five centrifugal transfer pumps, and a drum storage area. Three tanks hous PCB wastes contaminated with uranium, one tank contains nonradioactive PCB wastes, and one tank holds RCRA hazardous wastes. Likewise, a diked and covered pad furnishes space for 33m^3 (43 yd^3 of containerized waste. Wastes assigned to this facility are first stored at OD8 (Building 9811-1 RCRA storage facility) to await laboratory results. The diked area contains additional space for a sixth 151,000-L (40,000-gal) tank. This facility is projected to be used until 2010, due to the anticipated lack of disposal outlets for uranium-contaminated organic liquids.

The Liquid Organic Waste Solvent Storage Facility (OD10) contains four 24,600-L (6,500-gal) and two 11,400-L (3,000-gal) stainless steel tanks for storage of ignitable nonreactive liquids, including those contaminated with PCBs and uranium. In addition, a diked and covered storage area provides space for 40,000-L (10,600 gal) of containerized waste. The facility is capable of segregating various spent solvents for collection and storage. Major solvent waste streams are transferred to tanks until final disposition.

Building 9720-9 storage area supplies a drum storage area for mixed and PCB wastes, including an area designed to contain flammable wastes. The western half, which contains space for approximately 1,500 drums, stores both PCB and RCRA hazardous waste. The facility's eastern half is not currently in use. Upgrades are underway to the ventilation, diking, and fire-suppression systems to comply with RCRA, TSCA, and DOE standards and to allow for mixed and PCB waste storage.

The RCRA Staging and Storage Facility (Building 9720-31) prepares solid, liquid, and sludge wastes for offsite shipment. The facility consists of seven storage rooms and seven staging rooms, each with a separate ventilation system. The staging rooms house small containers that are packed with compatible materials and shipped. The storage rooms hold larger containers, such as 208-L (55-gal) drums. Each room, which can hold up to 90 drums, accommodates a different class of hazardous waste.

The RCRA and PCB Container Storage Area (Building 9720-58) is a warehouse facility utilized for staging prior to treatment or disposal of PCB-contaminated equipment (transformers, capacitors, and electrical switchgear) and nonreactive, nonignitable RCRA waste contaminated with uranium. Waste containers received at Building 9720-58 include 114- and 208-L (30- and 55-gal) drums, 1,250- and 2,500-L (330- and 660-gal) portable tanks, B-25 boxes, and self-contained PCB equipment.

The Solid Storage Facility provides 1,630 m2 (17,500 ft ^{2}) of storage space for PCB- and uranium-contaminated soil. The facility also contains a synthetic liner for leachate collection and a leak detection system. Collected leachate is transferred to the Liquid Storage Facility for pretreatment. The Solid Storage Facility is currently undergoing the RCRA Part B permitting process. No additional wastes are being added to the facility.

Hazardous Waste. Plating rinsewaters, waste oil, and solvents from machining and cleaning operations; contaminated soil, soil solutions, and soil materials from RCRA closure activities; and waste contaminated with hazardous constituents from construction/demolition activities are the major sources of hazardous waste. In 1993, approximately 8,840,000 L (2,340,000 gal) of hazardous liquid were treated (OR MMES 1995c:6-6). The remaining hazardous waste consists of 1,080 m ^{3} (1,420 yd ^{3}) of solid waste which is stored at the RCRA Storage and Staging Facility. In 1994, approximately 190 m3 (250 yd ^{3}) of PCB hazardous material was shipped offsite for treatment (DOE 1995h). The Y-12 Waste Management Division operates several hazardous treatment facilities that are described below and are summarized in table H.2.1-4.

The Plating Rinsewater Treatment Facility treats dilute plating rinsewaters contaminated primarily with chromium, copper, nickel, and zinc. In addition, the facility can treat cyanide-bearing wastes and remove chlorinated hydrocarbons. The design capacity for this facility is 30.3 million l/yr (MLY) (8 million gal/yr [MGY]). Under normal conditions, the Plating Rinsewater Treatment Facility treats 852,000 L (225,000 million gal) of plating rinsewater per year (DOE 1995gg). The facility is located across the street from the Building 9401-2 plating shop, which produces most of Y-12's rinsewaters. The facility neutralization, equalization, and cyanide destruction equipment is located outdoors in a diked basin. The remainder of the facility process is located in Building 9623. Rinsewaters are received via a direct pipeline from the plating shop. In addition, rinsewaters may be received in tankers, polytanks, or in any acceptable waste shipping container. The Plating Rinsewater Treatment Facility performs the following treatment operations: pH adjustment, flow equalization, heavy metal removal by electrochemical precipitation, flocculation, clarification, carbon adsorption, and filtration. After the clarification operation, the rinsewater is transferred to the Central Pollution Control Facility. The Central Pollution Control Facility provides the carbon adsorption operation, final filtration, and discharge to East Fork Poplar Creek through an NPDES monitoring station. Treated rinsewater is sometimes recycled for use as make-up water for Central Pollution Control Facility processes. Sludge from the clarification process is transferred to the Central Pollution Control Facility and then taken to the West Tank Farm for interim storage.

The Steam Plant Wastewater Treatment Facility treats approximately 144 MLY (38 MGY) of wastewater from steam plant operations, demineralizers, and coal pile runoff (OR MMES 1995c:8-7). Treatment processes include wastewater collection/sedimentation, neutralization, clarification, pH adjustment, and dewatering. The treatment facility utilizes automated processes for continuous operation. All solids generated during treatment are nonhazardous and are disposed of in the sanitary landfill. The treated effluent is monitored prior to NPDES discharge to the East Fork Poplar Creek. The Y-12 utilities department manages this facility.

Hazardous waste is being stored until the management and operations contractor and DOE approve shipment for offsite disposal under the DOE "No Rad Added" performance objective. As of June 1994, approximately 60 m3 (79 yd ^{3}) of hazardous waste and 20 m3 (26 yd ^{3}) of PCB wastes was in storage at Y-12 (OR MMES 1995c:6-11). Table H.2.1-5 summarizes the major existing Y-12 hazardous wast storage facilities described below.

The Oil Landfarm Soil Storage Facility contains approximately 420 m^3 (550 yd^3 of soil contaminated with PCBs and volatile organics (OR DOE 1993a:9-21). The soil was excavated from the Oil Landfarm and Tributary 7 in 1989. The soil is contained in a covered, double-lined concrete dike with a leak-detection system. The leak-detection system will soon be modified to enhance detection capabilities.

The Liquid Storage Facility of the Disposal Area Remedial Actions Liquid Storage Treatment Unit is a hazardous waste storage facility built during the Bear Creek Burial Ground closure activities. It is located in Bear Creek Valley approximately 3.2 kilometers (km) (2 miles [mi]) west of Y-12. It collects and stores groundwater and otehr wastewaters received fromt he seep collection lift station, the Solid STorage Facility, tankers, polytanks, and the diked area rainfall accumulation. Feed streams may contain oil contaminated with PCB's, volatile and nonvolatile organic compounds, and heavy metals. Processing and storage equipment include:

- Two 284,000-L (75,000-gal) bulk storage tanks
- 22,700-L (6,000-gal) oil storage tank
- Gravity separator
- Filtering unit
- Composite sampling station
- Tanker transfer station

The wastewater travels through the gravity separator, cartridge filters, and composite sampling station prior to storage in the bulk tanks. A reinforced concrete dike surrounds all equipment to provide spill containment. After sufficient wastewater accumulates in the bulk storage tanks, it is processed at the Groundwater Treatment Facility. A new leachate collection system collects and pumps hazardous waste seepage from the burial ground to the Liquid Storage Facility.

The Y-12 Waste Management Division operates Industrial Landfill V, which provides for the disposal of industrial and institutional solid waste and special wastes such as asbestos materials, empty aerosol cans, materials contaminated with beryllium oxide, glass, fly ash, coal pile runoff sludge, empty pesticide containers, and Steam Plant Wastewater Treatment Facility sludge. The landfill area is located on Chestnut Ridge near the eastern end of the plant and serves Y-12, ORNL, K-25, and other DOE prime contractors at Oak Ridge. The landfill utilizes shallow land burial by the area fill method and is permitted by the State of Tennessee. Requests are filed with the state to provide disposal for additional materials as needed.

The Chestnut Ridge Borrow Area Waste Pile (Industrial Waste Landfill III) consists of mercury-contaminated soil removed from the Oak Ridge Civic Center area and deposited at Y-12 Chestnut Ridge. No further disposal at this site has been made.

Nonhazardous Waste. Major waste-generating activities include construction and demolition activities that produce large volumes of noncontaminated wastes, including lumber, concrete, metal objects, and soil and roofing materials. Industrial trash is generated by daily operations throughout the plant. These operations include janitorial services, floor sweepings in production areas, and production activities. In 1993, Y-12 generated 145 million L (38.3 million gal) of industrial and sanitary liquid waste (OR MMES 1995c:8-5) that included oils and solvents, operational wastewater, Central Pollution Control Facility/Plating Rinsewater Treatment Facility wastewater, steam plant wastewater, environmental restoration waste, and liquid waste received from ORNL and K-25. The Waste Storage Facility in Building 9720-25 has a solid waste baler with an 8:1 compaction ratio (DOE 1994n). Approximately 43,900 m3 (57,600 yd ^{3}) of solid nonhazardous waste were compacted and/or stored during 1993 (OR MMES 1995c:8-5).

The Sludge Handling Facility (T-118) was designed and constructed to provide water filtration and sludge dewatering in support of a storm sewer cleaning and relining project. Filtered water was reused by the sewer-cleaning contractor, and the dewatered slude was stored in specially constructed containers for future disposal. The facility is currently being used to store containers of LLW.

The Steam Plant Ash Disposal Facility is used to collect, dewater, and dispose of sluiced bottom ash generated during operation of the coal-fired steam plant. An additional trench was constructed for the disposal of sanitary and industrial wastes generated by ORNL, K-25, and Y-12. In order to comply with environmental regulations for landfill operations, the Steam Plant Ash Disposal Facility includes a leachate collection system, a transfer system to discharge the collected leachate into the Oak Ridge public sewage system, groundwater monitoring wells, and a gas migration/ventilation system.

In 1992, approximately 677 m^3 (887 yd^3 of clean scrap metal was stored at Y-12 (OR DOE 1993b:9-6). The new salvage yard is used for the staging and public sale of nonradioactive, nonhazardous scrap metal. Sales have been suspended, however, until procedures to meet the DOE "No Rad Added" performance objective have been approved. The New Salvage Yard provides accumulation and sorting activities for nonradiologically contaminated scrap metal. Plans are in place to provide an automotive lead cell battery repository for used batteries until recycling options are initiated. This facility is located near the Bear Creek Burial Ground.

The new Industrial Landfill V and Construction Demolition Landfill VI permits disposal of approximately 93,500 m^3/yr (122,000 yd $^{3/yr}$) of industrial and sanitary waste (OR MMES 1995c:8-18). The facilities were designed and operated in accordance with Tennessee solid waste disposal regulations. A baler, located in Building 9720-25, is used for compaction of sanitary/industrial solid waste destined for the Industrial Landfill V.

Oak Ridge National Laboratory Because ORNL is a research facility, it has many diverse waste-generating activities, each of which may produce only a small quantity of waste. Isotope production, utilities, and support functions such as photography are additional sources of waste. The radioactive wastes produced by each activity at ORNL reflect the nature of its operation. A large number of radioisotopes are handled, in isotope production and packaging, in reactor and accelerator operations, in reprocessing studies on nuclear fuel, and in investigations into the interactions of radioactivity with living systems. The radioactive wastes generated by these activities can be classified as follows:

- Concentrates generated by the treatment of intermediate-level wastes, which are disposed of by hydrofracture.
- LLW contaminated with beta/gamma emitting radioactivity. These wastes, which have a low surface dose rate, are compacted, if possible, and disposed of in earthen trenches; those wastes that exhibit a high surface dose rate are disposed of in augered holes.
- Low-level alpha-emitting wastes, which are evaluated for criticality hazards before disposal in augered holes.

Pollution Prevention. Waste segregation is used to minimize the generation of solid LLW. By providing collection barrels for both radioactive and nonradioactive wastes, the volume of wastes that requires handling as radioactive waste has been reduced. Before these procedures were implemented, radioactive and nonradioactive wastes were discarded in the same barrel. This contaminated the nonradioactive portion and required special disposal of an inflated amount of waste.

Low-Level Waste. Isotope production and research activities generate a variety of low-level radioactive wastes to include low-level wastewater. Sources of solid LLW include contaminated equipment, filters, paper, rags, plastic, and glass and sludge from the Process Waste Treatment Plant. Table H.2.1-6. shows the LLW treatment facilities that are operating at ORNL. In 1993, 434 m3 (569 yd ^{3}) of solid LLW were compacted and 180,000 L (47,700 gal) of liquid LLW were solidified at ORNL. Approximately 25 m3 (33 yd ^{3}) were sent offsite to be compacted and/or incinerated (OR MMES 1995c:5-14, 5-15).

Solid LLW to include radioactive scrap metal is placed in storage prior to disposal. Table H.2.1-7 lists the LLW and mixed LLW storage facilities currently operating at ORNL. As of June 1994, approximately 1,050 m3 (1,370 yd ^{3}) of solid LLW and 2,960 m3 (3,870 yd ^{3}) of radioactive scrap metal were in storage awaiting disposal at ORNL (OR unit on ORR. It receives solid LLW, including radioactively contaminated asbestos. Table H.2.1-8 lists the LLW disposal units at SWSA-6. As of the end of 1993, approximately 606 m3 (794 yd ^{3}) of solid LLW were buried at SWSA-6 (OR MMES 1995c:5-27).

The area designated as SWSA-6 at ORNL is the only active onsite disposal unit on ORR. It receives solid LLW, including radioactively contaminated asbestos. Table H.2.1-8 lists the LLW disposal units at SWSA-6. As of the end of 1993, approximately 606 m^3 (794 yd^3 of solid LLW were buried at SWSA-6 (OR MMES 1995c:5-29).

Mixed Low-Level Waste. Mixed wastes are generated by research projects and some facility operations. Isotope production and research activities generate a variety of mixed low-level and mixed TRU wastes. Table H.2.1-9 presents the inventory of mixed LLW at ORNL as of December 31, 1994, along with a 5-year projection.

As shown in table H.2.1-6, three facilities are currently treating or are capable of treating mixed waste at ORNL: the Process Waste Treatment Plant, the Liquid Low-Level Waste Evaporation Facility, and the Melton Valley Low-Level Waste Immobilization Facility (DOE 1995gg). One other treatment facility at ORNL, the Nonradiological Wastewater Treatment Plant, is operating and could be used to treat mixed waste.

The Process Waste Treatment Plant is designed to treat process wastewaters, groundwater, and evaporator condensate wastewaters that contain low levels of radioactivity. Small concentrations of radioactive materials have occasionally been processed. Process wastewaters may contain small quantities of radionuclides, metals, anions, and organic chemicals. Under normal operating conditions, the Process Waste Treatment Plant can process wastewater at a rate of 492 L/minute (min) (130 gal/min). The design capacity is 757 L/min (200 gal/min) (DOE 1994n). Wastewaters can contain organic materials and low levels of radioactivity. The facility can treat waste streams with some heavy metals but not streams containing PCBs.

The Liquid Low-Level Waste Evaporation Facility treats liquid LLW using evaporation. It operates in a semicontinuous mode; waste is accumulated in collection tanks and transferred through underground piping to an evaporator system. The design capacity is 106,000 L/day (28,000 gal/day). The facility processes an average of 1,140 L (300 gal) of liquid wastes per day under normal operating conditions (OR DOE 1993a:9-22). The facility can treat waste streams containing organic contaminants.

A summary of the mixed LLW storage facilities at ORNL is shown in table H.2.1-7. An estimate of the capacity of these facilities is also given. As of June 30, 1994, approximately 3,190 m3 (4,180 yd ^{3}) of mixed waste were in storage at ORNL (OR MMES 1995c:7-32).

The only disposal of mixed waste done at ORNL is the burial of radioactive asbestos at SWSA-6. Asbestos contaminated with low levels of radioactivity is placed in silos. In 1992, approximately 23 m3 (30 yd ^{3}) of contaminated asbestos was buried (OR DOE 1993b:9-4). Low-level contaminated biological waste has also been buried at SWSA-6.

Hazardous Waste. Hazardous wastes are generated in laboratory research, electroplating operations, painting and maintenance operations, descaling, demineralizer regeneration, and photographic processes. Few hazardous wastes are treated in onsite facilities. Onsite treatment at ORNL includes elementary neutralization and detonation facilities. A summary of the hazardous waste treatment facilities at ORNL is shown in table H.2.1-10.

The Chemical Detonation Facility treats small amounts of wastes that would be dangerous to transport offsite. Explosives such as aged picric acid are detonated in the detonation facility. Certain other wastes (e.g., spent photographic processing solutions) are processed onsite into a nonhazardous state. Those wastes that are safe to transport are shipped to offsite RCRA-permitted commercial treatment/disposal facilities.

The Nonradiological Wastewater Treatment Plant is designed to reduce pollutant concentrations in nonradiological wastewaters including hazardous wastes to levels acceptable for effluent discharge. The plant operates in a continuous mode and involves physical and chemical processing steps. The facility contains a heavy-metal removal system, where the pH of the wastewater is raised to 10.5 in a clarifier. Polymers are added to induce flocculation and settling of the metal precipitates. The wastewater is passed through a filtration system to remove particulates. An air stripper then removes volatile organics and activated carbon columns remove mercury. In 1993, approximately 23,800,000 L (6,300,000 gal) of liquid hazardous wastes were treated at the Nonradiological Wastewater Treatment Plant (OR MMES 1995c:6-6).

As of June 1994, approximately 60 m3 (79 yd ^{3}) of hazardous waste and 20 m3 (26 yd ^{3}) of PCB waste were stored at ORNL (OR MMES 1995c:6-11). PCB wastes are managed in storage facilities until they can be shipped offsite for treatment and/or disposal. PCB-contaminated and hazardous wastes are temporarily stored at Building 7507, and PCB-contaminated wastes are stored on the 7507W storage pad. Due to the "No Rad Added" policy, hazardous wastes are being stored as mixed waste. A listing of the hazardous waste storage facilities at ORNL is shown in table H.2.1-11. Approximately 10 m3 (13 yd ^{3}) of asbestos wastes were sent offsite in 1992 to Y-12 Sanitary and Industrial Landfill II. About 12 m3 (16 yd ^{3}) of hazardous and PCB wastes were sent to K-25 for storage and incineration in the TSCA incinerator (OR DOE 1993b:9-5).

Nonhazardous Waste. Nonhazardous wastes result from ORNL maintenance and utilities. The s team plant and the sanitary waste treatment plant produce a sludge which is sampled to demonstrate that it is nonhazardous and meets the Y-12 Industrial and Sanitary Landfill II waste acceptance criteria. The sewage treatment facility treats sanitary and laundry wastewater. It is an extended aeration-activated sludge unit followed by mixed media tertiary filtration of secondary effluent dewatering. The sludge is dried onsite in open-air drying beds. In 1993, approximately 331 million L (88 million gal) of industrial and sanitary liquid waste were treated at the sewage treatment plant (OR MMES 1995c:8-7).

The Melton Valley Low-Level Waste Immobilization Facility is currently treating nonhazardous liquid waste (OR DOE 1994a:A-20). The facility can be used to solidify liquid mixed LLW that has a pH greater than 12.5 and that contains some heavy metals. This liquid mixed LLW is transferred from tanks by interconnecting pipelines. Batches of waste are pumped from a liquid decantation system to a solidification system as required to provide adequate storage-tank capacity. The facility operates only on a campaign basis to provide adequate storage capacity. Solidification is currently performed using cementation. Design capacity is 62,500 L (16,500 gal) of liquid waste per month. Under normal operating conditions, the facility can process 7,570 L/month (mo) (2,000 gal/mo) as required to provide adequate storage-tank capacity. The facility cannot treat HLW, alpha-contaminated waste with TRU activity levels greater than 100 nanocuries per gram (nCi/g), organic wastes, or PCBs.

Scrap metals are discarded from maintenance and renovation activities and are recycled when appropriate. Construction and demolition projects also produce nonhazardous industrial wastes. All solid nonhazardous and medical wastes (after they are autoclaved to render them noninfectious) except scrap metal are sent to the Y-12 Industrial and Sanitary Landfill II. Approximately 16 m3 (21 yd ^{3}) of scrap metal were placed in storage at ORNL in 1992. This waste will remain at ORNL until it is characterized as nonradioactive per the "No Rad Added" policy (OR DOE 1993b:9-7).

Rainfall runoff from the ORNL steam plant coal yard storage area plus additional wastewater from the sulfuric acid tank diked area runoff, steam plant boiler blowdown, and water softener regenerate are collected in a basin. This waste is treated at the Coal Yard Runoff Treatment Facility.

K-25 Site. Enrichment, maintenance, decontamination, and R&D activities have generated a wide variety of waste at K-25. Because of its past uranium enrichment mission, uranium is the predominant radionuclide found in K-25 waste streams. Waste management activities are increasing. Low-level radioactive wastes from other DOE sites are placed in building vaults until a final disposition strategy is identified. Also, PCB wastes and RCRA wastes contaminated with uranium began arriving from other DOE sites in 1987 for incineration in the K-1435 TSCA incinerator. Tables H.2.1-12 and H.2.1-13 summarize the treatment and storage facilities, respectively, at K-25 that are capable of treating and storing multiple categories of waste.

Pollution Prevention. K-25 policy mandates minimization of waste generated while achieving compliance with applicable environmental regulations. Five waste reduction options are used at K-25: segregation, material substitution, process innovation, mechanical volume reduction, and recycling/ reuse. In recent years, some aluminum cans, worker clothing, and office furniture have been recycled for use at K-25. Such recycling has saved approximately 1,150,000 kg (2,520,00 lb) of materials as of 1991. K-25 management supports the waste reduction program. An example of this program is the conversion to gas-fired boilers to reduce capacity excursions and, in effect, reduce or eliminate fly ash production.

Low-Level Waste. Solid LLW is generated by discarding radioactively contaminated construction debris, wood, paper, asbestos and trapping media. Solid LLW is also generated by process equipment and by removing radionuclides from liquid and airborne discharges. Currently, solid LLW is being stored for future disposal. Table H.2.1-14 shows the storage facilities that deal only with LLW. Specifics on some of the storage facilities are described below. Treatment of the current inventory of contaminated scrap metal at K-25 (as well as at Portsmouth, Paducah, and Fernald facilities) is expected to occur over the next 3 to 5 years as part of a comprehensive DOE Scrap Metal Program to be managed through K-25. All contaminated scrap metal is stored aboveground at the K-770 scrap metal facility until further disposal methods are evaluated.

The Uranium Hexafluoride Cylinder Program is directed toward improving the safety and reliability of long-term storage for 7,000 cylinders currently at K-25. These cylinders remain from the now-terminated gaseous diffusion mission. In storage at the site are approximately 5,000 9-metric tons (t) (10-tons) and 13-t (14 tons) cylinders of depleted uranium hexafluoride; 1,000 cylinders of normal-assay feed uranium hexafluoride; 400 cylinders containing more than 23 kg (50 lbs) of "enriched" material; and 600 miscellaneous empty cylinders. The Uranium Hexafluoride Cylinder Program is being designed to develop a clear understanding of the current conditions of the cylinders and define any near-term and long-term actions for safe storage of the cylinders, pending decisions on ultimate disposition of the uranium hexafluoride material. Some of the initial actions in the program are a baseline inspection, a corrosion coupon program, and an ultrasonic thickness measurement program. The baseline inspection identified a variety of cylinder defects that will require special attention and also identified four breached cylinders. Immediate corrective actions have been taken to handle the breached cylinders and a schedule of activities has been developed for moving and repairing the cylinders.

The cylinders containing normal-assay feed uranium hexafluoride are currently being shipped to the Paducah Gaseous Diffusion Plant. The current DOE direction for the 5,000 cylinders with depleted uranium hexafluoride is to store them until at least 2020, at which time conversion to oxide will be performed if no other uses have been determined. A plan for cleaning the cylinders containing more than 110 kg (50 lb) of enriched material and empties has not yet been approved (this may be performed at K-25 or at one of the operating gaseous diffusion plants).

Currently, there are no onsite disposal facilities being operated at K-25. An ORR Centralized Waste Management Organization has been established and assigned the responsibility to design, construct, and operate all new LLW disposal facilities for ORR. This organization is physically located at K-25.

Mixed Low-Level Waste . Mixed LLW primarily consists of contaminated waste oils, solvents, sludges, soils, and acid wastes. Table H.2.1-15 presents the inventory of mixed LLW as of December 31, 1992, along with a 5-year projection. Sludges contaminated with low-level radioactivity were generated by settling and scrubbing operations and were stored in K-1407B and K-1407C ponds. Sludges have been removed from these ponds, and a portion have been fixed in concrete at the K-1419 Sludge Treatment Facility and stored at Building K-33. These materials are considered mixed LLW and will be shipped offsite for disposal at a permitted commercial facility.

Most of the treatment of mixed waste is at the TSCA Incinerator and the Central Neutralization Facility. The majority of waste treated at the TSCA Incinerator cannot be treated by commercial incinerators because of radioactive contamination. All waste sent to this facility must be fully characterized and identified. DOE has an approved chain-of-custody system for all waste received from offsite. The K-1435 TSCA Incinerator is capable of incinerating waste that is mixed or contains PCBs. In 1990, a limited amount of waste was incinerated as a part of the startup testing. The incinerator began full operations in early 1991 and met all regulatory requirements in processing 1,000 m3 (1,310 yd ^{3}) of mixed waste. Mixed TSCA waste is being generated in the ash residue at the TSCA Incinerator. Compliance issues regarding the management of the mixed PCB and radioactive waste generated in the ash are being pursued with EPA by DOE.

Most of the radioactively contaminated wastewater treated at the Central Neutralization Facility is generated at the TSCA Incinerator from the wet scrubber blowdown. Treated effluents are discharged through a designated release point. The contaminated sludges that precipitate in the sludge-thickener tank are stored in an approved aboveground storage area at K-25.

RCRA-mixed, radioactive land-disposal-restricted waste (including some nonradiological classified land-disposal-restricted waste) has been stored in some areas for longer than 1 year. These wastes are currently subject to the land disposal restriction that permits storage only for accumulation of sufficient quantities to facilitate proper treatment, recycling, or disposal. This waste is being stored because of the nationwide shortage of treatment and disposal facilities for this type of waste. Private-sector technology demonstrations are being conducted that involve uranium extractions from sludge.

Uranium-contaminated PCB wastes (i.e., mixed wastes) are being stored in excess of the 1-year limit imposed by TSCA because of the lack of treatment and disposal capacities. DOE and EPA have signed a Federal Facility Compliance Agreement, effective February 20, 1992, to bring the facility into compliance with TSCA regulations for use, storage, and disposal of PCBs. It also addresses the approximately 10,000 pieces of nonradioactive PCB-containing dielectric equipment associated with the shutdown of diffusion plant operations.

In 1989, during routine inspections of the drums of stabilized K-1407 pond sludge at the K-1417 storage facility, it was discovered that many of the drums had begun to corrode. Free liquid (waste with a pH of 12) on top of the concrete in the drums was found to be causing the corrosion (OR DOE 1993a:9-16). An action plan has been implemented to decant and/or dewater the mixed waste contained in the drums. A total of 45,000 drums of stabilized material and 32,000 drums of raw sludge must be processed and moved to storage facilities that meet regulations governing mixed wastes. All containers will be transferred to and stored in new and existing facilities at the K-1065 site, and the K-31 and K-33 buildings.

Hazardous Waste. Hazardous wastes generated at K-25 include PCB articles and items, waste oils and items, and uncontaminated asbestos waste. All hazardous wastes are managed according to applicable state and Federal regulations and DOE orders. Several waste management facilities are already in place. Changing laws and regulations have made it necessary to upgrade several facilities and to design and construct new facilities that reflect the most recent environmental technology. The Central Neutralization Facility and the TSCA Incinerator are the two major facilities that treat hazardous waste.

The Central Neutralization Facility provides pH adjustment and chemical precipitation for several aqueous streams throughout K-25. The main purpose of the Central Neutralization Facility is to treat wastewater to ensure compliance with the requirements of NPDES discharge limits on pH, heavy metal concentrations, and suspended solids. The treatment system consists of two 94,600-L (25,000-gal) reaction tanks and a 227,000-L (60,000-gal) sludge-thickener tank. Acidic wastes are neutralized with a hydrated-lime slurry, and basic wastes are neutralized with sulfuric or hydrochloric acid. The hydrated lime bin and acid tanks are located at the facility. The treatment facility is physically divided into two distinct sections for treating both hazardous and nonhazardous waste streams.

The TSCA Incinerator consists of storage tanks, dikes, and the incinerator. The incinerator system consists of a liquid, solid, and sludge feed system; a rotary kiln incinerator; and a secondary combustion chamber. The wastes treated at this facility include oils, solvents, chemicals, sludges, and aqueous waste.

In general, most of the waste stored at K-25 is designated as hazardous waste that has been contaminated with PCBs. Recyclable materials such as mercury and silver-bearing photographic wastes are stored before recycling, while other hazardous wastes are stored until sufficient quantity is accumulated for an offsite shipment. All offsite disposals of hazardous wastes were halted in 1991 until procedures addressing a DOE performance objective of "No Rad Added" were developed by the sites and approved by DOE Headquarters. Incineration is the preferred method for offsite treatment or disposal of wastes, particularly PCB wastes; however, landfills and other types of disposal are used as needed. On the K-25 Site all hazardous waste is treated as mixed LLW.

Nonhazardous Waste. Computer paper is being recycled from the K-25 Computer Technology Center. The program for recycling paper is being reviewed for expansion into nonradiological areas. Product substitutions at the paint shop and photography lab have resulted in a decrease of waste generation. No percentage of reduction has been calculated due to the lack of baseline data.

Waste assay monitors have been purchased and are being used to screen solid, potentially radioactive waste to determine the potential to manage it as a nonhazardous waste. The K-770 clean scrap yard provides storage for nonradioactive scrap metal. The scrap metal is stockpiled before being sold to the public. The solid nonhazardous waste from K-25 is sent to Y-12 Industrial Landfill V. Some materials such as furniture, file cabinets, and paper are sold through property sales. The only nonhazardous treatment facility at K-25 is the Sanitary Waste Treatment Plant (Building K-1203). The system consists of an extended aeration treatment plant with a rate capacity of approximately 2,270,000 L/day (600,000 gal/day). The current demand is about 1,140,000 L/day (301,000 gal/day) (OR MMES 1995c:8-9). The sanitary sludge is disposed of in the Y-12 landfill. The Central Neutralization Facility does treat some nonhazardous liquid waste streams along with hazardous and/or mixed waste streams.

H.2.2 Savannah River Site

The process of manufacturing useful nuclear materials has produced radioactive, mixed, and hazardous wastes that are treated, stored, or disposed of at SRS. The *Savannah River Site Waste Management Final Environmental Impact Statement* (DOE/EIS-0217, July 1995) addressed the tasks to be completed in the next 10 years to clean up existing waste units and bring current operations into compliance with applicable regulations. The EIS discusses the current conditions and provides DOE's preferred alternatives for processing current and future waste streams. It also addresses the development and funding of processes to minimize waste generation and to safely process and dispose of future waste generation. Because there is no spent nuclear fuel associated with the fabrication of primaries, there will be no further discussion of spent nuclear fuel at SRS.

Pollution Prevention. Pollution prevention, previously driven by best management practices and economics, is now mandated by statutes, regulations, and agency directives. The SRS Waste Minimization and Pollution Prevention Program is designed to achieve a continuous reduction of wastes and pollutant releases to the maximum extent feasible in accordance with regulatory requirements while fulfilling national security missions. The SRS Waste Minimization and Pollution Prevention Awareness Plan addresses wastes and potential pollutants of all types and establishes priorities for accomplishing waste minimization and pollution prevention through source reduction, recycling, treatment, and environmentally safe disposal.

High-Level Waste. Liquid HLW containing actinides and hazardous chemicals was generated from recovery and purification of TRU products and from spent fuel processing, and is retrievably stored in 51 underground tanks. One of these tanks is out of service. The tanks are managed in compliance with Federal laws, State of South Carolina regulations, and DOE orders. The waste is segregated by heat generation rate, neutralized to excess alkalinity, and stored to permit the decay of short-lived radionuclides before its volume is reduced by evaporation. Of the 51 tanks, 29 are located in the H-Area Tank Farm, and 22 are located in the F-Area Tank Farm. The tanks are of four different designs, but all are of carbon steel. Newer tanks which have full height secondary containment and forced water cooling are used for waste processing. Some older tanks contain salt and sludge awaiting waste removal. Old tanks that have had waste removed except for residue are used to store low-activity waste. The older tanks will be taken out of service when space in other tanks becomes available due to transfer to the Defense Waste Processing Facility.

High-heat liquid waste is stored for 1 to 2 years to allow decay of radionuclides before being processed through evaporators. Low-heat waste is sent directly to the evaporator feed tanks. Each tank farm has one evaporator that is used to reduce the volume of the water and concentrate the solids. A replacement higher capacity evaporator is planned that may be used in conjunction with the current evaporators. Liquids can be reduced to 25 to 33 percent of their original volume and stored as salts or sludges. Cesium removal columns can operate in conjunction with the evaporators. The evaporators obtain decontamination factors of 10,000 to 100,000 and the cesium removal columns can obtain another 10 to 200 decontamination factors. Decontaminated liquids (overheads) are sent to the Effluent Treatment Facility for processing before being released to Upper Three Runs Creek. The concentrated salt solution is processed to remove radionuclides, and the decontaminated solution is sent to the Defense Waste Processing Facility Saltstone Facility for solidification and onsite storage in the Saltstone Vaults.

The remaining sludges and salts contain the majority of the radionuclides and are stored separately awaiting vitrification. Prior to vitrification, salt would be precipitated in the in-tank precipitation process. The precipitate and sludge would be fed into the vitrification process in the Defense Waste Processing Facility. The waste would be mixed with borosilicate glass and immobilized by melting and then pouring the mixture into stainless steel cylinders. These cylinders would be stored in a shielded facility at the Defense Waste Processing Facility until a repository is available. Figure H.2.2-1 illustrates HLW management at SRS. Tables H.2.2-1, H.2.2-2, and H.2.2-3 list HLW inventories and treatment and storage facilities at SRS.

Table H.2.2-1.-- High-Level Wastes at Savannah River Site

Waste Matrix	Number of Waste Streams	Inventory as of September 30, 1994 (m^3)	Number ofWaste Streams Five-Year Projection	Total Generation Five-Year Projection(m^3)
Remote-Handled				
Aqueous liquids, slurries	2	127,040	2	15,430
SR DOE 1995c; WSRC 1995a.				

Table H.2.2-2.-- High-Level Waste Treatment Capability at Savannah River Site

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity [1] (m^3 per year)	Comment
F- and H-Tank Farms	Neutralization dissolution and chemical reaction	HLW aqueous liquid solutions and slurries	HLW aqueous liquid, sludge, and solutions	[2]	Operational

Savannah River Technology Center high activity treatment probe	Ion exchange	HLW aqueous liquid	Mixed LLW liquid and HLW sludge	1,725	Operational
F- and H-evaporators	Evaporation and ion exchange (cesium removal)	HLW aqueous liquid	HLW sludge, salt, slurry, and organic solid	26,900[3]	Operational
Replacement evaporator	Evaporation and ion exchange (cesium removal)	HLW aqueous liquid	HLW sludge, salt, slurry, and organic solid	13,800	Design and construction phase planned for 1999
Defense Waste Processing Facility	Vitrification	HLW and precipitate slurry	HLW borosilicate	18,800	Operational
Extended sludge processing	Soil washing to remove soluble salts, precipitation	HLW sludge	HLW sludge	834	Operational
In-tank precipitation	Soil washing to remove soluble salts, precipitation	HLW salt solution	LLW salt solution and HLW precipitate slurry	Would produce 22,700 m^3 salt solution and 1,900 m^3 precipitate	Operational
Late wash	Washing to remove sodium nitrate	HLW precipitate slurry	HLW precipitate	24,600	Undergoing design and construction

Table H.2.2-3.-- High-Level Waste Storage at Savannah River Site

Storage Unit	Input Capability	Total Capacity[4]	Comment
F- and H-Area Tank Farms[5]	HLW, corrosive, toxic aqueous liquids, salt, and sludge	145,000 m^3	Operational
Defense Waste Processing Facility vitrification plant, glass waste storage buildings	HLW solid borosilicate glass in stainless steel cylinders	2,286 canisters (3.8 t glass)	First unit available December 31, 1995, one building constructed, one more planned

Defense Waste Processing Facility vitrification plant, failed equipment storage	Failed melters	3,720 m^3	

Transuranic Waste. All TRU waste currently being generated is stored in containers on aboveground storage pads in compliance with state regulations and DOE orders. Older TRU wastes (prior to 1965) were buried in plastic bags and cardboard boxes in earthen trenches. Wastes containing more than 0.1 curies (Ci) per package were placed in concrete containers and buried. Wastes containing less than 0.1 Ci per package were buried unencapsulated in earthen trenches. Since 1974, TRU wastes containing more than 10 nCi/g have been stored in retrievable containers free of external contamination. Polyethylene- lined galvanized drums containing more than 0.5 Ci are additionally protected by closure in concrete culverts.

Currently, approximately 85 percent of the TRU waste in storage is suspected of being contaminated with hazardous constituents. Presently, waste is characterized by onsite generators and is being stored prior to final disposal. TRU waste containing less than 100 nCi/g may be disposed of as LLW at SRS. Waste containing greater than 100 nCi/g and meeting the final WIPP Waste Acceptance Criteria will be sent to WIPP, if it is determined to be a suitable repository pursuant to the requirements of 40 CFR 191 and 40 CFR 268. Waste not meeting the acceptance criteria as currently packaged will be repackaged as necessary to meet the WIPP Waste Acceptance Criteria. If additional treatment is necessary for disposal at WIPP, SRS would develop the appropriate treatment technology, or ship this waste to another facility for treatment. Studies are underway to solve the problem of high-heat TRU waste, which is unique to SRS. Wastes with high plutonium-238 fractions generate too much heat to be shipped in the Transuranic Package Transporter (TRUPACT)-II container. TRU waste is currently stored on 17 pads at the Solid Waste Disposal Facility in E-Area. The TRU waste management plan is illustrated in figure H.2.2-2. Table H.2.2-4 lists the mixed TRU waste inventories. Tables H.2.2-5 and H.2.2-6 present the TRU and mixed TRU waste treatment and storage facilities.

Table H.2.2-4.-- Transuranic and Mixed Transuranic Waste at Savannah River Site

Waste Matrix	Number of Waste Streams	Inventory as ofSeptember 30, 1994 (m^3)	Number of Waste StreamsFive-Year Projection	Total GenerationFive-Year Projection(m^3)
Contact-Handled				
Organic liquids	1	<1	0	0
Combustible debris	3	7,693	1	240

Debris	2	199	2	2,613
Ash	1	<1	0	0
Total	**5**	8,162	1	2,853
DOE 1995gg; WSRC 1995a.				

Table H.2.2-5.-- Transuranic and Mixed Transuranic Waste Treatment Capability at Savannah River Site

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[6]	Comment
TRU Waste Characterization/ Certification Facility	Assaying, sorting, decontamination, size reduction, welding, venting, and encapsulation	Mixed and nonmixed TRU wastes	Certified forms for disposal	1,720 m3/yr	Begin operations in 2007
Alpha vitrification	Vitrification	TRU and mixed TRU waste	Certified and stabilized forms for disposal	559 m^3/yr liquid or 2,280 m^3/yr solid	Planned

Table H.2.2-6.-- Transuranic and Mixed Transuranic Waste Storage at Savannah River Site

Storage Unit	Input Capability	Total Capacity (m^3)	Comment
TRU storage pads	Miscellaneous solid TRU waste, extraction procedure toxic, listed	34,400	Operational RCRA Part A. No offsite waste planned. Buried waste to be exhumed, processed at TRU Waste Facility, and shipped to WIPP. Nineteen pads in use, 10 additional pads planned.
SR DOE 1995c; WSRC 1995a; WSRC 1995b.			

Low-Level Waste. Both liquid and solid LLW are treated at SRS. Liquids are managed and processed to remove and solidify the radioactive constituents and to release the balance of the liquids to permitted discharge points in compliance with state regulations. The bulk of liquid waste is aqueous process waste including effluent cooling water, purge water from storage basins for irradiated reactor fuel or target elements, distillate from the evaporation of process waste streams, and surface water runoff from areas where there is a potential for radioactive contamination. Aqueous LLW streams are sent to the Effluent Treatment Facility where they are treated by filtration, reverse osmosis, and ion exchange to remove the radionuclide contaminants. After treatment, the effluent is discharged to Upper Three Runs Creek. The resultant wastes are concentrated by evaporation and stored in the H-Area Tank Farm prior to treatment in the Defense Waste Processing Facility Saltstone Facility. In that facility, they are processed with grout for onsite disposal. Figure H.2.2-3 illustrates the LLW processing at SRS. Treatment and storage facilities for LLW are listed in tables H.2.2-7 and H.2.2-8.

Disposal of solid LLW at SRS traditionally has been accomplished using engineered trenches in accordance with the guidelines and technology existing at the time of disposal. Currently, packaged LLW is deposited in the E-Area vaults, which are concrete structures that meet the requirements of DOE orders, incorporate technological advances, and address more stringent Federal regulations and heightened environmental awareness. Four basic types of vaults/buildings are utilized for the different waste categories: low-activity waste vault, intermediate-level nontritium vault, intermediate-level tritium vault, and long-lived waste storage building. The vaults are below-grade concrete structures, and the storage building is a metal building on a concrete pad. Long-lived waste is being stored until a final disposition can be determined. Additional information on these facilities is given in table H.2.2-9.

Table H.2.2-7.-- Low-Level and Mixed Low-Level Waste Treatment Capability at Savannah River Site

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[7] (m ^{3} per year)	Comment
Consolidated Incineration Facility and Ashcrete Stabilization Facility	Incineration/ stabilization	LLW, mixed LLW, liquid, solid, ash, and slurry	Stabilized LLW, mixed LLW, and solid waste	4,630 (liquid) 17,830 (solid)	Planned, approved, RCRA final, available 1996

F- and H-Areas Effluent Treatment Facility	Neutralization, chemical precipitation, filtration, carbon adsorption, reverse osmosis, ion exchange, evaporation, and mercury adsorption	Mixed LLW, aqueous liquids (F- and H- area wastewater, evaporator overheads and condensate, and cesium removal column effluent)	Corrosive LLW liquid concentrate, treated water effluent used activated carbon, and used ion exchange resins (solid LLW)	1,930,000	Operational, NPDES operating
M-, L-, and H-Area compactors	Compaction	Solid LLW job waste	Compacted LLW	3,983	Operational
Hazardous/Mixed Waste Containment Building	Physical and chemical decontamination, wet chemical oxidation, encapsulation, and amalgamation	Liquids and solids, mixed LLW, toxic, corrosive, reactive, metal, sludge, and debris	Containment facility	703	Planned, approved, begin operation in 2006
Low-level waste smelter	Offsite decontamination	LLW and equipment	Recovered metal	600	Offsite facility
Non-alpha vitrificationfacility	Sorting and vitrification	LLW, mixed LLW, and hazardous wastes	Mixed LLW	3,090	Proposed facility
Offsite mixed wastetreatments	Amalgamation, PCB destruction, acid bath, and smelting	Mixed LLW	Solid LLW	124	Offsite facilities
M-area Liquid Effluent Treatment Facility	Filtration, flocculation neutralization, and precipitation	Liquid mixed LLW	Wastewater, solid mixed LLW, and sludge	999,000	Operational, NPDES: operating

M-Area Vendor Treatment Facility	Vitrification	Aqueous liquids and slurries, mixed LLW, and sludges	Wastewater, solid mixed LLW, and borosilicate glass	2,470	Planned, approved, contract awarded for construction NPDES
Savannah River Technology Center ion exchange treatment probe low activity	Ion exchange	Mixed LLW and aqueous liquids	Aqueous liquid, solid, and mixed LLW	11,200	Operational, RCRA: interim
Soil Sort Facility	Sorting and separating contaminated soils	LLW soil	Low-level contaminated and uncontaminated soil	2,540	Proposed facility
Offsite supercompactor	Compaction	Solid LLW	Compacted solid LLW	42,400	Commercial facilities
Onsite supercompactor	Compaction	Solid LLW	Compacted solid LLW	5,700	Proposed facility
Z-Area Saltstone Facility	Stabilization (solidification with radionuclide binders)	Liquids, mixed LLW, sludges, toxic, corrosive	Solid LLW, nonhazardous	28,400	Operational, permitted disposal, CWA, RCRA: final

Table H.2.2-8.-- Low-Level and Mixed Low-Level Waste Storage at Savannah River Site

Storage Unit	Input Capability	Total Capacity[8] (m^3)	Comment
Burial ground solvent tanks (S23-30)	Liquid mixed LLW	727	To be closed, RCRA Part A
Defense Waste Processing Facility organic waste storage tank (430-S)	Liquid mixed LLW, ignitable, toxic	568	Operational, RCRA Part A
Liquid waste solvent tanks (S33-36)	Liquid mixed LLW	454	Planned facility

M-Area Process Waste Interim Treatment/Storage Facility	Liquid mixed LLW, listed, (electroplate sludge)	8,300	Operational, RCRA Part A
Mixed waste storage buildings (643-29E and 643-43E)	Liquid mixed LLW solid, toxic, listed, ignitable, metal, sludge, soil	1,300	Operational, RCRA Part A
Mixed waste storage shed (316-M)	Liquid and solid mixed LLW	120	Operational, RCRA Part A
Savannah River Laboratory high activity storage tanks (772-2A)	Liquid mixed LLW, toxic, toxicity characteristic teaching procedure	198	Operational, RCRA Part A
Hazardous Waste Storage Facility (645-2N)	Mixed LLW	580	Operational, RCRA Part B
Process waste interim treatment	Liquid mixed LLW	8,300	Operational, RCRA Part A
Long-lived waste storage buildings	Process water deionizers containing carbon 14	3,330	Planned facility

Table H.2.2-9.-- Waste Disposal at Savannah River Site

Disposal Unit	Input Capability	Capacity [9],[10] (m^3)	Comment
Hazardous/mixed waste disposal vaults	Solid mixed LLW and listed (CIF, Ashcrete, blowdown, and vitrified)	45,600	10 vaults are planned and funded, RCRA submitted 1990, available 2002.
Intermediate-level waste vaults	Solid LLW	27,000	2 vaults operational, additional 5 planned
Low activity waste vaults	Solid LLW, compacted waste, contaminated equipment, filters, sediment, job control waste, process beds, soils, resins, and lithium-aluminum melted forms	61,500	1 vault constructed additional 12 planned.

LLW disposal facility, slit trenches	Solid LLW	407,000	58 trenches planned
Z-area saltstone vaults	Solid LLW	1,110,000	2 vaults operational, additional 12 vaults planned

Solid LLW is segregated into several categories to facilitate proper treatment, storage, and disposal. Solid LLW that radiates less than 200 mrem per hour at 5 centimeters (cm) (1.97 inch [in]) from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem per hour at 5 cm (1.97 in), it is considered intermediate-activity waste. This waste is typically contaminated equipment from separations, reactors, or waste management facilities. Intermediate-activity tritium waste is intermediate-activity waste with greater than 10 Ci of tritium per container. Spent lithium-aluminum targets from tritium operations equipment is included in this waste. Long-lived waste is contaminated with long-lived isotopes that exceed the waste acceptance criteria for disposal. Resin contaminated with carbon 14 from reactor operations is an example. Excavated soil from radiological materials areas that is potentially contaminated and cannot be economically demonstrated to be uncontaminated is managed as suspect soil. Solid LLW typically consists of protective clothing, contaminated equipment, irradiated hardware, spent lithium-aluminum targets (from tritium extraction), and spent deionizer resins. All LLW is disposed of in the Solid Waste Disposal Facility in E-Area between F- and H-Areas. Wastes are compacted and packaged for burial. Monitoring wells are located near each disposed waste area to verify performance and to monitor groundwater in the vicinity of the vaults. As of December 1994, the total inventory of LLW disposed of at SRS was 676,400 m3(884,700 yd ^{3}) (DOE 1995gg).

Mixed Low-Level Waste . *Management of mixed wastes includes safe storage until treatment is available.* Mixed LLW is stored in A-, E-, M-, N-, and S-Areas in various tanks and buildings. These facilities include burial ground solvent tanks, the M-Area process waste interim treatment/storage facility, Savannah River Technology Center mixed waste storage tanks, and the organic waste storage tanks. These South Carolina Department of Health and Environmental Control-permitted facilities will remain in use until appropriate treatment and disposal is performed on the waste.

The Hazardous/Mixed Waste Treatment and Disposal Facility and the Consolidated Incineration Facility will process both mixed and hazardous wastes. The mixed waste management plan for SRS, illustrated in figure H.2.2-4, has been reevaluated through the development of a Site Treatment Plan in accordance with the *Federal Facility Compliance Act* of 1992. Mixed waste inventories are listed in table H.2.2-10. Treatment facilities and processes are listed in table H.2.2-7. The capacities and status of the different storage facilities are listed in table H.2.2-8.

Table H.2.2-10.-- Mixed Low-Level Waste at Savannah River Site

Waste Matrix	Number of Waste Streams	Inventory as of September 30, 1994 (m^3)	Number of Waste Streams Five-Year Projection	Total Generation Five-Year Projection (m^3)
Aqueous liquids/ slurries	6	158	8	4,692
Debris	12	4,069	13	3,840
Special waste	4	83	4	32
Homogeneous solids	12	2,726	5	155
Lab packs	1	8	1	5
Organic liquids	3	139	4	587
Soil/gravel	2	17	0	0
Total	40	7,200	35	9,311
DOE 1995gg; WSRC 1995a; WSRC 1995b.				

Hazardous Waste. Typical hazardous wastes at SRS include lead, mercury, cadmium, 1,1,1-trichloroethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents. Figure H.2.2-5 illustrates the processing of hazardous wastes at SRS. Table H.2.2-11 lists hazardous waste storage facilities at SRS. This waste is stored in RCRA-permitted buildings in B-, M-, and N-Areas, and open storage areas located on the asphalt pads within the fenced area of N-Area. DOE started to send hazardous waste offsite for treatment and disposal, but in 1990 imposed a moratorium on shipments of hazardous materials from radiological areas. Waste that is not subject to the moratorium is shipped to an offsite vendor for processing and disposal. SRS annually publishes the SRS Tier Two Emergency and Hazardous Chemical Inventory Report, which lists hazardous chemicals that are present above their minimum threshold level or that are categorized as extremely hazardous substances by the emergency planning Community *Right-to-Know Act* of 1986. The annual reports filed under the *Superfund Amendments and Reauthorization Act* for the SRS facilities include year-to-year inventories of these chemicals.

Table H.2.2-11.-- Hazardous Waste Storage at Savannah River Site

Storage Unit	Input Capability	Capacity (m^3)	Comment
Solid Waste Storage Pads	Containerized solid hazardous wastes only	1,758	
Building 316-M	Containerized hazardous wastes	117	RCRA-permitted interim status

Building 710-B	Containerized hazardous wastes	146	RCRA-permitted interim status
Building 645-N	Containerized hazardous wastes	171	RCRA-permitted interim status
Building 645-4N	Containerized hazardous wastes	426	RCRA-permitted interim status
SR DOE 1995c.			

Nonhazardous Waste. Municipal solid waste generated at SRS is currently being sent to a permitted offsite disposal facility. DOE is evaluating a proposal to participate in an interagency effort to establish a regional solid waste management center at SRS (DOE/EA-0989, DOE/EA-1079).

SRS disposes of other nonhazardous wastes in addition to the nonhazardous wastes disposed of in the sanitary landfill. These wastes consist of scrap metal, powerhouse ash, domestic sewage, scrap wood, construction debris, and used railroad ties.

Scrap metal is sold to salvage vendors for reclamation. Powerhouse ash and domestic sewage sludge are used for land reclamation. Scrap wood is burned onsite or chipped for mulch. Construction debris is used for erosion control. Railroad ties are shipped offsite for disposal. Nonhazardous waste management is illustrated in figure H.2.2-6.

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1 For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

2 Batch process; depends on available tanks and process used.

3 Based on net tank space gained. Input volume. SR DOE 1994b; SR DOE 1995b; SR DOE 1995c; WSRC 1995a; WSRC 1995b.

4 Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

5 Tanks that do not meet secondary containment criteria as described in the Federal Facility Compliance Agreement are not included. SR DOE 1994b; SR DOE 1995c.

6 For facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance. SR DOE 1995c; WSRC 1995a; WSRC 1995b.

7 For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance. SR DOE 1995c; WSRC 1995a.

8 Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance. WSRC 1995a.

9 Schedules and capacities for the facilities under design or construction are subject to changes such as availability of funds and permit issuance.

10 Includes current capacity and projections through 2024. SR DOE 1994b; SR DOE 1995c; WSRC 1995a; WSRC 1995b.

H.2.3 Kansas City Plant

At Kansas City Plant (KCP), stockpile activities for national security result in the generation and management of hazardous, solid industrial, and sanitary wastes. No LLW or mixed LLW are routinely generated. However, operations resulting in the generation of LLW or mixed LLW may occasionally occur. There is no spent nuclear fuel, high-level, and TRU waste associated with the fabrication of nonnuclear components. The manufacturing operations include machining, plastic fabrication, plating, and electrical and mechanical assembly. Past activities associated with the manufacturing of nonnuclear components for nuclear weapons has resulted in some environmental contamination. The principal sources of contamination at KCP resulted from accidental spills and leaks during manufacturing operations. These spills and leaks have contaminated soils with Volatile Organic Carbons (VOCs), PCBs, and petroleum hydrocarbons. KCP is not on the NPL for sites requiring environmental restoration in accordance with CERCLA and SARA. However, there are some remedial actions required per a consent order between DOE and EPA. Pending future funding levels, these remedial actions are scheduled to be completed by 2001.

KCP does not presently dispose of waste onsite, although onsite disposal and leaks/discharges have occurred in the past. On March 6, 1989, EPA requested DOE to enter into a RCRA Section 3008(h) Administrative Order on Consent. On June 23, 1989, DOE and EPA Region VII signed the order. The provisions of the order require DOE to conduct all assessment and remediation activities regulated under the order in accordance with approved environmental restoration remediation schedules.

Pollution Prevention . A formal Waste Minimization and Pollution Prevention Awareness Program has been initiated and is ongoing at KCP to comply with EPA regulations and DOE orders. This program includes coordinating the development, promotion, implementation, and reporting of site-wide waste reduction activities. Activities include establishing site-wide recycling and source reduction programs for all waste streams. Near-term objectives are to reduce the disposal volume of sanitary, hazardous, and LLW streams. KCP will pursue and adopt appropriate processes and programs to minimize and recycle KCP wastes.

Low-Level Waste . KCP typically generates very small quantities of LLW (<1 m^3 /yr). Activities that generate LLW are the disassembly and testing of irradiated components, scheduled replacement of tritium exit signs, removal of used radioactive sources, and general debris (i.e., small amounts of contaminated cleanup towels, disposable gloves, and packing materials) from laboratory and assembly operations. Liquid LLW is solidified and mixed into concrete or plaster of paris for final handling and disposal in accordance with NTS waste acceptance criteria.

LLW is accumulated and stored in two controlled access areas used to store both LLW and mixed waste. LLW is stored onsite until sufficient quantities accumulate to warrant shipment to approved LLW disposal facilities at NTS. The last shipment of solid LLW took place in September 1995. The current inventory of LLW in storage is <1 m^3 .

Mixed Low-Level Waste . KCP currently has no mixed waste in storage. Process changes have been made to control the generation of mixed waste. The potential exists for mixed waste to be generated by changes in conditions in current operations or by new processes being brought into KCP through nonnuclear consolidation or new business. KCP mixed waste would be stored with LLW in a controlled access, RCRA-permitted storage area.

Hazardous Waste. Hazardous waste is generated by a number of activities at KCP and consists of wastes such as acidic and alkaline liquids, solvent, and oils and coolants. Processes such as plating, etching, electronic assembly, metals and plastics machining and forming, and wastewater treatment are the principal generating processes. Waste stream residue generated at KCP that is not reclaimed, treated onsite at the Industrial Wastewater Pretreatment Facility, or recycled, is manifested and shipped under contract with waste transporters to permitted offsite facilities. KCP utilizes processes that do not require a permit under RCRA in order to treat hazardous wastes.

Hazardous wastes are managed in compliance with RCRA requirements as delineated in the Operating Permit issued by the Missouri Department of Natural Resources under the provisions of 40 CFR 270-272. KCP currently operates RCRA interim status waste storage areas for containerized nonradioactive hazardous wastes and bulk storage tanks for nonradioactive hazardous wastes.

The KCP Environmental Restoration Program serves to identify the nature and extent of environmental contamination at inactive waste sites. The site investigations conducted to date have indicated that hazardous waste constituents found in soil and groundwater at KCP are associated with past operations and are found at or near units now considered regulated hazardous waste management and solid waste management units. Site reevaluation visits are conducted by KCP personnel for all treatment, storage, or disposal facilities utilized by KCP.

Waste that requires disposal under TSCA continues to decrease. The primary generation source of PCB wastes over the past 15 years has been equipment upgrades and electrical substation replacement (i.e., replacement of transformers). These projects are now complete, and this category of waste is primarily generated from restoration and remediation projects.

Hazardous waste quantities generated at and subsequently shipped offsite from KCP in 1994 are shown in table H.2.3-1. A summary of the hazardous waste storage facilities is shown in table H.2.3-2.

Table H.2.3-1.-- Hazardous Waste Quantities Shipped Offsite in 1994, Kansas City Plant

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume (m^3)[11]

Aerosols	1	2,480	2.5
Combustible liquid, n.o.s.	5	32,660	32.7
Corrosive liquid, n.o.s.	1	1,720	1.7
Cyanides, inorganic, n.o.s.	1	51	< 0.1
Environmentally hazardous substances, solid, n.o.s.	21	110,297	73.5
Flammable liquids, n.o.s.	4	20,930	20.9
Flammable liquids, poisonous, n. o.s.	1	1,180	1.2
Hazardous waste, liquid, n.o.s.	3	25,100	25.1
Hazardous waste, solid, n.o.s.	33	261,250	174.2
Isocyanate solutions, n.o.s.	1	3,830	3.8
Mercury	1	154	0.1
Polychlorinated biphenyls	3	10,555	7.0
Polychlorinated biphenyls (less than one pound reportable quantity)	5	41,485	27.7

Table H.2.3-2.-- Hazardous Waste Storage Capability at Kansas City Plant

Storage Unit	**Input Capability**	**Design Capacity[12] (m^3)**	**Comment**
2x40 yd^3 waste dumpsters	Solid hazardous waste (construction/D&D asbestos debris)	61.2	Operational; interim status
Acid pad	Liquid and solid hazardous waste (also sludge)	180.0	Operational; interim status
Acid plating waste tank	Liquid hazardous waste (also sludge)	22.7	Operational; interim status
Alkaline plating waste tank	Liquid hazardous waste (also sludge)	22.7	Operational; interim status
Bulk solvent waste tanks	Liquid hazardous waste	60.6	Operational; interim status

Demolition lot	Liquid and solid hazardous waste (also sludge, gas)	668.0	Operational; interim status
L-lot	Liquid hazardous waste	758.0	Operational; interim status
Oil/coolant storage tank	Liquid hazardous waste (also sludge)	30.3	Operational; interim status
PCB waste tank	Liquid hazardous waste (also sludge)	30.3	Operational; interim status
Reclamation area	Liquid and solid hazardous waste (also sludge)	16.0	Operational; interim status
Red-X lot	Liquid and solid hazardous waste (also sludge, gas)	250.0	Operational; interim status
Test cell #1	Solid hazardous waste (cyanide wastes)	82.5	Operational; interim status
Test cell #2	Liquid and solid hazardous waste (also gas)	82.5	Operational; interim status
Test cell #3	Solid hazardous waste (classified wastes)	82.5	Operational; interim status
Test cell #4	Liquid hazardous waste (PCB liquids)	82.5	Operational; interim status
Test cell #11	Liquid and solid hazardous waste (also sludge)	22.5	Operational; interim status

Nonhazardous Waste. Nonhazardous wastes are generated routinely and include general plant refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, etc. Nonhazardous wastes are segregated and recycled, whenever possible. The wastes are transported to a sanitary landfill. Sanitary wastewaters are discharged to the sanitary sewer in compliance with Kansas City, MO, sewer-use ordinance provisions and permit discharge limits. Biomedical waste is incinerated offsite at an incinerator permitted and approved by the Kansas Department of Health and Environment.

KCP also generates wastes that do not meet the definition of hazardous wastes and are not allowed to be incorporated with normal refuse sent to municipal solid waste landfills. These wastes are managed on a case-by-case basis in accordance with applicable regulations or best management practices.

11 For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m^3 for liquids and 1,500 kg/m^3 for solid.
n.o.s. - not otherwise specified.
DOE 1995h.

12 Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, etc.
DOE 1994n; KCP 1995a:4. DOE 1994k. -----------------------------7d418b1250286 Content-Disposition: form-data; name="file10"; filename="C:\workfolder\eis0236\Vol2\H24.htm" Content-Type: text/html

H.2.4 Pantex Plant

This section describes the baseline conditions and specific waste management operations at Pantex. As part of its normal operation, Pantex generates low-level, mixed low-level, hazardous, and nonhazardous wastes. Tables H.2.4-1 and H.2.4-2 present a detailed description of treatment and storage facilities and their estimated capacities.

Table H.2.4-1.-- Waste Treatment Capability at Pantex Plant

Treatment Unit	Treatment Method (s)	Input Capability	Output Capability	Total Capacity[13] (m^3/yr)	Comment
Batch Master Hazardous Waste Tank System (Bldg. 12-68)	Filtration, neutralization, and precipitation	Bldg. 12-5C metal cleaning bath, plating process waste, sodium hydroxide radiator cleaner, and spent electrolyte solutions	Metal precipitates to Hazardous Waste Storage Pad and effluent to wastewater treatment plant	Process as needed	Nonoperational due to pending closure
Building 11-15A	Immobilization	Mixed LLW	To be determined	185	Planned
Building 11-9	Immobilization	Mixed LLW	To be determined	185	Planned

Building 11-9S	Stabilization and macroencapsulation	Mixed LLW and hazardous waste	Sent to hazardous waste treatment and processing facility when completed	2 m^3/treatment	Also used as 90-day accumulation area for hazardous and mixed LLW
Building 11-50 (Wastewater Treatment Facility)	Filtration of organics and undissolved HE particles	HE machining operations	Playa 2	684	
Building 12-43 (HE Filtration Facility)	Filtration of HE and carbon	Explosive machining operations in Building 12-24	Playa 1	180	Sock filter and carbon filter
Building 12-73	Settlement and filtration	HE-contaminated water	Sanitary sewage system	Variable	Settling tank and fabric filter system
Burning Ground: one cage, one tray, and one pan	Open burning or detonation	Solid mixed LLW and hazardous waste	Ash to 11-71X storage pad	909	Design capacity. Interim permit until April 2001.
Closed-loop decon system	Reduction	Contaminated lead (solid mixed LLW)	Acid bath (liquid mixed LLW) to offsite commercial vendor	Campaign	One process per year. Standby mode.
Compactor (Bldg. 12-42)	Hydraulic ram compactor-in-drum compaction	Solid LLW (gloves, kim wipes, paper)	Compacted LLW in 17H 55-gallon drums to storage igloo 4-56	Process as needed	No TRU waste, waste greater than Class C, mixed waste, free liquids, or gases

Hazardous Waste Treatment & Processing Facility	Immobilization repackaging, neutralization compaction, shredding, sorting, and solidification	Liquid and solid LLW, mixed LLW and hazardous waste	To be determined. May be stabilized solids	500	Available for treating mixed waste by 1998
Sanitary Sewage Treatment System	Aeration and anaerobic microbial action	Sanitary sewage and industrial waste	Lagoon (chlorine pretreatment)	2,460,000 L/day	Permitted flow. Operational flow about 1,310,000 L/ day.

Table H.2.4-2.-- Waste Storage Capability at Pantex Plant

Storage Unit	Input Capability	Total Capacity (m^3)[14]	Comment
Buildings 4-46, 4-72 and 4-74	Liquid and solid mixed LLW	187	Permitted capacity pending permit modification. Operating capacity is 120 m^3.
Buildings 11-7A and 11-7B	Liquid and solid mixed LLW	402	Permitted and operating storage capacity.
Building 11-7N Pad	Various liquid/solid hazardous waste, mixed LLW, and LLW	125	Interim permit dated April 19, 1990. Permitted and operating capacity.
Building 11-9N Pad	Various liquid and solid hazardous wastes	379	Permit dated March 1994. Permitted capacity. Operating capacity is 252 m^3.
Conex containers WM-1 to WM-8	Containerized solid mixed low-level and silver photo wastes	575	Permit dated April 1, 1991. Permitted capacity. Operating capacity is 120 m^3.
Conex containers WM-1A, WM-1B, WM-3A, WM-5A, WM-5B	Containerized liquid and solid LLW	377	No plans to receive offsite waste. Permitted capacity pending permit modification. Operating capacity is 75 m^3.

Conex containers (25)	Solid/liquid LLW	1,800	Each Conex can store 72 55-gal drums (15 m^3) for an operating capacity of 375 m^3.
Magazine 4-50	Liquid/solid mixed LLW, hazardous waste, and LLW	421	Final permit dated April 24, 1992. Permitted capacity. Operating capacity is 40 m^3.
Magazine 4-56	Liquid and solid LLW	421	Temporary storage before shipment to NTS. Operating capacity is 40 m^3.
RCRA Hazardous Staging Facility (Bldg. 16-16)	Containerized liquid/solid LLW and mixed LLW	1,050	Permitted capacity. Operating capacity is 333 m^3. Currently under construction.

Pantex's goals regarding the management of LLW, mixed LLW, and hazardous wastes are as follows:

- Minimize the volumes of low-level radioactive and hazardous wastes generated to the extent technologically and economically practicable
- Recycle those wastes using the best available technology
- Minimize contamination of existing or proposed real property and facilities
- Ensure safe and efficient long-term management of all wastes

Pollution Prevention. The Pantex Waste Minimization Program was formed to define an effective waste minimization system for the site. A committee provides awareness of the program, identifies tasks, and provides a liaison between the site and outside entities. Some of this program's accomplishments are listed below:

- Compact 1,200 drums to approximately 250 drums using a compactor
- Separate radioactive and hazardous waste materials when shearing weapons components
- Reclaim oil, antifreeze, and refrigerant
- Substitute a scintillation solution that is nonhazardous
- Reuse explosives and solvents
- Repackage paint into smaller containers
- Substitute naphtha with nonhazardous biodegradable cleaning solutions

Transuranic Waste. No TRU waste or mixed TRU waste is currently generated at Pantex during normal operation. However, there is potential for an off-normal event to generate small amounts of contact-handled TRU waste or mixed TRU waste during a weapon dismantlement activity. Three drums of TRU waste were generated several years ago from an incident during weapon dismantlement. Ultimately, Pantex plans to ship its TRU waste to a DOE-approved storage site when one is available. In the interim, approximately 1 m^3 of TRU waste is temporarily stored in Building 12-42 (DOE 1995gg).

Low-Level Waste. The waste streams for LLW have the following options available for management consideration:

- Continue to ship to an approved DOE disposal site such as NTS
- Compact solid waste, if possible
- Improve computerized tracking of radioactive waste
- Implement an improved segregation program

Solid LLW consists of contaminated parts from weapons A/D functions and waste materials associated with these functions, such as protective clothing, cleaning materials, filters, and other similar materials. The compactible portions of this waste are processed at the Pantex Solid Waste Compaction Facility and staged along with the noncompactible portions for shipment to a DOE-approved disposal site. Table H.2.4-3 lists Pantex's primary LLW streams, how they are generated, primary radioactive constituents, and method of storage or disposal. Table H.2.4-4 presents the inventory of LLW at Pantex as of December 2, 1994. A 5-year projection is also given.

Mixed Low-Level Waste. The waste streams for mixed LLW have the following options available for management consideration:

- Treat to satisfy Land Disposal Restriction requirements and store onsite. This is the option now being used at Pantex (PX DOE 1996b:4-193).
- Treat to satisfy Land Disposal Restriction requirements and ship to an approved commercial facility for storage or disposal.
- Ship offsite for treatment and disposal.

Pantex generates solid mixed LLW during weapons component testing. These wastes consist primarily of depleted uranium and beryllium residue and fragments from explosives components tests, contaminated gravel, cleaning materials, and protective clothing associated with these operations. Other mixed LLW streams include cleaning materials from weapons A/D operations. Table H.2.4-5 lists Pantex's primary mixed waste streams, composition, method of process, and treatment alternatives. Pantex will manage mixed waste in accordance with the Pantex Plant Federal Facility Compliance Act Compliance Plan. Pantex currently has a contract with a commercial facility for mixed waste treatment and/or disposal. Table H.2.4-6 lists organic liquid mixed LLW waste streams that are being evaluated for commercial treatment and/or disposal. Table H.2.4-7 lists the mixed waste storage inventory as of September 1995. Projections for the following 5 years are also included.

Mixed LLW (HE contaminates only) is currently treated at the Burning Ground which has a permitted capacity of 180 m^3/yr (236 yd^3/yr) (DOE 1995gg). The Hazardous Waste Treatment and Processing Facility is being planned to house mixed waste mobile treatment units.

Hazardous Waste. The waste streams for hazardous waste have the following options available for management consideration:

- Continue to ship to approved hazardous waste disposal facilities
- Encapsulate solid waste and ship to an approved DOE disposal site
- Treat onsite to neutralize corrosive wastes

Table H.2.4-8 presents the inventory and 5-year projection for hazardous waste at Pantex as of December 2, 1994. Two facilities treat hazardous waste: the Burning Ground Facility and the Hazardous Waste Treatment Processing Facility. The Burning Ground is an open-burning area where explosives, explosives-contaminated waste, and explosives-contaminated spent solvents are burned, resulting in a large reduction in volume. The Hazardous Waste Treatment and Processing Facility will house liquid-phase and solid-phase hazardous, low-level, and mixed waste processing facilities. The facility has been planned and approved and should be available in 1998 (DOE 1995gg).

Not all of the hazardous waste is treated at Pantex. Table H.2.4-9 shows the amount of hazardous waste shipped offsite in 1994. There are several separate storage facilities for hazardous wastes. At the Hazardous Waste Drum Storage Area, all drums containing liquid are placed in spill-containment pans. The facility is inspected weekly for leaking drums. Small lab samples of hazardous waste are stored in two chemical storage containers in this area. The materials stored there include asbestos, mercury-contaminated wastes, Burning Ground ash, and electroplating sludge. At Building 16-1, used crank case oil is stored underground until sufficient quantities are generated for offsite processing.

Table H.2.4-3.-- Low-Level Waste Streams at Pantex Plant

Sources	Waste Description	Radioactive Constituents	Primary Materials	Disposition
Assembly/ dismantlement operations	Debris from demilitarization and sanitization operations	Thorium, U-238, tritium	Generally noncompactible crushed/granulated plastic and metal debris	Disposed of at DOE-approved offsite facility
Assembly/ dismantlement/ stockpile surveillance	Compactible material from normal assembly/ dismantlement/ stockpile surveillance	U-238, tritium, thorium, and plutonium	Lab wipes and other support materials	Disposed of at DOE-approved offsite facility

Assembly/ dismantlement and stockpile surveillance operations	Radiological materials from normal operations associated with weapons assembly, dismantlement, facility surveillance, container monitoring and routine sample counting operations	U-238, tritium, thorium, and plutonium	Protective clothing, wipes, swipes, tape, plastic and other material in the radiation protection program	Disposed of at DOE-approved offsite facility
Weapon component testing and evaluation	Debris generated during past testing of mock devices associated with any known waste stream	Depleted U-238 residue	Contaminated soil and gravel, additional miscellaneous materials	Stored onsite pending eventual shipment to DOE-approved disposal site
Decontamination products	Materials generated during the decontamination of a concrete assembly work cell (one time generation)	Tritium	Protective clothing, concrete rubble, solidified liquids, tools, equipment, plastic and paper products containing tritium	Stored onsite pending eventual shipment to DOE-approved disposal site
PX DOE 1995i.				

Table H.2.4-4.-- Low-Level Waste Inventory at Pantex Plant

Waste Stream Name	Inventory as of December 2, 1994(m^3)	Total GenerationFive-Year Projection (m^3)
Beryllium waste, radioactive	114	0[15]
Tritium contaminated waste (solid/liquid)	55	179
Lab packs, nonregulated radioactive (solid)	1	1
Contaminated soil	8	0
Waste water	7	9
Contaminated metal, radioactive	2	0.02

Desiccant, radioactive	0.2	22
Plant refuse (paper, foam, rags, cardboard)	105	711
Miscellaneous ash, radioactive	9	0
Total	**301**	**922**

Table H.2.4-5.-- Mixed Low-Level Waste Streams at Pantex Plant

Treatability Group	Waste Stream Name	Composition[16]	Process Description	Treatment Alternatives
Organic liquids	Paint waste - organic liquids	Paint and solvent	Stripping, surface preparation, and repainting	Planning packed bed reactor (Mobile Treatment Unit)
	Spent solvents	Freon, methyl ethyl ketone, High Explosive (HE), and dimethyl sulfoxide	Cleaning dissolution of HE	Planning hydrothermal oxidation (Mobile Treatment Unit or offsite commercial vendor)
	Contaminated liquid	Mercury-contaminated oil	Vacuum pump oil change	Planning packed bed reactor (Mobile Treatment Unit)
Aqueous liquids	Wastewater	Water, HE, chromium, lead	Water-let and thermal shock activities	Planning evaporation oxidation and stabilization (Mobile Treatment Unit)
	Alodine solution	Chromic acid, fluoride salt and iron cyanide	Surface preparation before paint removal	Planning plating waste treatment (Mobile Treatment Unit)
	Metal cleaning waste	Water, alodine, nitric acid, U, Th, cadmium, Cr, Lead, and Hg	Etching and cleaning of metals	Planning plating waste treatment (Mobile Treatment Unit)
Homogeneous solids	Wastewater sludge from explosives	Explosive-contaminated solids, dimethyl sulfoxide	Filtering of wastewater with HE	Open-air burning

	Burning Ground ash	Inorganic ash residue, metals, and some unburned organic material	Burning of HE and HE-contaminated materials	Planning stabilization/ barium sulfate (Mobile Treatment Unit)
	Process residues	Residues resulting from treatment of mixed waste	Waste not generated until onsite mixed waste treatment commences in 2000.	Planning stabilization (Mobile Treatment Unit)
Soils/gravels	ER potential mixed waste (soils)	Contaminated soils from solid waste management units, spill cleanup, drill cuttings, sample wastes, etc.	ER program site contaminated soils	Planning thermal desorption and stabilization
Debris waste	Solvent-contaminated solid material	Alcohol, kimwipes, filters, rags, leads, solvents	Weapon dismantlement and maintenance	Planning macroencapsulation
	Contaminated scrap metal	Contaminated scrap metal from demilitarized and sanitized weapons parts	Demilitarized and sanitation activities	Planning macroencapsulation
	Lead-contaminated waste, solid	Seals and tape intermixed with gloves and paper	Demilitarization and sanitization activities	Planning macroencapsulation
	Mercury-contaminated solids	Glass bulbs, mercury-contaminated solids	Maintenance of lighting	Planning macroencapsulation
	Heterogeneous debris- metal contaminated waste	Metals, alodine, light ballasts, beryllium	Maintenance and special activities	Planning macroencapsulation

	Heterogeneous debris	Solid wipes, gloves, and anti-C suits	Painting, paint removal, maintenance testing, and disarmament activities	Planning macroencapsulation
	Plutonium-contaminated solids	Personnel protective equipment, epoxy, floor sweepings, paint, and paint thinner	Dismantlement operations in Building 12-98	Planning macroencapsulation
	Contaminated explosives and contaminated support materials	Support materials with explosive residue, mercury, and solvents	Assembly/ disassembly process	Planning macroencapsulation
Lab packs	Lab packs	Epoxy, uranium, acid, lead, thorium nitrate crystals	Disposal of chemicals from testing labs	Proposed radiation surveying followed by separation and onsite treatment if unable to reclassify as hazardous
	Miscellaneous organic liquids	Halogenated and nonhalogenated solvents	Paints, solvents, and special product materials storage	Planning hydrothermal oxidation (Mobile Treatment Unit)
	Scintillation fluids	Scintillation fluids packaged with vermiculite	Radioactivity testing	Commercial treatment. Fluids need to be bulked first.
Special wastes	Used batteries	Nickel, cadmium, lead, silver, mercury, and asbestos	Dismantlement activities	Decontaminate and recategorize as hazardous waste
	Lead waste	Portion of lead drum liners	Removal of lead liners	Planning treatment utilizing decontamination. If not successful, then macroencapsulation (Mobile Treatment Unit)

	Aerosol containers	Discarded spray paint cans	General maintenance	Decontamination

Table H.2.4-6.-- Organic Liquid Waste Stream Candidates for Commercial Treatment and/or Disposal

Waste Stream	Quantities of Waste (L)	Treatable Volume(L)	Composition[17]	Process Description
Lab packs[18]	4,030	988	Scintillation vials packed in cardboard boxes in vermiculite	Laboratory waste packages
Organic debris; solvent-contaminated	163	163	Joint test assembly cleanup water, oil, water	Support material
Spent solvent	3,920	1,740	Scintillation vials packed in cardboard boxes in vermiculite; joint test assembly cleanup water; freon with HE	Spent solvents
Mercury-contaminated liquids	492	492	Oil contaminated with mercury	Discarded oil from vacuum pumps in laboratory equipment; source of mercury contamination from samples analyzed in lab equipment
Total	**8,605**	**3,383**		

Table H.2.4-7.-- Mixed Low-Level Waste Inventory at Pantex Plant

Treatability Group	Number of Waste Streams	Inventory as ofMarch 1995 (m^3)	Total Generation Five-Year Projection (m^3)
Aqueous liquids/ slurries	3	2	22
Organic liquids	3	3	2

Homogeneous solids	3	19	29
Soils	1	None	190
Debris waste	8	97	714
Lab packs	3	7	4
Special wastes	3	<1	1
Total	**24**	**128**	**963**
DOE 1995gg.			

Table H.2.4-8.-- Hazardous Waste Inventory at Pantex Plant

Waste Stream Name	Inventory as ofDecember 2, 1994 (m^3)	Total Generation Five-Year Projection (m^3)
Explosive-contaminated solid waste	4	23
Burning Ground waste from thermal treatment	1	7
Lab packs (solid)	0.4	6
Photographic film	0	0.7
Lead waste	0.7	0.08
Spent halogenated and nonhalogenated solvents and mixtures	2	34
Heavy metal contaminated parts	0	0.8
Contaminated soil[19]	0	14,800
Sodium hydroxide waste (solid)	0	8
Paint sludge	2	3
Wastewater from operations and monitoring Contaminated soil[19]	0.4	34
Metal cleaner and photographic waste	0.05	13
Recyclable and nonrecyclable used batteries	0.4	197
Solvent-contaminated solids	3	29
Mercury (solid/liquid)	0	0.01
Sandblasting waste	0.6	1

Lead-contaminated waste	0	0.7
Miscellaneous organics(solid/liquid)	0.4	15
Contaminated engine oil	0.1	2
Oil filter waste	0.02	0.5
Miscellaneous discards contaminated with heavy metals	23	356
Empty organic compressed gas cylinders	0.3	24
Recyclable scrap metal with precious metals	0.2	1
Total	**39**	**15,556**[20]

Table H.2.4-9.-- Hazardous Waste Quantities Shipped Offsite in 1994, Pantex Plant

Description	**Number of Shipments Containing Description**	**Quantity (kg)**	**Estimated Volume**[21] **(m^3)**
Hazardous waste, solid, n.o.s.	9	14,200	9
Corrosive liquids, n.o.s.	2	538	0.5
Flammable liquids, n.o.s.	1	202	0.2
Hazardous waste, liquid, n.o.s.	2	149	0.2
Oxidizing substances, solid, corrosive, n.o.s.	1	166	0.1
Oxidizing substances, solid, poisonous, n.o.s.	1	6	<0.1
Poisonous liquids, n.o.s.	1	28	<0.1

Class 1 non-RCRA hazardous waste includes waters that contain asbestos, PCBs with a concentration greater than 50 parts per million (ppm), and oils with a total petroleum hydrocarbon concentration greater than 1,500 ppm. Table H.2.4-10 presents the Class 1 non-RCRA hazardous waste streams, current inventories as of December 2, 1994, and projected generation volumes. Medical waste is defined as any solid waste that is generated in the diagnosing, treating, or immunizing of human beings or animals, in research, or in producing or testing biologicals. This waste includes cultures and stocks, pathological wastes, human blood and blood products, sharps, animal waste, and isolation wastes. Pantex currently generates approximately two boxes of medical waste per week, each with a capacity of 0.142 m^3 (0.186 yd^3). The annual generation rate of medical waste at Pantex is approximately 15 m^3 (19 yd^3) (PX DOE 1995i: 14-15).

Table H.2.4-10 Class 1 Non-Resource Conservation and Recovery Act Hazardous Waste Inventory at Pantex Plant

Waste Stream	**Inventory as of December, 1994 (m^3)**	**Total Generation Five-Year Projection (m^3)**
Beryllium waste	0	740
Empty Containers	142	985
PCB-contaminated solids	0.05	0.05
Crank case oil	1	260
Asbestos solids	13	24
PCB-contaminated oil	0	0.06
Paint residue	3	53
Contaminated soil[22]	5	2,350
Metal cleaning waste (solid)	0	0.3
Wastewater *Contaminated soil*[22]	24	1,600
Recyclable and nonrecyclable photographic waste	0.02	0.3
Contaminated metal	0.1	0.7
Antifreeze and engine coolants	0.3	337
Desiccant	0	4
Plant refuse, such as paper, foam, rags, and cardboard	51	543
Used oil filters generated during maintenance	3	23
Miscellaneous ash	4	5
Resins, tar, or tarry sludge (excess material from laboratories)	3	36
Total	**249**	**6,961**

Nonhazardous Waste. The Sewage Treatment Quality Upgrade is a project for 1996 at Pantex. This project would upgrade Pantex's sanitary system to ensure that wastewater standards are met through secondary/tertiary treatment. This project includes upgrading the existing treatment lagoon to treat sewage, repairing and replacing existing deteriorated sewer lines, constructing a closed system to eliminate the use of open ditches for conveyance of industrial wastewater discharges, and implementing a plant stormwater management system.

Table H.2.4-11. Class 2 Nonhazardous Waste Disposal in Amarillo Landfill from Pantex Plant

Year	Total Disposal (kg)	Total Volume of Disposal (m^3)
1989	79,600	53
1990	335,000	223
1991	307,000	205
1992	371,000	247
1993[24]	428,000	285
1994	589,000	393
1995-1999 (estimate) [25]	2,610,000	1,740

Class 2 nonhazardous waste (general refuse) is collected at each building from trash cans and placed in dumpsters. This includes cardboard, computer paper, white paper, colored paper, mixed steel, steel and aluminum cans, mixed metal, mixed plastic, foam rubber, and glass. Currently, telephone directories, paper, certain plastics, and some steel and aluminum cans are being recycled. The weights of Class 2 nonhazardous waste disposed of from 1989 to 1994 and the estimated volumes for 1995 through 1999 are given in table H.2.4-11.

DOE 1994n; KCP 1995a:4.

[13] For those facilities already in use this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability funds and permit issuance. DOE 1993h; DOE 1994n; DOE 1995gg; PX DOE 1995i; PX DOE 1996b.

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[15] One-time event, no further generation is expected. PX DOE 1995i.

[16] Typical radionuclides that may be present in the mixed waste include uranium, thorium, and tritium. ER - environmental restoration. DOE 1994k; DOE 1995gg.

[17] Mixed LLW stream may include uranium, thorium, tritium, and plutonium.

[18] Cardboard boxes and vermiculite used to pack scintillation vials will be recontainerized and treated as separate sampling lots. PX DOE 1995i.

[19] These waste streams are primarily associated with environmental restoration activities.

[20] Of this total, about 550 m3 is directly from weapons activities. PX DOE 1995i.

[21] For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m ^{3} for liquids and 1,500 kg/m ^{3} for solids. n.o.s. - not otherwise specified. DOE 1995h.

[22] These waste streams are primarily associated with environmental restoration activities. PX DOE 1995i.

[23] Contract for disposal began in 1989 and included approximately 3 months.

[24] In midyear, recycling was stopped because of low cost effectiveness.

[25] Waste minimization efforts are expected to provide an average reduction of 4 percent each year. PX DOE 1995i. DOE 1994k.

H.2.4 Pantex Plant

This section describes the baseline conditions and specific waste management operations at Pantex. As part of its normal operation, Pantex generates low-level, mixed low-level, hazardous, and nonhazardous wastes. Tables H.2.4-1 and H.2.4-2 present a detailed description of treatment and storage facilities and their estimated capacities.

Table H.2.4-1.-- Waste Treatment Capability at Pantex Plant

Treatment Unit	Treatment Method (s)	Input Capability	Output Capability	Total Capacity[13] (m^3/yr)	Comment
Batch Master Hazardous Waste Tank System (Bldg. 12-68)	Filtration, neutralization, and precipitation	Bldg. 12-5C metal cleaning bath, plating process waste, sodium hydroxide radiator cleaner, and spent electrolyte solutions	Metal precipitates to Hazardous Waste Storage Pad and effluent to wastewater treatment plant	Process as needed	Nonoperational due to pending closure
Building 11-15A	Immobilization	Mixed LLW	To be determined	185	Planned
Building 11-9	Immobilization	Mixed LLW	To be determined	185	Planned
Building 11-9S	Stabilization and macroencapsulation	Mixed LLW and hazardous waste	Sent to hazardous waste treatment and processing facility when completed	2 m^3/ treatment	Also used as 90-day accumulation area for hazardous and mixed LLW
Building 11-50 (Wastewater Treatment Facility)	Filtration of organics and undissolved HE particles	HE machining operations	Playa 2	684	

Building 12-43 (HE Filtration Facility)	Filtration of HE and carbon	Explosive machining operations in Building 12-24	Playa 1	180	Sock filter and carbon filter
Building 12-73	Settlement and filtration	HE-contaminated water	Sanitary sewage system	Variable	Settling tank and fabric filter system
Burning Ground: one cage, one tray, and one pan	Open burning or detonation	Solid mixed LLW and hazardous waste	Ash to 11-71X storage pad	909	Design capacity. Interim permit until April 2001.
Closed-loop decon system	Reduction	Contaminated lead (solid mixed LLW)	Acid bath (liquid mixed LLW) to offsite commercial vendor	Campaign	One process per year. Standby mode.
Compactor (Bldg. 12-42)	Hydraulic ram compactor-in-drum compaction	Solid LLW (gloves, kim wipes, paper)	Compacted LLW in 17H 55-gallon drums to storage igloo 4-56	Process as needed	No TRU waste, waste greater than Class C, mixed waste, free liquids, or gases
Hazardous Waste Treatment & Processing Facility	Immobilization repackaging, neutralization compaction, shredding, sorting, and solidification	Liquid and solid LLW, mixed LLW and hazardous waste	To be determined. May be stabilized solids	500	Available for treating mixed waste by 1998
Sanitary Sewage Treatment System	Aeration and anaerobic microbial action	Sanitary sewage and industrial waste	Lagoon (chlorine pretreatment)	2,460,000 L/day	Permitted flow. Operational flow about 1,310,000 L/day.

Table H.2.4-2.-- Waste Storage Capability at Pantex Plant

Storage Unit	Input Capability	Total Capacity (m^3)[14]	Comment
Buildings 4-46, 4-72 and 4-74	Liquid and solid mixed LLW	187	Permitted capacity pending permit modification. Operating capacity is 120 m^3.
Buildings 11-7A and 11-7B	Liquid and solid mixed LLW	402	Permitted and operating storage capacity.
Building 11-7N Pad	Various liquid/solid hazardous waste, mixed LLW, and LLW	125	Interim permit dated April 19, 1990. Permitted and operating capacity.
Building 11-9N Pad	Various liquid and solid hazardous wastes	379	Permit dated March 1994. Permitted capacity. Operating capacity is 252 m^3.
Conex containers WM-1 to WM-8	Containerized solid mixed low-level and silver photo wastes	575	Permit dated April 1, 1991. Permitted capacity. Operating capacity is 120 m^3.
Conex containers WM-1A, WM-1B, WM-3A, WM-5A, WM-5B	Containerized liquid and solid LLW	377	No plans to receive offsite waste. Permitted capacity pending permit modification. Operating capacity is 75 m^3.
Conex containers (25)	Solid/liquid LLW	1,800	Each Conex can store 72 55-gal drums (15 m^3) for an operating capacity of 375 m^3.
Magazine 4-50	Liquid/solid mixed LLW, hazardous waste, and LLW	421	Final permit dated April 24, 1992. Permitted capacity. Operating capacity is 40 m^3.
Magazine 4-56	Liquid and solid LLW	421	Temporary storage before shipment to NTS. Operating capacity is 40 m^3.
RCRA Hazardous Staging Facility (Bldg. 16-16)	Containerized liquid/solid LLW and mixed LLW	1,050	Permitted capacity. Operating capacity is 333 m^3. Currently under construction.

Pantex's goals regarding the management of LLW, mixed LLW, and hazardous wastes are as follows:

- Minimize the volumes of low-level radioactive and hazardous wastes generated to the extent technologically and economically practicable
- Recycle those wastes using the best available technology
- Minimize contamination of existing or proposed real property and facilities
- Ensure safe and efficient long-term management of all wastes

Pollution Prevention. The Pantex Waste Minimization Program was formed to define an effective waste minimization system for the site. A committee provides awareness of the program, identifies tasks, and provides a liaison between the site and outside entities. Some of this program's accomplishments are listed below:

- Compact 1,200 drums to approximately 250 drums using a compactor
- Separate radioactive and hazardous waste materials when shearing weapons components
- Reclaim oil, antifreeze, and refrigerant
- Substitute a scintillation solution that is nonhazardous
- Reuse explosives and solvents
- Repackage paint into smaller containers
- Substitute naphtha with nonhazardous biodegradable cleaning solutions

Transuranic Waste. No TRU waste or mixed TRU waste is currently generated at Pantex during normal operation. However, there is potential for an off-normal event to generate small amounts of contact-handled TRU waste or mixed TRU waste during a weapon dismantlement activity. Three drums of TRU waste were generated several years ago from an incident during weapon dismantlement. Ultimately, Pantex plans to ship its TRU waste to a DOE-approved storage site when one is available. In the interim, approximately 1 m^3 of TRU waste is temporarily stored in Building 12-42 (DOE 1995gg).

Low-Level Waste. The waste streams for LLW have the following options available for management consideration:

- Continue to ship to an approved DOE disposal site such as NTS
- Compact solid waste, if possible
- Improve computerized tracking of radioactive waste
- Implement an improved segregation program

Solid LLW consists of contaminated parts from weapons A/D functions and waste materials associated with these functions, such as protective clothing, cleaning materials, filters, and other similar materials. The compactible portions of this waste are processed at the Pantex Solid Waste Compaction Facility and staged along with the noncompactible portions for shipment to a DOE-approved disposal site. Table H.2.4-3 lists Pantex's primary LLW streams, how they are generated, primary radioactive constituents, and method of storage or disposal. Table H.2.4-4 presents the inventory of LLW at Pantex as of December 2, 1994. A 5-year projection is also given.

Mixed Low-Level Waste. The waste streams for mixed LLW have the following options available for management consideration:

- Treat to satisfy Land Disposal Restriction requirements and store onsite. This is the option now being used at Pantex (PX DOE 1996b:4-193).
- Treat to satisfy Land Disposal Restriction requirements and ship to an approved commercial facility for storage or disposal.
- Ship offsite for treatment and disposal.

Pantex generates solid mixed LLW during weapons component testing. These wastes consist primarily of depleted uranium and beryllium residue and fragments from explosives components tests, contaminated gravel, cleaning materials, and protective clothing associated with these operations. Other mixed LLW streams include cleaning materials from weapons A/D operations. Table H.2.4-5 lists Pantex's primary mixed waste streams, composition, method of process, and treatment alternatives. Pantex will manage mixed waste in accordance with the Pantex Plant Federal Facility Compliance Act Compliance Plan. Pantex currently has a contract with a commercial facility for mixed waste treatment and/or disposal. Table H.2.4-6 lists organic liquid mixed LLW waste streams that are being evaluated for commercial treatment and/or disposal. Table H.2.4-7 lists the mixed waste storage inventory as of September 1995. Projections for the following 5 years are also included.

Mixed LLW (HE contaminates only) is currently treated at the Burning Ground which has a permitted capacity of 180 m^3/yr (236 yd^3/yr) (DOE 1995gg). The Hazardous Waste Treatment and Processing Facility is being planned to house mixed waste mobile treatment units.

Hazardous Waste. The waste streams for hazardous waste have the following options available for management consideration:

- Continue to ship to approved hazardous waste disposal facilities
- Encapsulate solid waste and ship to an approved DOE disposal site
- Treat onsite to neutralize corrosive wastes

Table H.2.4-8 presents the inventory and 5-year projection for hazardous waste at Pantex as of December 2, 1994. Two facilities treat hazardous waste: the Burning Ground Facility and the Hazardous Waste Treatment Processing Facility. The Burning Ground is an open-burning area where explosives, explosives-contaminated waste, and explosives-contaminated spent solvents are burned, resulting in a large reduction in volume. The Hazardous Waste Treatment and Processing Facility will house liquid-phase and solid-phase hazardous, low-level, and mixed waste processing facilities. The facility has been planned and approved and should be available in 1998 (DOE 1995gg).

Not all of the hazardous waste is treated at Pantex. Table H.2.4-9 shows the amount of hazardous waste shipped offsite in 1994. There are several separate storage facilities for hazardous wastes. At the Hazardous Waste Drum Storage Area, all drums containing liquid are placed in spill-containment pans. The facility is inspected weekly for leaking drums. Small lab samples of hazardous waste are stored in two chemical storage containers in this area. The materials stored there include asbestos, mercury-contaminated wastes, Burning Ground ash, and electroplating sludge. At Building 16-1, used crank case oil is stored underground until sufficient quantities are generated for offsite processing.

Table H.2.4-3.-- Low-Level Waste Streams at Pantex Plant

Sources	Waste Description	Radioactive Constituents	Primary Materials	Disposition
Assembly/ dismantlement operations	Debris from demilitarization and sanitization operations	Thorium, U-238, tritium	Generally noncompactible crushed/granulated plastic and metal debris	Disposed of at DOE-approved offsite facility
Assembly/ dismantlement/ stockpile surveillance	Compactible material from normal assembly/ dismantlement/ stockpile surveillance	U-238, tritium, thorium, and plutonium	Lab wipes and other support materials	Disposed of at DOE-approved offsite facility
Assembly/ dismantlement and stockpile surveillance operations	Radiological materials from normal operations associated with weapons assembly, dismantlement, facility surveillance, container monitoring and routine sample counting operations	U-238, tritium, thorium, and plutonium	Protective clothing, wipes, swipes, tape, plastic and other material in the radiation protection program	Disposed of at DOE-approved offsite facility
Weapon component testing and evaluation	Debris generated during past testing of mock devices associated with any known waste stream	Depleted U-238 residue	Contaminated soil and gravel, additional miscellaneous materials	Stored onsite pending eventual shipment to DOE-approved disposal site

Decontamination products	Materials generated during the decontamination of a concrete assembly work cell (one time generation)	Tritium	Protective clothing, concrete rubble, solidified liquids, tools, equipment, plastic and paper products containing tritium	Stored onsite pending eventual shipment to DOE-approved disposal site
PX DOE 1995i.				

Table H.2.4-4.-- Low-Level Waste Inventory at Pantex Plant

Waste Stream Name	**Inventory as of December 2, 1994(m^3)**	**Total GenerationFive-Year Projection (m^3)**
Beryllium waste, radioactive	114	0[15]
Tritium contaminated waste (solid/liquid)	55	179
Lab packs, nonregulated radioactive (solid)	1	1
Contaminated soil	8	0
Waste water	7	9
Contaminated metal, radioactive	2	0.02
Desiccant, radioactive	0.2	22
Plant refuse (paper, foam, rags, cardboard)	105	711
Miscellaneous ash, radioactive	9	0
Total	**301**	**922**

Table H.2.4-5.-- Mixed Low-Level Waste Streams at Pantex Plant

Treatability Group	**Waste Stream Name**	**Composition[16]**	**Process Description**	**Treatment Alternatives**
Organic liquids	Paint waste - organic liquids	Paint and solvent	Stripping, surface preparation, and repainting	Planning packed bed reactor (Mobile Treatment Unit)

	Spent solvents	Freon, methyl ethyl ketone, High Explosive (HE), and dimethyl sulfoxide	Cleaning dissolution of HE	Planning hydrothermal oxidation (Mobile Treatment Unit or offsite commercial vendor)
	Contaminated liquid	Mercury-contaminated oil	Vacuum pump oil change	Planning packed bed reactor (Mobile Treatment Unit)
Aqueous liquids	Wastewater	Water, HE, chromium, lead	Water-let and thermal shock activities	Planning evaporation oxidation and stabilization (Mobile Treatment Unit)
	Alodine solution	Chromic acid, fluoride salt and iron cyanide	Surface preparation before paint removal	Planning plating waste treatment (Mobile Treatment Unit)
	Metal cleaning waste	Water, alodine, nitric acid, U, Th, cadmium, Cr, Lead, and Hg	Etching and cleaning of metals	Planning plating waste treatment (Mobile Treatment Unit)
Homogeneous solids	Wastewater sludge from explosives	Explosive-contaminated solids, dimethyl sulfoxide	Filtering of wastewater with HE	Open-air burning
	Burning Ground ash	Inorganic ash residue, metals, and some unburned organic material	Burning of HE and HE-contaminated materials	Planning stabilization/ barium sulfate (Mobile Treatment Unit)
	Process residues	Residues resulting from treatment of mixed waste	Waste not generated until onsite mixed waste treatment commences in 2000.	Planning stabilization (Mobile Treatment Unit)

Soils/gravels	ER potential mixed waste (soils)	Contaminated soils from solid waste management units, spill cleanup, drill cuttings, sample wastes, etc.	ER program site contaminated soils	Planning thermal desorption and stabilization
Debris waste	Solvent-contaminated solid material	Alcohol, kimwipes, filters, rags, leads, solvents	Weapon dismantlement and maintenance	Planning macroencapsulation
	Contaminated scrap metal	Contaminated scrap metal from demilitarized and sanitized weapons parts	Demilitarized and sanitation activities	Planning macroencapsulation
	Lead-contaminated waste, solid	Seals and tape intermixed with gloves and paper	Demilitarization and sanitization activities	Planning macroencapsulation
	Mercury-contaminated solids	Glass bulbs, mercury-contaminated solids	Maintenance of lighting	Planning macroencapsulation
	Heterogeneous debris- metal contaminated waste	Metals, alodine, light ballasts, beryllium	Maintenance and special activities	Planning macroencapsulation
	Heterogeneous debris	Solid wipes, gloves, and anti-C suits	Painting, paint removal, maintenance testing, and disarmament activities	Planning macroencapsulation
	Plutonium-contaminated solids	Personnel protective equipment, epoxy, floor sweepings, paint, and paint thinner	Dismantlement operations in Building 12-98	Planning macroencapsulation

	Contaminated explosives and contaminated support materials	Support materials with explosive residue, mercury, and solvents	Assembly/ disassembly process	Planning macroencapsulation
Lab packs	Lab packs	Epoxy, uranium, acid, lead, thorium nitrate crystals	Disposal of chemicals from testing labs	Proposed radiation surveying followed by separation and onsite treatment if unable to reclassify as hazardous
	Miscellaneous organic liquids	Halogenated and nonhalogenated solvents	Paints, solvents, and special product materials storage	Planning hydrothermal oxidation (Mobile Treatment Unit)
	Scintillation fluids	Scintillation fluids packaged with vermiculite	Radioactivity testing	Commercial treatment. Fluids need to be bulked first.
Special wastes	Used batteries	Nickel, cadmium, lead, silver, mercury, and asbestos	Dismantlement activities	Decontaminate and recategorize as hazardous waste
	Lead waste	Portion of lead drum liners	Removal of lead liners	Planning treatment utilizing decontamination. If not successful, then macroencapsulation (Mobile Treatment Unit)
	Aerosol containers	Discarded spray paint cans	General maintenance	Decontamination

Table H.2.4-6.-- Organic Liquid Waste Stream Candidates for Commercial Treatment and/or Disposal

Waste Stream	**Quantities of Waste (L)**	**Treatable Volume(L)**	**Composition[17]**	**Process Description**
Lab packs[18]	4,030	988	Scintillation vials packed in cardboard boxes in vermiculite	Laboratory waste packages

Organic debris; solvent-contaminated	163	163	Joint test assembly cleanup water, oil, water	Support material
Spent solvent	3,920	1,740	Scintillation vials packed in cardboard boxes in vermiculite; joint test assembly cleanup water; freon with HE	Spent solvents
Mercury-contaminated liquids	492	492	Oil contaminated with mercury	Discarded oil from vacuum pumps in laboratory equipment; source of mercury contamination from samples analyzed in lab equipment
Total	**8,605**	**3,383**		

Table H.2.4-7.-- Mixed Low-Level Waste Inventory at Pantex Plant

Treatability Group	Number of Waste Streams	Inventory as ofMarch 1995 (m^3)	Total Generation Five-Year Projection (m^3)
Aqueous liquids/ slurries	3	2	22
Organic liquids	3	3	2
Homogeneous solids	3	19	29
Soils	1	None	190
Debris waste	8	97	714
Lab packs	3	7	4
Special wastes	3	<1	1
Total	**24**	**128**	**963**
DOE 1995gg.			

Table H.2.4-8.-- Hazardous Waste Inventory at Pantex Plant

Waste Stream Name	**Inventory as ofDecember 2, 1994 (m^3)**	**Total Generation Five-Year Projection (m^3)**
Explosive-contaminated solid waste	4	23
Burning Ground waste from thermal treatment	1	7
Lab packs (solid)	0.4	6
Photographic film	0	0.7
Lead waste	0.7	0.08
Spent halogenated and nonhalogenated solvents and mixtures	2	34
Heavy metal contaminated parts	0	0.8
Contaminated soil[19]	0	14,800
Sodium hydroxide waste (solid)	0	8
Paint sludge	2	3
Wastewater from operations and monitoring Contaminated soil[19]	0.4	34
Metal cleaner and photographic waste	0.05	13
Recyclable and nonrecyclable used batteries	0.4	197
Solvent-contaminated solids	3	29
Mercury (solid/liquid)	0	0.01
Sandblasting waste	0.6	1
Lead-contaminated waste	0	0.7
Miscellaneous organics(solid/liquid)	0.4	15
Contaminated engine oil	0.1	2
Oil filter waste	0.02	0.5
Miscellaneous discards contaminated with heavy metals	23	356
Empty organic compressed gas cylinders	0.3	24
Recyclable scrap metal with precious metals	0.2	1
Total	**39**	**15,556 [20]**

Table H.2.4-9.-- Hazardous Waste Quantities Shipped Offsite in 1994, Pantex Plant

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume 21 (m^3)
Hazardous waste, solid, n.o.s.	9	14,200	9
Corrosive liquids, n.o.s.	2	538	0.5
Flammable liquids, n.o.s.	1	202	0.2
Hazardous waste, liquid, n.o.s.	2	149	0.2
Oxidizing substances, solid, corrosive, n.o.s.	1	166	0.1
Oxidizing substances, solid, poisonous, n.o.s.	1	6	<0.1
Poisonous liquids, n.o.s.	1	28	<0.1

Class 1 non-RCRA hazardous waste includes waters that contain asbestos, PCBs with a concentration greater than 50 parts per million (ppm), and oils with a total petroleum hydrocarbon concentration greater than 1,500 ppm. Table H.2.4-10 presents the Class 1 non-RCRA hazardous waste streams, current inventories as of December 2, 1994, and projected generation volumes. Medical waste is defined as any solid waste that is generated in the diagnosing, treating, or immunizing of human beings or animals, in research, or in producing or testing biologicals. This waste includes cultures and stocks, pathological wastes, human blood and blood products, sharps, animal waste, and isolation wastes. Pantex currently generates approximately two boxes of medical waste per week, each with a capacity of 0.142 m^3 (0.186 yd^3). The annual generation rate of medical waste at Pantex is approximately 15 m^3 (19 yd^3) (PX DOE 1995i: $^{14-15}$).

Table H.2.4-10 Class 1 Non-Resource Conservation and Recovery Act Hazardous Waste Inventory at Pantex Plant

Waste Stream	Inventory as of December, 1994 (m^3)	Total Generation Five-Year Projection (m^3)
Beryllium waste	0	740
Empty Containers	142	985
PCB-contaminated solids	0.05	0.05

Crank case oil	1	260
Asbestos solids	13	24
PCB-contaminated oil	0	0.06
Paint residue	3	53
Contaminated soil[22]	5	2,350
Metal cleaning waste (solid)	0	0.3
Wastewater *Contaminated soil*[22]	24	1,600
Recyclable and nonrecyclable photographic waste	0.02	0.3
Contaminated metal	0.1	0.7
Antifreeze and engine coolants	0.3	337
Desiccant	0	4
Plant refuse, such as paper, foam, rags, and cardboard	51	543
Used oil filters generated during maintenance	3	23
Miscellaneous ash	4	5
Resins, tar, or tarry sludge (excess material from laboratories)	3	36
Total	**249**	**6,961**

Nonhazardous Waste. The Sewage Treatment Quality Upgrade is a project for 1996 at Pantex. This project would upgrade Pantex's sanitary system to ensure that wastewater standards are met through secondary/tertiary treatment. This project includes upgrading the existing treatment lagoon to treat sewage, repairing and replacing existing deteriorated sewer lines, constructing a closed system to eliminate the use of open ditches for conveyance of industrial wastewater discharges, and implementing a plant stormwater management system.

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Year	Total Disposal (kg)	Total Volume of Disposal (m^3)
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1995-1999 (estimate) [25]	2,610,000	1,740

Class 2 nonhazardous waste (general refuse) is collected at each building from trash cans and placed in dumpsters. This includes cardboard, computer paper, white paper, colored paper, mixed steel, steel and aluminum cans, mixed metal, mixed plastic, foam rubber, and glass. Currently, telephone directories, paper, certain plastics, and some steel and aluminum cans are being recycled. The weights of Class 2 nonhazardous waste disposed of from 1989 to 1994 and the estimated volumes for 1995 through 1999 are given in table H.2.4-11.

DOE 1994n; KCP 1995a:4.

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[17] Mixed LLW stream may include uranium, thorium, tritium, and plutonium.

[18] Cardboard boxes and vermiculite used to pack scintillation vials will be recontainerized and treated as separate sampling lots. PX DOE 1995i.

[19] These waste streams are primarily associated with environmental restoration activities.

[20] Of this total, about 550 m3 is directly from weapons activities. PX DOE 1995i.

[21] For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m^3 for liquids and 1,500 kg/m^3 for solids. n.o.s. - not otherwise specified. DOE 1995h.

[22] These waste streams are primarily associated with environmental restoration activities. PX DOE 1995i.

[23] Contract for disposal began in 1989 and included approximately 3 months.

[24] In midyear, recycling was stopped because of low cost effectiveness.

[25] Waste minimization efforts are expected to provide an average reduction of 4 percent each year. PX DOE 1995i. DOE

1994k.

H.2.5 Los Alamos National Laboratory

Laboratory research activities at LANL result in the generation of TRU, mixed TRU, mixed low-level, low-level, hazardous, and nonhazardous wastes. Wastes are treated, stored, and disposed of both on and offsite. LANL is not listed on the NPL. As a function of obtaining a RCRA permit, however, the Hazardous and Solid Waste Amendments of 1984 mandate that permits for treatment, storage, and disposal facilities include provisions for corrective action to mitigate releases from facilities in operation and to clean up contamination in areas designated as solid waste management units at LANL. LANL does not generate or manage HLW. The site does manage a small amount of spent nuclear fuel originating from the Omega West Reactor. This spent nuclear fuel is in temporary storage at the Chemistry and Metallurgy Research Complex awaiting shipment to SRS for long-term storage.

Pollution Prevention. Radioactive, hazardous, and mixed wastes are treated, stored, or disposed of at LANL. The total amount of waste generated and disposed of at LANL has been, and is being, reduced through the efforts of the pollution prevention and waste minimization programs at the site. The LANL Waste Minimization and Pollution Prevention Program is an ambitious program aimed at source reduction, product substitution, recycling, surplus chemical exchange, and waste treatment. The program is tailored to meet Executive Order 12780, DOE orders, and RCRA and EPA guidelines. All wastes at LANL, including radioactive, mixed, hazardous, and nonhazardous regulated waste, are included in the LANL Pollution Prevention Program. Reductions in the volumes of radioactive wastes generated have been achieved through methods such as intensive surveying, waste segregation, recycling, and use of administrative and engineering controls.

Transuranic Waste. The primary source of LANL liquid TRU waste is the processing of caustic and acidic wastes by the Plutonium Facility (Technical Area [TA]-55). Treatment of liquid TRU wastes yields a solid TRU waste and a liquid LLW that is further treated at TA-50. The pretreatment facility consists of storage and neutralization tanks, a clariflocculator and filter tanks, two precipitate storage tanks, and an in-drum cement mixing area. Lime and/or iron sulfate are added to the liquid TRU stream, resulting in a precipitate containing over 99.9 percent of the plutonium and americium. The precipitate is mixed with cement in drums to form the solid TRU waste. Variations in waste volumes and radioactive content result primarily from program changes, facility D&D activities, and general cleanup programs for laboratory areas.

The TRU waste size reduction facility at LANL is designed to repackage and reduce the volume of various types of metallic waste items such as glove boxes, process equipment, and ductwork. The items are processed in the disassembly/cutting area where attached combustible items are removed and where a plasma torch cuts it into smaller pieces for packaging. The pieces are placed into accepted WIPP containers, then sealed for storage at TA-54, Area G.

LANL has managed solid TRU waste at TA-54, Area G, since approximately 1957. Solid TRU and mixed TRU wastes are stored above ground on asphalt pads at TA-54, Area G. Membrane-covered fabric dome enclosures provide weather protection and prevention of run-on. Drums stored on pallets and fiberglass-reinforced, polyester-coated crates are fitted with skids to maintain them above the floor. Additional TRU container storage units are located within permanent structures at TA-3 and TA-55. These units support R&D activities and are not intended for long-term storage of mixed TRU waste. High-activity or remote-handled TRU wastes are placed in shafts at TA-54, Area G.

In January 1993, the New Mexico Environment Department issued Compliance Order 93-03, which required LANL to retrieve TRU wastes from aboveground earth-covered Pads 1, 2, and 4 and manage them in accordance with requirements of 40 CFR 264, Subpart I. Pursuant to the December 1993 Consent Agreement, LANL has initiated the TRU Waste Inspectable Storage Project to provide for retrieval and inspection of the wastes and replacement in new aboveground storage domes at TA-54, Area G.

In addition, LANL completed the Preconceptual Study for EPA in September 1994 to identify short- and long-term storage needs for mixed TRU waste. This study recommended constructing eight new storage domes for TRU waste at Area G by the year 2000. The domes will have the same structural design and operational capabilities as existing structures. However, based on estimates of anticipated TRU and mixed TRU waste generation, this design may not provide sufficient capacity for all wastes by the year 2000. New requirements for fire protection are being evaluated to determine whether they will further reduce available storage capacity by reducing aisle space.

Most of LANL's TRU waste is currently stored on four asphalt pads, all designated as RCRA interim status storage units. TRU wastes are currently being stored, pending the outcome of WIPP to serve as a repository for these wastes. Assuming WIPP is determined to be a suitable repository for these wastes, pursuant to the requirements of 40 CFR 191 and 40 CFR 268, these wastes will be treated to meet WIPP Waste Acceptance Criteria and packaged in accordance with DOE, NRC, and DOT requirements for transport to WIPP for disposal. The TRU Retrieval Tension Support Dome project will retrieve approximately 16,900 containers of TRU waste from three storage pads. Drums will be cleaned and inspected for corrosion and leakage. Extensively damaged drums and drums containing liquids will be overpacked. Drums which are not overpacked may have HEPA filters installed to prevent the potential for accumulation of hydrogen gas in the drum headspace during storage. All of the drums and crates will be reconfigured in six temporary storage domes erected exclusively for the storage of this waste.

Mixed TRU waste represents the majority of the mixed waste stored at LANL, accounting for approximately 80 percent of the total volume of TRU waste. All mixed TRU waste has been characterized by process knowledge. Some of the waste requires remote-handling during waste management. The regulatory status of stored mixed TRU waste can be broken down into three categories: (1) facilities that meet RCRA storage requirements; (2) facilities designed prior to and subject to RCRA but not in compliance with current storage requirements; and (3) facilities designed and operated prior to RCRA and subject to RCRA.

LANL has identified approximately 7,690 m3 (10,000 yd3) of mixed TRU waste in storage (DOE 1995gg). Mixed TRU waste has been stored since 1971. The hazardous components of TRU waste are not well defined. Activities to improve characterization of mixed TRU waste are the subject of a revised waste analysis plan that was submitted to the New Mexico Environment Department in March 1995. Activities to improve storage of these wastes are the subject of a separate compliance order. The preferred option to meet Federal Facility Compliance Act requirements follows the DOE national policy on mixed TRU waste, which is shipment to WIPP. Table H.2.5-1 provides information about the mixed TRU waste streams at LANL that are expected to go to WIPP.

The LANL TRU Waste Certification Plan specifies all required information for certification. This information on certifiable/certified TRU waste that is required for transportation, for completion of the WIPP data package, and for certification is supplied by the waste generator. Uncertified waste packages, primarily stored in drums and crates, will be repackaged and treated when possible to meet the WIPP Waste Acceptance Criteria. Table H.2.5-2 describes the current and planned TRU and mixed TRU waste treatment capability at LANL. Table H.2.5-3 shows TRU and mixed TRU waste storage at LANL.

Special modes have been created for storing high beta-gamma active hot-cell wastes (remote-handled TRU wastes), for wastes containing more than 1 gram of plutonium-238, and for the TRU cement paste previously generated at the TA-21 Liquid Waste Treatment Plant. The hot-cell waste is handled remotely and stored in modified shafts. Because the waste is actually below ground during storage, little additional shielding is needed. The storage array currently employed is compatible with the remote-handled canister now approved for WIPP disposal.

The following LANL facilities treat TRU wastes:

- *Radioactive Liquid Waste Treatment Technical Area 50 (TA-50, Room WM-66).* This facility consists of holding/accumulation, neutralization, precipitation, settling, immobilization, and certification for aqueous wastes. The sludge produced is dewatered to 30- to 40-percent solids, placed in lined 208-L (55-gal) drums, and forwarded to TA-54, Area G for storage.
- *Plutonium Facility Solidification (TA-55).* This facility immobilizes liquid and particulate process residues in cement. The solidified product from the process is WIPP-certifiable TRU waste. It is sent to TA-54, Area G for storage.
- *Size Reduction Facility (WM-69).* This facility is designed to repackage and reduce the volume of various types of metallic waste items such as glove boxes, process equipment, and duct work.
- *Drum Preparation Facility.* This facility would be used to clean retrieved drums of TRU waste. Modifications are currently in final design. Drums coated with a "grease" to enhance long-term storage capability would be steam-cleaned and integrity checked before transfer to the waste preparation or transportation facilities. A RCRA Part B Permit application has been submitted to operate the facility. At the present time, there are no drums being cleaned in the drum preparation facility.
- *Transuranic Waste Treatment Facility.* This is a planned but not funded facility. The multiprocess facility would be used for processing LANL legacy TRU waste to meet WIPP certification requirements. Hot-cell capability would exist to process remote-handled waste. The facility would handle currently generated wastes from present and future environmental restoration/corrective actions; and legacy waste from storage and previously treated wastes.

The following LANL facilities store TRU wastes:

- *TA-54-153, TA-54-48 Transuranic Storage Pad (Building 153).* This unit is a steel frame tension support structure on a curbed asphalt pad. It would be used for damaged fiberglass reinforced plastic coated boxes once retrieved from the current storage configurations. Initial repairs would be made to the containers prior to shipment to onsite processing facilities. This unit is 95 percent full.
- *Corrugated Metal Pipe Storage (Pit 29).* This waste stream is no longer generated at LANL. During 1986, the 158 TRU corrugated metal pipes stored at TA-21, Area T, were retrieved, decontaminated, and moved to TA-54, Area G, for storage. They were placed horizontally in the upper layer of Pit 29. Accepted waste streams are corrugated metal pipes and cemented sludge.
- *Storage Holding Shed (MD-8).* This unit is used for TRU waste. This unit is RCRA-permitted, but currently does not have any waste stored in it.
- *TRU Shafts (Various).* High beta-gamma active TRU hot-cell wastes are handled remotely and stored in modified shafts. Because the waste is below ground during storage, little additional shielding is needed.
- *TRU Storage Pads (Pads 1, 2, 4, Pit 9).* Drums are stacked with other TRU wastes on asphalt pads and covered with 1 to 2 m (3 to 7 ft) of earth backfill.
- *TRU Storage Trenches (Trenches A, B, C).* Through 1985, the high activity plutonium-238 wastes were routinely packaged in 114-L (30-gal) drums and placed in concrete casks for storage. Drums of combustible and noncombustible waste were placed in separate casks. The casks were sealed with asphalt and then covered with earth.
- *New Domes, TA-54-224, 283.* Operational soon.

Low-Level Waste. Both liquid and solid LLW are generated and managed at LANL. In 1993, approximately 2,694 m3 (3,524 yd ^{3}) of solid LLW were generated (as packaged for treatment, storage, and disposal, not including process wastewater). LLW process wastewater generation in 1993 was 21,400 m3. Liquid LLW is generated from many areas throughout LANL. Major generators are the Chemistry-Metallurgy Building (TA-3), TA-21 Site, Radiochemistry (TA-48), and Plutonium Processing (TA-55). LANL has two onsite liquid LLW treatment facilities. The liquid LLW treatment facilities include a chemical treatment and ion-exchange plant and a 132,659 m3/yr chemical treatment plant. Significant waste-generating processes for solid LLW are concentrated in nine TAs: TA-2, Omega Site; TA-3, South Mesa (mainly the Chemistry and Metallurgy Research Building and the Sigma Complex); TA-21, DP-Site; TA-35, Ten-Site; TA-46, WA-Site; TA-48, Radiochemistry Laboratory; TA-50, Waste Management Site; TA-53, Meson Physics Facility; and TA-55, Plutonium Facility.

Solid LLW, such as paper, plastic, glassware, and rags, are separated into compactible and noncompactible materials by the waste generators. Compactible waste is solid waste that consists of trash-type materials such as paper, plastic, rubber, and small items of glassware and small items such as short lengths of pipe conduit and small pieces of wood or sheet metal. Excluded are larger noncompactible items, waste chemicals, free or absorbed liquids, biological waste, pressurized containers, powders, and other particularly hazardous materials.

LLW noncompactible items such as large equipment and much of the D&D wastes generally are not packaged but delivered to the burial site in covered or enclosed vehicles. Short-term storage may occur at treatment or disposal facilities to accumulate a required quantity of waste for an operation to be conducted effectively. Area G, situated in Mesita del Buey in TA-54, is the active burial and storage site for solid LLW at LANL. The area has been used since 1957. Burial facilities within the area include pits and shafts of varying dimensions. Most solid LLW waste generated at LANL is buried in large pits ranging in size from 122 to 183 m (400 to 600 ft) long, 8 to 30 m (26 to 98 ft) wide, and 8 to 20 m (26 to 66 ft) deep. The current disposal facility has a remaining capacity of 22,000 m^3 (28,770 yd^3). At current operational generation rates and implementation of waste minimization, Area G has an operational life of 10 years. However, if environmental restoration activity cleanups are accelerated as presently planned, Area G will reach its useful design life by the end of 1997. Continued construction at Area G is dependent on decisions made in conjunction with the LANL Site-Wide EIS and DOE Waste Management PEIS. As an alternative to the continued construction at Area G, LANL is exploring other options for the disposal of LLW in the future (e.g., NTS) (DOE 1995q:NM 23).

Mixed Low-Level Waste. Under the Federal Facility Compliance Act, DOE is required to develop a site treatment plan for mixed wastes at LANL. The site treatment plan is intended to bring LANL into compliance with land disposal restrictions storage prohibitions under the New Mexico Hazardous Waste Act and RCRA. On March 31, 1995, DOE submitted its proposed site treatment plan to the New Mexico Environment Department for review, public comment, and approval. On October 4, 1995, a Compliance Order was issued by the State of New Mexico requiring LANL to comply with the site treatment plan for the treatment of mixed wastes at LANL. The Compliance Plan Volume of the site treatment plan provides overall schedules for achieving compliance with the RCRA storage and treatment requirements, a schedule for the submittal of applications for permits, construction of treatment facilities, technology development, offsite transportation for treatment, and the treatment of mixed wastes in full compliance with the New Mexico Hazardous Waste Act and RCRA. An annual update to the site treatment plan is required.

LANL has approximately 600 m3 (785 yd3) of mixed LLW in storage. The waste is made up of just over 5,000 separate items that have been combined into 30 treatability groups, each with a preferred treatment option as shown in table H.2.5-4. LANL just completed recharacterizing the mixed LLW as required by the Federal Facility Compliance Agreement; the recharacterization resulted in a significant decrease in the volume reported in past documentation. Over 1,200 mixed LLW items (approximately 14 m3 [18.3 yd3]) are suspect for radioactive contamination. A field sort, survey, and decontamination operation will determine whether or not these wastes are contaminated with radioactivity. If not, they will be treated at commercial offsite facilities. If contaminated, they will be handled with the preferred option identified for that treatability group.

Five-year projections estimate that approximately 108 m3 (141 yd^3) of mixed LLW would be generated at LANL. Almost all of this waste would result from small-scale R&D projects. Each project would be reviewed for waste minimization and waste treatment, storage, and disposal requirements.

The large variety and relatively small volumes of waste require a substantial array of treatment options. Table H.2.5-5 summarizes LLW and mixed LLW treatment capability at LANL. The treatment of mixed LLW is built around two major components: using offsite commercial treatment or treatment available at other DOE sites, and mixed waste treatment skids that are being designed to treat onsite hazardous and mixed waste streams that are not amenable to offsite treatment. LANL has one existing facility designed to treat mixed waste, the lead decontamination trailer.

A commercial lead decontamination unit has been purchased and located at TA-50. The treatment process is applicable to lead shapes with surface contamination. The unit would be used to decontaminate lead bricks to allow recycling by using an abrasive slurry of water, blasting media, and air. A lead sulfide sludge would be produced which would be solidified for disposal.

The scintillation vial crusher is a standard crusher with a vibrating screen to separate the broken vial glass from the liquid waste. This unit crushes the vials allowing separation of the vial from the liquid. The glass is disposed of as LLW, and the liquid is collected for further treatment. The unit does not rinse vial solid residues.

The following LANL facility would treat mixed LLW:

- *Reactive Waste Treatment.* A wet chemical process would be used to handle reactive mixed wastes, including pyrophoric uranium, sodium metal, and lithium hydride. The process would create a nonhazardous metal salt that would be solidified. Feed materials are limited to chips and powders. Pieces must be smaller than 0.3 m (1 ft) in diameter.

Table H.2.5-6 describes mixed LLW storage at LANL. Table H.2.5-7 summarizes waste disposal at LANL. LANL currently has 1,700 drum equivalents of mixed LLW in storage at TA-54, Areas G and L. Additional container storage facilities exist to support research activities at other areas at the laboratory including TAs -3, -16, -21, -50, and -55. Wastes are stored in compliance with 40 CFR 265 (and, in some cases, Part 264) requirements. To comply with the Federal Facility Compliance Agreement, schedules to complete facility upgrades that address 40 CFR 264 permitted standards and/or identified best management practices were submitted to EPA in September 1994. Several upgrades have been completed. For TA-55, a Part B Permit application addressing storage requirements under 40 CFR 264 is currently in development.

The storage of mixed wastes at Areas L and G complies with requirements of 40 CFR 265, Subpart I, the interim management standards that currently apply to these units. LANL believes that the Area G storage facility also generally complies with the requirements of 40 CFR 264. Both facilities are being upgraded, as necessary, to comply with 40 CFR Part 264 requirements before the permit is issued for these units, which is not anticipated to occur before 1998.

The following LANL facilities are used for storage of mixed LLW:

- *Low-Level Waste Shaft (Shaft 145)*. Tritiated waste (>20 mCi/m3 [740 MBq/m3]) has been placed in asphalt lined or encapsulated drums and then placed in shafts lined with corrugated metal pipe at Area G. This shaft has been removed from the RCRA Permit and is no longer considered a mixed waste shaft. Shaft 145 is now an LLW shaft.
- *Lead Stringer Shafts (Shaft 35)*. The shafts are 9.14 m (30 ft) deep by 1.83 m (6 ft) in diameter and lined with corrugated pipe located at Area L. The stringers are approximately 7.62 m (25 ft) by 0.15 m (0.5 ft) by 0.2 m (0.7 ft) hollow steel columns filled with a concrete/lead mixture. The wastes were generated at Los Alamos Meson Physics Facility.
- *TA-21-61*. Used during the 1980s for storage of PCB wastes, this building has a large diked area for waste storage. The floor is sealed with an epoxy paint. In 1990, two drums of liquid mixed LLW were stored in this facility. In 1991, the RCRA Part A application was modified identifying this facility as an interim status storage facility for mixed LLW. No mixed LLW are presently stored in this facility. LANL anticipates closing this unit in 1996.
- *Mixed Waste Dome*. Solid mixed LLW is stored primarily at Area G in Building 49. This facility contains a bermed (curbed) asphalt pad with a tension support dome structure (18.29 m by 134.11 m) (60 ft by 440 ft).
- *Area L Gas Cylinder Storage*. The RCRA Part B application for this facility was approved November 9, 1989. Accepted waste streams are legacy waste compressed gas cylinders.
- *Mixed Waste Berm*. Liquid mixed LLW is stored at TA-54, Area L. This storage area has an approximate 378,540-L (100,000-gal) capacity.

Hazardous Waste. LANL produces a wide variety of hazardous wastes. Small volumes of all chemicals listed under 40 CFR 261.33 could be generated as a result of ongoing research. Primary laboratory sites for basic and applied chemistry R&D generate typical chemical wastes consisting primarily of laboratory reagent chemicals, pump oil, solvents, test samples, and miscellaneous laboratory wastes. Significant volumes of beryllium, lithium hydride, and magnesium turnings are generated from the main shop department. Plating solutions containing chromates and cyanides, acid or base wastes heavily contaminated with copper, and nitric and sulfuric acid wastes are also generated. All developer, ferric chloride, and sodium hydroxide hazardous wastes are sent out of state for incineration. Fixer photo-wastes undergo metals recycling for silver and other precious metals. Nearly all of LANL's chemical waste is treated at commercial offsite facilities, but LANL does perform volume reduction for some waste (e.g., crushing scintillation vials) and treatment of barium sands. In the future, these hazardous wastes, which cannot be handled by commercial facilities, will be treated at yet to be determined offsite locations. Table H.2.5-8 shows hazardous waste quantities shipped offsite from LANL in 1994. Table H.2.5-9 lists LANL hazardous waste treatment capability. Table H.2.5-10 describes LANL hazardous waste storage capability.

HE waste is generated during processing and testing of various HE materials. Processing, which includes pressing, machining, and casting HE, produces pieces of HE, chips, machine cuttings, and powder. The chips, cuttings, and powder usually are in the form of waterborne suspensions, collected in specially designed accumulating and settling sump tanks. Wastes also consist of materials contaminated with HE: paper, oils, solvents, wood, machine tools, fixtures, and so forth. Chemically the wastes consist of cyclotetramethylenetetranitramine, cyclotrimethylenetrinitramine, trinitrotoluene, pentaerythritoltetranitrate, triaminotrinitrobenzene, ammonium nitrate, barium nitrate, boric acid, nitrocellulose, tetryl, nitroguanidine, and various plastic binders.

All HE hazardous wastes and potentially contaminated HE waste are picked up and delivered to the TA-16 (S-Site) incinerator or flash pad where it is burned. Treated ash residue that is nonhazardous is disposed of in the industrial non-RCRA landfill, TA-54, Area J. Any residue with hazardous constituents remaining is shipped offsite to a commercial RCRA-permitted disposal facility.

HE wastewater is treated by gravity settlement in a sump and then discharged from NPDES-permitted outfalls. Initially, there were 21 such outfall discharges from widespread TAs that process HE. Waste minimization efforts have reduced the number of outfalls from 21 to 2. Dissolved constituents are not removed by this treatment. As a result, there are often compliance issues associated with the NPDES permit. LANL is under Administrative Order from EPA to treat all HE wastewater by 1997, and LANL has agreed to this requirement. To meet this obligation, LANL is developing a HE wastewater treatment facility that will collect and treat these wastewaters with stepped filtration. The ultimate goal for this facility is zero discharge with complete recycling of the system water. Construction is scheduled for completion in 1997 (DOE 1995q:NM 22).

All hazardous waste treatment, storage, and disposal facilities at LANL are either fully permitted, have interim status, or are operating pursuant to enforceable agreements with the regulators while other waste management facilities are being developed. LANL does not landfill RCRA hazardous waste onsite, but contracts with certified transporters to deliver hazardous waste to commercial RCRA-permitted disposal facilities. Before waste is sent offsite, the potential disposal facility is inspected by LANL personnel. Operating records and permits are also reviewed. LANL has an EPA Letter of Authorization allowing disposal of PCB-contaminated articles at the TA-54, Area G Landfill.

TA-54, Area L, is the waste transfer, packaging, and storage unit for accumulating, packaging, and greater-than-90-day storage of RCRA hazardous waste. Concrete containment structures and modular storage buildings are located at Area L. These facilities are used for accumulating, packaging, and storing waste containers generated throughout LANL. Hazardous waste containers generated at the various laboratories are routinely delivered to the waste transfer, packaging, and storage facilities.

Thermal Treatment Facilities at Technical Area-16. Four types of open burn units are at the TA-16 burning ground: a flash pad, where any HE contamination is removed from excess equipment or scrap generated within the TA; two burn pads for destruction of solid HE material; a pad with trays in which HE-contaminated waste oil is burned; and two pressure vessels for reacting HE-contaminated sludge.

The flash pad area is covered with sand. Material to be flashed is placed on the pad with any necessary additional fuel to maintain the burn until all HE has been reacted. The scrap material is then handled as solid nonhazardous waste. Because the burn pad sand may contain toxic characteristic barium, it is put in drums, stored, and managed as a hazardous waste until sampling and analysis are complete. Burn pad sand that is toxic characteristic for barium is treated at TA-54, Area L, to render it nonhazardous.

The two burn pads are used to destroy solid chunks of excess or off-specification HE and machine turnings. The material is placed on a sand-filled steel table lined with refractory brick and then ignited. Used oil and/or solvent that may be contaminated with HE is poured into metal trays lined with fire brick. The trays are in a sand-filled metal tray. The oil is ignited using a remotely operated "electric match." Approximately 374 L (99 gal) of oil are burned each month.

HE-contaminated washwater is collected in sumps at HE fabrication facilities in several TAs. HE settles out of the washwater, is collected in a vacuum truck, and is taken to TA-16 for treatment. Up to 1,650 kg (3,638 lbs) of sludge can be burned in the pressure vessels at one time. Processing liquid effluent is sent to a nearby carbon-filter wastewater treatment unit (TA-16). Treated effluent is regulated by an NPDES permit.

Thermal Treatment Facilities at Technical Areas -14, -15, -36, and -39 . Open detonation sites for destruction of excess or waste HE are at TAs -14, -15, -36, and -39. These sites are used routinely to detonate scrap HE, failed experimental detonations, unneeded classified explosives shapes, and small quantities of reactive chemicals. These sites consist of detonation points on the open ground, often in a small canyon. Material to be detonated is placed on sand or on a wooden table at the firing point and detonated with a remote firing mechanism.

Industrial Incinerator at Technical Area 16. A baffled single-chamber industrial incinerator, equipped for combustion of potentially HE-contaminated trash and machine oil, is located outdoors in the northeastern part of TA-16. The incinerator burns potentially HE-contaminated paper, cardboard, wooden boxes, and occasionally a limited volume of potentially HE-contaminated machine oil. The industrial incinerator does not burn wastes other than those permitted by 40 CFR 264.340(b)(i), (ii), (iii), or (iv) [NMHWMR 206.D.8a(2)(a)(i), (ii), (iii), or (iv)]. Emissions from the incinerator conform to Federal and state standards.

Nonhazardous Waste. Nonhazardous wastes are generated routinely and include general facility refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, and dirt and rubble. In 1993, 5,453 m3 (7,132 yd3) of solid nonhazardous wastes were generated by LANL (LANL 1994b:6). Nonhazardous wastes are segregated and recycled whenever possible. Trash is accumulated onsite in dumpsters, which are emptied on a regular basis by a commercial waste disposal firm and taken to the county sanitary landfill.

Solid sanitary waste generated by LANL is currently disposed of at the Sandia Canyon Site (TA-61) on East Jemez Road. Owned by DOE, this site serves the landfill needs of both LANL and Los Alamos County. Approximately one-third of the domestic solid waste disposed of at the county landfill originates from LANL. The county has operated this landfill under a Special Use Permit from DOE since 1971. The existing sanitary landfill is expected to reach the end of its useful life by 2008. At that time, either a new landfill will have to be constructed or provisions made for offsite disposal.

Administratively controlled waste is not regulated by RCRA and TSCA but is deemed by LANL to be inappropriate for disposal at the Los Alamos County sanitary landfill. Examples are classified computer equipment, magnetic tapes, or any wastes controlled for national security purposes. These wastes are disposed of in the Area J solid waste landfill at TA-54, which is regulated by the New Mexico Solid Waste Bureau, as is the sanitary landfill. Future plans for disposal will depend on the future strategy for sanitary waste disposal. If not, an alternative site will be identified when Area J reaches capacity (DOE 1995q:NM 24).

A new LANL Sanitary Wastewater Treatment Plant and Collection System have been completed to replace 7 existing wastewater treatment facilities and 30 existing septic tanks. The new treatment plant enables reuse of the treated wastewater for nondrinking water uses such as cooling and irrigation. The plant and collection system is designed to meet the requirements of LANL's existing Federal Facility Compliance Agreement.

Waste Category
Mixed scrap metal
Cemented process sludge
Solidified aqueous waste
Combustible debris
Noncombustible debris
Solidified inorganic and organic process solids
Glove box and ducting metallic waste
Mixed scrap metal
Noncombustible debris
Metallic waste
Total
DOE 1995gg.

Table H.2.5-1.-- Mixed Transuranic Wastes for Disposal at the Waste Isolation Pilot Plant at Los Alamos National Laboratory

Storage Locations	Storage Method	RCRA Code	Inventory as of December 31, 1994 (m^3)	Projected Generation (1995-1999) (m^3)
TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (retrievably buried)	D008	2,206.38	25

TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	D007 D008, D009, F001, F002, F005	3,052.97	100
TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	F001	1,277.42	100
TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (retrievably buried)	D007,D008, D019, D040, F001, F002, U080	252.43	125
TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	D008, D019, D040	213.06	125
TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	D006, D007, D008, D019, D021, D039, F001, F002, F003	527.65	150
TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	D007, D008	142.46	100
TA-54 Area G Remote shafts	Remote shafts	D008	2.12	8
TA-54 Area G Remote shafts	Remote shafts	D008	15.84	8

TA-54 Area G Pad 1,2, and 4	Container (covered)	D008	0.567	No future generation
			7,690.897	**741**

Treatment Unit
Plutonium Facility solidification (TA-55)
Pretreatment Plant (Rm. WM-66, TA-50-1)
Size Reduction Facility(WM-69)
TRU Waste Treatment Facility
Radioactive liquid waste treatment (TA-50-1)
Radioactive Liquid Waste Treatment Plant
Drum Preparation Facility

TCLP - Toxicity Characteristic Leaching Procedure. DOE 1994k.

Table H.2.5-2.-- Transuranic and Mixed Transuranic Treatment Capability at Los Alamos National Laboratory

Treatment Method	Input Capability	Output Capability	Design Feedrate	Comment
Encapsulation	Liquid, solid and sludge mixed TRU waste, TRU waste, hazardous waste. Solid type: filters, glass, metal, paper, plastic, rags, rubber, corrosive, listed, reactive, TCLP	Solid mixed TRU and TRU cement; corrosive, listed, reactive, TCLP. Contact-handled shielded containers to TA-54, Area G storage	0.08 m^3/hr	Operational; the solidified product from the process is WIPP certifiable TRU

Liquid/solid separation, sedimentation, neutralization, precipitation	Liquid mixed TRU waste. Specific waste: listed, corrosive, TCLP. Contact-handled	Liquid TRU to Radioactive Liquid Waste Treatment (TA-50-1), TRU sludge-solidified (cement) to Certified Waste Pad storage. Specific Waste: listed, corrosive, TCLP. Contact-handled	5.70 m^3/hr	Operational
Size reduction	Solid mixed TRU waste, TRU waste, LLW. Solid type: equipment, filters, glass, metal, other, paper, plastic, rags, rubber	Size reduced TRU metal to storage LANL TA-54, Area G; TRU certified mixed waste and certified TRU waste to storage Certified Waste Pad	1.36 m^3/hr	Operational
Decontamination, solidification, repackaging, shredding, size reduction	Solid and sludge mixed TRU waste, TRU waste. Solid type: filters, glass, labpack, metal, paper, plastic, rags, rubber. Specific waste: corrosive, reactive, TCLP. Contact-handled and remote-handled	Solid and sludge mixed TRU waste, TRU waste. Solid type: filters, glass, labpack, metal, paper, plastic, rags, rubber. Specific waste: TCLP. Contact-handled and remote-handled TRU certified mixed waste and TRU certified waste disposal to WIPP	Planned	Planned but not funded Date available: January 1, 2000

Adsorption, liquid/solid separation, coagulation, filtration, neutralization, precipitation	Liquid mixed TRU waste, LLW, corrosive	Liquid sludge, mixed LLW, LLW. Specific waste: listed liquid effluent to storage; vacuum filter sludge to storage	30 m^3/hr	Operational; NPDES Permit
Neutralization, precipitation	Liquid mixed TRU waste, mixed LLW, LLW, hazardous waste, corrosive	Gas, liquid, sludge, solid mixed TRU waste, TRU waste, mixed LLW, LLW, hazardous waste, sanitary waste Solid LLW to disposal TA-54; Solid TRU to storage TA-54; Solid TRU to disposal WIPP	600 m^3/hr	Planned but not funded. Date available: January 1, 2004. Will replace the existing treatment plant, TA-50-1, including the pretreatment plant which cannot realistically be modified or upgraded to meet expected ES&H requirements
Decontamination	Solid mixed TRU waste, TRU waste, hazardous waste. Solid type: Construction/D&D debris, equipment, filters, glass, metal, paper, plastic, rags, rubber, soil. Specific waste: reactive, listed, ignitable, TCLP, corrosive	Liquid, solid and sludge mixed TRU waste, TRU waste, LLW	0.50 m^3/hr	Operational

Storage Unit
Certified waste pad
TRU storage pad 1
TRU storage pad 2
TRU storage pad 4

Storage holding shed, MD-8
TRU storage trench A
TRU storage trench B
TRU storage trench C
TRU shafts
TRU storage pad, pit 9
Short-term enhanced storage
Corrugated metal pipes storage, pit 29
New TRU storage pad, Bldg. 153

Table H.2.5-3.-- Transuranic and Mixed Transuranic Waste Storage at Los Alamos National Laboratory

Input Capability	Design Capacity[26] (m^3)	Comment
Solid mixed TRU waste, TRU waste, hazardous waste. Solid type: glass, metal, paper, plastic, rags, rubber, soil. Specific waste: corrosive, ignitable, listed, reactive, TCLP. Contact-handled	570	Operational
Solid and sludge mixed TRU waste, TRU waste; metal, other; listed, TCLP.	Under evaluation per LANLsite treatment plan	Operational
Solid and sludge mixed TRU waste, TRU waste; hazardous waste; other; ignitable, listed, TCLP	Under evaluation per LANLsite treatment plan	Operational
Solid and sludge mixed TRU waste, TRU waste; hazardous waste; other; listed, TCLP	3,000	Operational
Solid mixed TRU waste, TRU waste, hazardous waste. Specific waste: corrosive, ignitable, listed, reactive, TCLP. Contact-handled	6.25	Operational
Solid mixed TRU waste, TRU waste, hazardous waste. Specific waste: corrosive, ignitable, listed, reactive, TCLP	Under evaluation per LANL site treatment plan	Operational
Solid mixed TRU waste, TRU waste, hazardous waste. Specific waste: corrosive, ignitable, listed, reactive, TCLP	Under evaluation per LANL site treatment plan	Operational

Solid mixed TRU waste, TRU waste, hazardous waste. Specific waste: corrosive, ignitable, listed, reactive, TCLP	Under evaluation per LANL site treatment plan	Operational
Solid mixed TRU waste, TRU waste. Solid type: equipment, glass, metal, paper, plastic, rags, rubber, soil. Specific waste: listed. Contact-handled, remote-handled	357	Operational
Solid and sludge mixed TRU waste, TRU waste, hazardous waste. Specific waste: listed, TCLP	Under evaluation per LANL site treatment plan	Operational
Solid mixed TRU waste, TRU waste. Specific waste: listed, TCLP. Remote-handled	Under evaluation per LANL site treatment plan	Planned and funded
Solid and sludge mixed TRU waste, TRU waste, hazardous waste. Specific waste: listed. Contact-handled	418.81	Operational
Solid mixed TRU waste, TRU waste, hazardous waste. Solid type: equipment, filters, glass, metal, paper, plastic, rags, rubber, soil. Specific waste: listed. Contact-handled	570	Operational

Treatability Group
IPA wastes
Scintillation fluids
Lead blankets
Soil with heavy metals
Environmental restoration soils
Aqueous organic liquids
Halogenated organic liquids
Nonhalogenated organic liquids
Bulk oils
Polychlorinated biphenyls wastes with *Resource Conservation and Recovery Act* components
Organic-contaminated combustible solids
Combustible debris
Aqueous wastes with heavy metals
Corrosive solutions
Aqueous cyanides, nitrates, chromates, and arsenates

Water-reactive wastes
Compressed gases requiring scrubbing
Compressed gases requiring oxidation
Organic-contaminated noncombustible solids
Elemental mercury
Activated or inseparable lead
Noncombustible debris
Inorganic solid oxidizers
Lead wastes
Mercury wastes
Compressed gases
Biochemical laboratory wastes
Dewatered treatment sludge
Nonradioactive or suspect waste items
Surface-contaminated lead
Lead requiring sorting
Total
LANL 1995a.

Table H.2.5-4.-- Mixed Low-Level Waste Streams at Los Alamos National Laboratory

Number of Items	Net Volume (m^3)	Projected Net Volume (1995-2000) (m^3)	Preferred Option	Alternate Option	Treatment Site
104	15.89	0.01	Commercial thermal treatment	Hydrothermal	offsite
18	2.47	4.0	Commercial thermal treatment	Hydrothermal	offsite
4	0.74	0.2	Commercial treatment	Macroencapsulation	offsite
59	10.53	2.0	Commercial treatment	Chelator extraction	offsite
36	39.32	unknown	Commercial treatment	Macroencapsulation	offsite
45	1.65	0.5	Evaporative oxidation	Hydrothermal	onsite
385	16.58	5.5	Hydrothermal	DETOX process	onsite
275	14.34	10.0	Hydrothermal	DETOX process	onsite
28	3.75	3.0	Hydrothermal	DETOX process	onsite
4	0.74	0.2	Hydrothermal	DETOX process	onsite

307	28.32	7.0	Thermal desorption	Under evaluation per LANL site treatment plan	onsite
83	13.82	1.5	Macroencapsulation	Under evaluation per LANL site treatment plan	onsite
203	1.85	1.0	Chemical plating waste skid	Evaporative oxidation	onsite
162	1.36	0.5	Chemical plating waste skid	Evaporative oxidation	onsite
15	0.13	0.01	Chemical plating waste skid	Evaporative oxidation	onsite
78	6.03	0.2	Water-reactive metals skid	Under evaluation per LANL site treatment plan	onsite
13	0.35	0.1	Gas scrubbing skid	Under evaluation per LANL site treatment plan	onsite
6	0.08	0.1	Gas oxidation skid	Under evaluation per LANL site treatment plan	onsite
80	7.82	8.0	Thermal desorption	Under evaluation per LANL site treatment plan	onsite
45	0.5	0.05	Amalgamation	Under evaluation per LANL site treatment plan	onsite
74	15.6	1.0	Macroencapsulation	Under evaluation per LANL site treatment plan	onsite
41	5.62	3.0	Macroencapsulation	Under evaluation per LANL site treatment plan	onsite
55	0.2	0.05	Hydrothermal	Under evaluation per LANL site treatment plan	onsite

186	51.44	10.0	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
63	18.3	25.5	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
10	1.25	2.0	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
9	1.34	unknown	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
1,288	268.17	unknown	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
1,250	14.24	9.5	Sort, survey, and decontaminate	Appropriate treatment	onsite
125	56.2	12.5	Lead decontamination trailer	Under evaluation per LANL site treatment plan	onsite
48	9.97	0.0	Sort based on treatment	Under evaluation per LANL site treatment plan	onsite
5,099	608.61	107.9			

26 Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, and so forth. New shafts and domes can be built as needed.

Only one half of the 64-acre site is used for aboveground storage.

DOE 1994k.

DOE 1994k.

H.2.6 Lawrence Livermore National Laboratory

The DOE Oakland Operations Office is the field organization responsible for the implementation of waste management plans at Lawrence Livermore National Laboratory (LLNL). The LLNL Hazardous Waste Management Division is responsible for preparing those plans. The Division is also responsible for processing all hazardous wastes, radioactive wastes, and mixed wastes generated at both the Livermore Site and Site 300. The Livermore Site and Site 300 do not generate or manage spent nuclear fuel or HLW. Both the Livermore Site and Site 300 are on the NPL for sites requiring environmental restoration in accordance with CERCLA and SARA. Because there is no spent nuclear fuel, HLW, or TRU waste associated with any of the proposed activities at the Livermore Site and Site 300 (secondary and case fabrication, HE fabrication, nonnuclear fabrication, NIF, and CFF), there will be no further discussion in this appendix of spent nuclear fuel, HLW, or TRU waste generation and management at the Livermore Site and Site 300.

Pollution Prevention. The *Waste Minimization and Pollution Prevention Awareness Plan* published on April 25, 1994, documents LLNL projections for present and future waste minimization and pollution prevention. The plan specifies those activities and methods used to reduce the quantity and toxicity of wastes generated at the site.

Low-Level Waste. LLNL has a relatively large inventory of noncertified LLW that must be characterized, certified, and disposed of. Most of this waste was generated between 1988 and 1993 and consists of roughly 7,000 drum equivalents. An ongoing multiphase project will ultimately conclude with the disposal of the entire LLNL legacy LLW inventory. This project includes the preparation of a waste disposal addendum to the LLNL waste disposal application that will cover legacy waste and any waste certification procedures.

Aqueous LLW is treated at Building 514, the Liquid Waste Treatment Facility. At the facility, containerized and bulk radioactive liquid wastes are transferred into one of the six 7,000-L (1,850-gal) tanks to be treated chemically. The tanks are used to treat both radioactive and mixed waste liquids. Following treatment, if the tank's contents are below established sewer discharge limits, the liquid is released to the sanitary sewer. The precipitate wastes from the chemical treatments are filtered to create a filter cake. The filter cake is then stabilized. Captured filtrate is either discharged to the sanitary sewer or retreated.

No liquid LLW is generated at Site 300. Most Site 300 solid LLW is generated from the detonation of test assemblies on firing tables. The debris consists of gravel and fragments of wood, metal, and glass; larger debris consists of tent poles and pieces of wood, steel, aluminum, concrete, plastic, glass, burlap bags, cables, and other inert testing materials. These parts are contaminated with depleted uranium and sometimes, thorium. Firing table operations have also periodically generated wastes containing tritium. LLW, including the gravel from firing table operations, is packaged in approved waste containers and transported to Building 804 for staging, pending shipment to the Livermore Site or shipment directly to NTS for disposal.

Mixed Low-Level Waste. Current inventories of mixed LLW at LLNL total approximately 457 m^3 (598 yd^3). Schedules for waste treatment vary by waste stream. Mixed waste (other than wastewater, which is treated at Building 514) is appropriately packaged and stored at the Area 514 complex or the Area 612 complex, pending establishment of a suitable onsite or offsite facility that can dispose of such waste according to applicable regulations. Descriptions of mixed waste treatment options, inventory, treatment, disposal and storage facilities for LLW, and mixed LLW are listed in tables H.2.6-1, H.2.6-2, and H.2.6-3.

Some mixed waste can be chemically or physically treated at LLNL. Existing treatment for mixed wastes includes neutralization, flocculation, chemical reduction and oxidation, precipitation, separation, filtration, solidification, size reduction, shredding, adsorption, and blending. Mixed wastes are currently treated in the Building 513 Solidification Unit, the Area 514 Wastewater Filtration Unit, and the Area 514 Wastewater Treatment Tank Farm Unit.

LLNL has requested regulatory agency approval to add centrifugation and evaporation treatment units, as well as to increase current treatment operations for mixed wastes. Also, mixed wastes are stored in appropriate units at the Livermore Site for extended periods until they can be shipped to an approved offsite treatment and/or disposal facility. Although LLNL does not have current existing treatment units to treat its organic liquid mixed waste, it is planning to develop treatment technology for these waste streams.

The matrices of the mixed LLW to be generated in the future include aqueous liquid, homogeneous solids, organic and inorganic debris, organic liquids, reactive metals, elemental lead, high efficiency particulate air (HEPA) filters, and elemental mercury. The aqueous liquid and homogeneous solids waste streams are projected to each generate 92 percent of the mixed LLW. Organic liquids will account for almost 3 percent of the future volume and the organic/inorganic debris is projected to account for approximately 4 percent of the mixed LLW. Reactive metals, elemental lead, HEPA filters, and elemental mercury account for the remaining 1 percent.

Soils from environmental restoration activities may contain low-level radioactivity (primarily tritium and some depleted uranium at Site 300) mixed with low concentrations of VOCs and possibly some metals (i.e., cadmium, lead, chromium, copper, nickel, zinc, beryllium, and mercury) in the soil matrix. The waste would primarily be generated during drilling operations and minor excavations. Environmental restoration drilling activities at LLNL are likely to occur through 1998. The generation rate of wastes from LLNL drilling is estimated to be 20 to 50 drums per year, or approximately 17 to 42 m^3 (22 to 55 yd^3) through 1998 (LLNL 1995h:6-2).

At Site 300, liquids (groundwater) from developing, testing, and purging wells that contain tritium and VOCs as the primary contaminants could potentially be generated. The total estimated volume of potential liquid mixed waste is less than 18,927 L/yr (5,000 gal/yr). This would correspond to 76 m^3 (100 yd^3) through 1998 (LLNL 1995h:6-2). Future generation of mixed waste at Site 300 is not anticipated.

Hazardous Waste. As a research facility, LLNL generates a variety of hazardous wastes, many in relatively small quantities. Almost all buildings generate hazardous wastes, ranging from common household items such as fluorescent light tubes, batteries, and lead-based paint to solvents, metals, cyanides, toxic organics, pesticides, asbestos, and PCBs. Table H.2.6-4 lists hazardous waste quantities shipped offsite from LLNL in 1994.

LLNL presently operates five hazardous waste management facilities. These are the Area 514 Facility, Area 612 Facility, Building 233 Facility, Building 693 Facility, and Building 419 Facility. The Area 514 and 612 facilities include treatment and storage units for hazardous and mixed wastes; the Building 233 facility is a container storage unit for hazardous and mixed wastes; the Building 693 Facility is a container storage unit for hazardous wastes, but will eventually be used for the storage of both hazardous and mixed wastes; and the Building 419 Facility includes inactive treatment units that are awaiting regulatory closure.

LLNL is currently operating its hazardous waste management activities under the interim status standards of the California Code of Regulations, Title 22, Part 66265. A RCRA Part B Permit application has been submitted to the State of California for continued operation, and a final permit is expected in 1996. Under interim status, LLNL receives hazardous and/or mixed wastes from Site 300.

Site 300 operates two hazardous waste management units. These units are only used for the treatment and long-term storage (i.e., greater than 90-day storage) of hazardous wastes. The Building 883 container storage area is a covered storage area on the southwest side of Building 883. The facility is designed primarily to hold hazardous waste before it is transferred to the Area 612 Facility at LLNL for treatment, storage, and disposal or sent directly offsite for disposal. It is currently permitted under the RCRA Part B Permit for Site 300. Table H.2.6-5 lists hazardous waste quantities shipped offsite from Site 300 in 1994.

Table H.2.6-1. Mixed Low-Level Waste Streams at Lawrence Livermore National Laboratory

Waste Description	Source Description	Inventory as of January 1995(m^3)	Total Generation 1995-1999 Projection (m^3)	Treatment Option
Organic fluids and glass	Changing R&D activities which provide liquid organic fluids in glass vials	5.5	5	Treating or plan to treat onsite

Filter cake	Rotary drum vacuum filtration of LLNL wastewaters (Building 514)	105.9	110	Treating or plan to treat onsite
Inorganic trash	Changing R&D activities which generate cleanup trash and used safety equipment such as coveralls	8.7	7	Treating or plan to treat offsite
Wash waters	Laboratory-wide R&D	68.1	1,350	Treating or plan to treat onsite
Inorganic sludges and particulates	Onsite retention tank cleaning and surface spill cleanup	2.8	5	Treating or plan to treat onsite
Scrap metal	Onsite research and maintenance including lab	15.2	5	Treating or plan to treat offsite
Lead bricks	Used and discarded lead bricks which may have been used for shielding purposes	3.9	5	Treating or plan to treat offsite
Halogenated solvent	From/by phase separation from onsite waste water treatment processes	7.1	10	Treating or plan to treat onsite
Oils	Waste oils skimmed by phase separation from onsite waste water treatment processes	3.6	8.5	Treating or plan to treat onsite
Soil-1	Soil excavated from onsite trenching activities	10.1	10	Treating or plan to treat onsite
Lithium metal	Used and discarded laboratory waste from changing R&D activities	1.0	1.0	Treating or plan to treat onsite

Oils	Draining of vacuum pumps. Onsite R&D activities which use halogenated solvents	13.7	20	Treating or plan to treat onsite
HEPA filters	Generated by onsite research activities and facility maintenance	3	15	Treating or plan to treat offsite
Organic liquids	Changing biomedical and nuclear chemistry R&D activities	0.3	1	Treating or plan to treat onsite
Inorganic trash-3	Changing research and laboratory cleanup activities	50.7	50	Treating or plan to treat offsite
Lab packs with metals	Onsite R&D activities	0.8	1.5	Treating or plan to treat offsite
Metal chips and coolant	Depleted uranium turnings and chips from machining operations	3.2	unknown	Treatment options still being assessed
Contaminated soils	Waste generated from equipment maintenance	6.6	30	Treating or plan to treat onsite
Liquid mercury waste	Equipment maintenance	0.09	0.05	Treating or plan to treat offsite
Stabilized sludges and particulates	Sludges from tank bottoms and equipment cleanout that have been solidified/stabilized with cement	141.3	125	Treating or plan to treat onsite
Organic sludges and particulates	Sump waste, lab sink waste, dip tanks, etc.	1.2	5	Treating or plan to treat onsite
Other reactives	Contaminated equipment and containerized waste generated from onsite R&D activities	4.4	1	Treatment options still being assessed

Total		**457.19**	**1,765**	
DOE 1995gg.				

Table H.2.6-2. Low-Level Waste and Mixed Low-Level Waste Treatment Capability at Lawrence Livermore National Laboratory

Treatment Unit	**Treatment Method**	**Input Capability**	**Output Capability**	**Total Capacity[1] (m^3/yr)**	**Comment**
Building 513 shredding unit	Shredding, size reduction	Solid mixed LLW	Solid mixed LLW to Area 612 container storage units	5.5×10^6 kg/yr	RCRA Part A interim status; Closure date: 2009
Building 612 drum/container crushing unit	Size reduction	Solid mixed LLW	Solid mixed LLW (crushed empty drums) to Area 612 container storage unit	1.248×10^6 kg/yr	Permits: District Air; RCRA Part A interim status; Closure date: 2004
Area 514-1 cold vapor evaporation unit	Evaporation neutralization	Liquid mixed LLW	Liquid mixed LLW to Area 514 wastewater filtration	7,495	Permits: District Air; RCRA Part A interim status; Closure date: 2011
Area 514-1 centrifugation unit	Centrifugation separation	Liquid mixed LLW	Liquid mixed LLW to Area 514 wastewater filtration	7,495	Permits: District Air; RCRA Part A interim status; Closure date: 2011

Area 514 wastewater filtration unit	Filtration	Liquid mixed LLW	Solid mixed LLW to Area 612 container storage unit	3,731	Permits: RCRA Part A interim status; Closure date: 2004
Area 514 Wastewater Treatment Tank Farm	Liquid/solid separation, ion exchange, neutralization; leaching, oxidation, carbon adsorption, precipitation; deactivation, reduction, flocculation	Liquid mixed LLW	Liquid mixed LLW to Area 514 wastewater filtration	7,495	Permits: RCRA Part A interim status; Closure date: 2004
Area 514-1 carbon adsorption unit	Carbon adsorption, solvent extraction	Liquid mixed LLW	Liquid mixed LLW to Area 514 wastewater filtration	7,495	Permits: District Air; Closure date: 2011
Area 514-1/ portable blending unit	Neutralization blending, flocculation	Liquid mixed LLW	Mixed LLW to Area 514 wastewater filtration	7,495	Permits: District Air; Closure date: 2011
Area 514-1/tank blending unit	Neutralization blending, flocculation	Liquid mixed LLW	Mixed LLW to Area 514 wastewater filtration	7,495	
Building 513 solidification unit	Solidification neutralization stabilization, immobilization	Liquid mixed LLW, solid mixed LLW	Solid mixed LLW to Area 612 container storage units	1,347	RCRA Part A interim status; Closure date: 2004

Building 612 size reduction unit	Size reduction, decontamination	Solid mixed LLW	Solid mixed LLW (size reduced) to Area 612 container storage units	1 x 10^6kg/yr	RCRA Part A interim status; this unit replaces the size reduction unit in building 419. Closure date: 2011
Decontamination and Waste Treatment Facility	Will replace areas 514 and 612 using same type treatment methods	Liquid mixed LLW, solid mixed LLW; liquid LLW; solid LLW	**Not determined**	Not determined	The RCRA Part B permit application has not been submitted yet. This is a planned facility.

Table H.2.6-3. Low-Level Waste and Mixed Low-Level Waste Storage at Lawrence Livermore National Laboratory

Storage Unit	Input Capability	Design Capacity[2] (m^3)	Comment
Receiving, segregation, and container storage (Area 612-4)	Liquid mixed LLW; solid mixed LLW	180.1	Container storage-RCRA Part A interim status; Closure date: 2009
Building 513 container storage unit	Solid mixed LLW	60	Container storage-RCRA Part A interim status; Closure date: 2004
Building 625 container storage unit	Liquid mixed LLW; solid mixed LLW	80.28	Container storage-RCRA Part A interim status; Closure date: 2009

Building 612 container storage unit	Liquid mixed LLW; solid mixed LLW	145.9	Container storage-RCRA Part A interim status; Closure date: 2009
Building 614 west cells container storage	Liquid mixed LLW; solid mixed LLW	2.55	Container storage-RCRA Part A interim status; Closure date: 2004
Area 514-2 container storage unit	Liquid mixed LLW; solid mixed LLW	39.4	Container storage-RCRA Part A interim status; Closure date: 2009
Area 514-1 container storage unit	Liquid mixed LLW; solid mixed LLW	53.4	Container storage-RCRA Part A interim status; Closure date: 2009
Area 514 storage tank (514-R501 unit)	Liquid mixed LLW; liquid hazardous waste	84.5	Tank storage-RCRA Part A interim status; Closure date: 2004
Area 514-3 container storage unit	Liquid mixed LLW; solid mixed LLW	83.47	Container storage-RCRA Part A interim status; Closure date: 2009
Area 612 tank trailer storage unit	Liquid mixed LLW	19	Tank storage-RCRA Part A interim status; Closure date: 2009
Area 612-1 container storage unit	Solid mixed LLW	1,086.4	Container storage-RCRA Part A interim status; Closure date: 2004
Area 612-5 container storage unit	Solid mixed LLW	760.78	Container storage-RCRA Part A interim status; Closure date: 2004
Area 612-2 container storage unit	Liquid mixed LLW; solid mixed LLW	40	Container storage-RCRA Part A interim status; Closure date: 2009

Building 612 container storage unit	Liquid mixed LLW; solid mixed LLW; PCB TSCA mixed only	281.9	Container storage-RCRA Part A interim status; Closure date: 2014
Building 233 container storage unit	Liquid mixed LLW; solid mixed LLW	56.63	Container storage-RCRA Part A interim status; Closure date: 2023

Table H.2.6-4. Hazardous Waste Quantities Shipped Offsite in 1994, Lawrence Livermore National Laboratory

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume[3] (m^3)
Articles, explosives, n.o.s.	6	12	<0.1
Barium nitrate	1	68	<0.1
Blue asbestos	8	321,113	214.1
Caustic alkali liquids, n.o.s.	17	3,828	3.8
Combustible liquid, n.o.s.	23	31,472	31.5
Compounds, cleaning liquid	3	91	<0.1
Corrosive solids, poisonous, n.o.s.	1	5	<0.1
Corrosive liquids, n.o.s.	41	11,755	11.8
Corrosive solids, n.o.s.	8	585	0.4
Corrosive liquids, oxidizing, n.o.s.	5	612	0.6
Corrosive liquids, poisonous, n.o.s.	3	151	0.2
Corrosive liquids, flammable, n.o.s.	3	37	<0.1
Environmentally hazardous substances, solid, n.o.s.	2	23,827	15.6
Environmentally hazardous substances, liquid, n.o.s.	1	438	0.4
Flammable solids, n.o.s.	10	977	0.7

Flammable liquids, corrosive, n.o.s.	12	302	0.3
Flammable liquids, n.o.s.	37	17,292	17.3
Flammable solids, poisonous, n.o.s.	1	12	<0.1
Flammable solids, corrosive, n.o.s.	1	32	<0.1
Flammable liquids, poisonous, n.o.s.	16	988	1.0
Hazardous waste, liquid	1	1,429	1.4
Hazardous waste, solid, n.o.s.	2	36,505	24.3
Hazardous waste, solid	3	37,025	24.7
Metal powders, flammable, n.o.s.	4	872	0.6
Nitrates, inorganic, n.o.s.	1	40	<0.1
Non-RCRA hazardous waste solid	53	287,054	191.4
Non-RCRA hazardous waste, liquid	60	62,121	62.1
Organochlorine pesticides, solid toxic, n.o.s.	1	8	<0.1
Oxidizing substances, liquid, corrosive, n.o.s.	2	211	0.2
Oxidizing substances, solid, corrosive, n.o.s.	2	16	<0.1
Oxidizing substances, solid, n.o.s.	7	149	0.1
Oxidizing substances, solid, poisonous, n.o.s.	5	65	<0.1
Oxidizing substances, liquid, n.o.s.	1	6	<0.1
Poisonous solids, corrosive, n.o.s.	1	6	<0.1
Poisonous liquids, corrosive, n.o.s.	4	288	0.3
Poisonous solids, n.o.s.	12	177	0.1
Poisonous liquids, n.o.s.	11	329	0.3
Polychlorinated biphenyls	20	21,779	14.5
Pyrophoric, liquids, n.o.s.	2	19	<0.1

Pyrophoric metals, n.o.s.	3	150	0.1
Pyrophoric solids, n.o.s.	1	15	<0.1
Substances, explosive, n.o.s.	1	8	<0.1
Substances which in contact with water emit flammable gases, liquid	5	39	<0.1
Substances which in contact with water emit flammable gases, solid	12	158	0.1

LLNL generates several types of medical wastes consisting of biohazardous waste and sharps (i.e., needles, blades, and glass slides) waste from biomedical research, Center for Chemical Forensics, and health services facilities. In July 1991, LLNL registered with the Alameda County Environmental Health Services as a large-quantity generator of medical waste, and submitted an application for a medical waste treatment permit. The treatment permit was issued in August 1991 and is valid through July 1996.

Table H.2.6-5. Hazardous Waste Quantities Shipped Offsite in 1994, Lawrence Livermore National Laboratory Site 300

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume[4] (m^3)
Combustible liquids, n.o.s.	5	30,030	30.0
Compounds, cleaning liquid	4	174	0.2
Corrosive liquids, n.o.s.	1	309	0.3
Non-RCRA hazardous waste liquid	10	34,036	34.0
Non-RCRA hazardous waste solid	8	28,316	18.9

Medical wastes from the Biomedical Sciences Division are autoclaved in Building 365 for sterilization before disposal as sanitary waste, except those biological wastes containing carcinogens. These wastes are inactivated chemically, or when this is not possible, disposed of in an appropriately labeled carcinogen/radioactive waste container. Sharps waste is sent to a commercial incinerator following sterilization.

Medical waste from Site 300 is generated at the Medical Facility, Building 877. These wastes are transported to LLNL where they are autoclaved at Building 365. The sterilized materials are then disposed of as sanitary waste.

Nonhazardous Waste. The Livermore Site discharges approximately 1.1 million liters per day (0.209 million gallons per day) of wastewater to the city of Livermore sewer system; this amount is less than 7 percent of the total flow to the city system (LLNL 1995d:6-1). This volume includes wastewater generated by Sandia National Laboratories (SNL) (Livermore). The wastewater contains sanitary sewage and industrial effluent from both LLNL and SNL and is discharged according to permit requirements and the city of Livermore Public Services Ordinance. The effluent is processed at the Livermore Water Reclamation Plant. As part of the Livermore-Amador Valley Wastewater Management Program, the treated sanitary wastewater is transported out of the valley through a pipeline and discharged into the San Francisco Bay. A small portion of the treated effluent from the Livermore Water Reclamation Plant is used for summer irrigation of the municipal golf course, which is next to the Livermore Water Reclamation Plant. Sludge from the treatment process is disposed of in sanitary landfills.

Administrative and engineering controls at the Livermore Site prevent potentially contaminated wastewater from being discharged directly to the sanitary sewer. Wastewater is collected and monitored at several different points from its generation to its release to the municipal collection system. LLNL completed construction of a diversion system to hold wastewater that is unacceptable for release to the Livermore Water Reclamation Plant. When an unacceptable discharge is detected by the monitoring system, the diversion system is automatically activated. Up to 775,000 L (205,000 gal) of potentially contaminated sewage can be held pending analysis to find the appropriate handling methods. The diverted effluent may be returned to the sanitary sewer, shipped for offsite disposal, or treated at LLNL's Hazardous Waste Management Facility.

Sanitary wastewater generated within the General Services Area at Site 300 is discharged to an onsite sewer lagoon. Other more remotely located buildings on Site 300 are serviced by septic systems and leach fields. Industrial wastewaters are contained in retention tanks and analyzed, and their proper disposition decided. These wastewaters may be shipped to LLNL for treatment and discharged to the sanitary sewer system or shipped directly to an offsite treatment and disposal facility. The nonhazardous rinsewaters from the HE machining, pressing, and formulation processes are disposed of by surface evaporation from two ponds.

LLNL does not have any onsite solid waste disposal facilities. After waste reduction and recycling, solid wastes are collected in dumpsters and other similar containers and transported to the Vasco Road Landfill for disposal. Solid waste generated at Site 300 is transported to the Corral Hollow Sanitary Landfill, approximately 6.44 km (4 mi) east of Site 300 on Corral Hollow Road. The San Joaquin County Public Works Department is currently evaluating alternatives for solid waste disposal, including expansion of the Corral Hollow Sanitary Landfill, siting of new landfills, and construction of a transfer station for disposal at another landfill.

The California Integrated Waste Management Act of 1989 mandates reductions in sanitary waste by counties. Sanitary waste must be reduced by at least 25 percent by 1995; the base year for this reduction is 1990. By 2000, the reduction must be 50 percent compared to the 1990 base. LLNL has already reduced this waste stream by over 40 percent from the 1990 base (LLNL 1995b:68).

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1 For those facilities in use this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc. DOE 1994n; LLNL 1996i:2.

2 Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, etc. > DOE 1994k.

3 For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m^3 for liquids and 1,500 kg/m^3 for solids. n.o.s. - not otherwise specified. DOE 1995h.

4 For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m ^{3} for liquids and 1,500 kg/m ^{3} for solids. n.o.s. - not otherwise specified. DOE 1995h.

H.2.7 Sandia National Laboratories

At the Albuquerque location of SNL, activities for R&D on national security and energy projects result in the generation and required management of TRU, low-level, mixed, hazardous, solid industrial, and sanitary wastes. SNL also has five spent nuclear fuel storage facilities: the Manzano Storage Structures, the Annular Core Research Reactor Facility, the Sandia Pulse Reactor Facility, the Hot Cell Facility, and the Special Nuclear Materials Storage Facility. Past activities associated with nuclear weapon development, engineering, and testing at the site has resulted in environmental contamination. The principal sources included tests on weapons and weapon components, discharges of radioactive liquids and hazardous chemicals into the environment, oil spills, disposal of radioactive waste and hazardous chemicals in landfills, rocket launches, and burning of waste, including HE. The contaminated facilities range from reactors to scrap yards. SNL is not on the NPL for sites requiring environmental restoration in accordance with CERCLA and SARA. Because there is no spent nuclear fuel, HLW, or TRU waste associated with any of the proposed activities at SNL (nonnuclear fabrication and NIF), there will be no further discussion of these wastes at SNL in this appendix.

Pollution Prevention. A formal Waste Minimization and Pollution Prevention Awareness Program was initiated at SNL in 1989 to comply with EPA regulations and DOE orders. A Waste Minimization and Pollution Prevention Awareness Plan was completed in December 1991 and updated in December 1992 and May 1994. The plan specifies those activities and methods required to reduce the quantity and toxicity of wastes generated at the site.

Low-Level Waste. Onsite disposal of LLW at SNL was terminated in December 1988 as a result of a DOE order. Currently, all newly generated LLW is stored temporarily above ground at generator sites or in transportation containers at the inactive Technical Area III disposal site. In 1994, approximately 53 m3 (69 yd3) of LLW was accepted at the Technical Area III storage site (SNL 1995g:3-5). This waste consisted primarily of fission product and uranium-contaminated waste on a volumetric basis, and tritium-contaminated waste on an activity basis. The total liquid LLW and solid LLW generated in 1994 as packaged for treatment or storage was 0.912 m3 (1.19 yd ^{3}) and 53.3 m^3 (69.7 yd^3), respectively (SNL 1995f:7). All LLW packages were stored at the Technical Area III storage site and shipped for disposal at NTS.

Mixed Low-Level Waste. Unique tests and experimental programs at SNL have generated small volumes of a broad variety of mixed wastes. The total SNL liquid mixed LLW and solid mixed LLW generated in 1994 as packaged for treatment or storage was 0.007 m^3 (2 gal) and 1.94 m^3 (2.54yd^3), respectively (SNL 1995f:7).

SNL has submitted a Part B Permit application for a permit under RCRA, as amended, to allow for the storage and treatment of mixed radioactive and hazardous wastes. In August 1990, SNL submitted a RCRA Part A Permit application (interim status) to the State of New Mexico for the storage and limited treatment of mixed waste. In October 1992, a permitting strategy in the form of a Letter Agreement was submitted to the State of New Mexico for the SNL mixed waste Part B Permit application. In November 1992, SNL submitted a RCRA Part B Permit application for mixed waste.

This application and the Part A application were amended in August 1993 and December 1994 submittals to the state. In January 1995, SNL submitted a revised mixed waste Part A and Part B Permit application to the New Mexico Environment Department. Treatments in the combined permit application now include compaction, stabilization/solidification, shredding/baling, decontamination/ waste segregation, pH neutralization, encapsulation, chemical stripping/dissolution, destruction/ extraction, chemical precipitation, amalgamation, ion exchange, reverse osmosis, demineralization, and hazard separation.

The Environmental Restoration Program at SNL is being performed under a RCRA Hazardous and Solid Waste Amendments Permit. The permit outlines the corrective action or cleanup processes at specific sites at SNL. The Environmental Restoration Program currently has no existing mixed waste in inventory. It is likely that some mixed waste will be generated during corrective action activities such as RCRA closures, RCRA facility investigations, corrective measures studies, and the implementation of selective corrective measures. The possible waste forms include soil and soil cuttings from drilling and excavation, excavated material such as discarded equipment, contaminated groundwater, decontamination liquid from the cleaning of drilling and sampling equipment, and personal protective equipment (SNL 1995c:6-2).

Although there are currently no operational onsite mixed LLW treatment facilities at SNL, plans are underway to develop some limited capabilities to ensure that mixed LLW can be treated to meet the land disposal restrictions treatment standards using existing technologies. The mixed waste site treatment plan at SNL is heavily integrated with the work at other DOE sites that are tasked with developing mobile treatment units for use at multiple sites. This development involves proving-in new applications of technologies that are currently available but will require testing through treatability studies (SNL 1995c:iii).

Other waste streams, such as explosives, are being studied for onsite treatment by SNL because of its unique nature or handling requirements, or for development of treatment procedures that will facilitate eventual disposal, such as those required by the Nevada Operations Office for disposal at NTS. Offsite commercial treatment and disposal is an option for a small volume of scintillation waste and for waste that may not be treatable to meet the NTS Waste Acceptance Criteria (SNL 1995c:iii).

The Radioactive and Mixed Waste Management Facility at SNL Technical Area III was completed in 1990. Due to changes in regulations during construction, some facility upgrades are required before operations can begin. Once operational, mixed LLW will be treated in accordance with the strategies identified in the mixed waste Site Treatment Plan. This 557-m2 (6,000-ft2) facility will provide the means to open, treat, and repackage LLW and mixed LLW. The Radioactive and Mixed Waste Management Facility is expected to be operational in 1996 (SNL 1995g:3-5).

Currently, the Waste Operations Department operates the Technical Area III interim storage site. There are nine units described in the current RCRA Mixed Waste Part B Permit application, as amended in December 1994. The seven Manzano bunkers, the Radioactive and Mixed Waste Management Facility, and Building 6596 will be the main areas for mixed waste storage in the future. No additional storage capacity will be needed based on future generation rates. Most of these units are within the SNL technical areas although explosives are stored in the Manzano bunkers.

The mixed waste streams at SNL have been combined into 16 treatability groups, each with a preferred treatment option. Descriptions of the mixed waste treatability groups, volumes, preferred treatment option, and treatment site and facility are listed in table H.2.7-1. Treatment and storage facilities for LLW and mixed LLW are listed in tables H.2.7-2 and H.2.7-3.

Table H.2.7-1. Mixed Low-Level Waste Streams at Sandia National Laboratories

Treatability Group	Number of Waste Streams	Inventory as of May 1995 (m3)	Projected Generation 1995 to 1999 5 (m^3)	Preferred Treatment Option	Treatment Site and Facility
Inorganic debris (with an explosive component): neutron generators, thermal batteries, and four small waste streams contaminated wit h energetic materials	6	2.7	<1	Deactivation	Onsite treatability study
Inorganic debris (with a water reactive constituent): lithium batteries and activated metallic sodium	2	0.04	<1	Deactivation	Onsite treatability study
Reactive metals: pyrophoric metal powders and finely divided metal powders	7	0.02	<1	Deactivation/ stabilization	Onsite treatability study
Elemental lead: lead shielding, bricks, pigs, boxes, and gasket	3	0.04	<1 6	Macroencapsulate	Onsite using Pantex MTU

Aqueous liquids (corrosive): liquid acids or bases (pH < 2.1 or >12.4)	2	0.02	<1	Neutralization and stabilization	Onsite treatability study
Elemental mercury: tritium-contaminated mercury from temperature and altitude chambers; and tritium and uranium-238 contaminated mercury	1	0.0001	<1 [7]	Amalgamate	Onsite using Pinellas MTU
Organic liquids I: hazardous scintillation waste and methanol	1	0.2	0 [8]	Incineration	Offsite commercial facility
Organic debris (with organic contaminants): swipes, wipes, and personal protective equipment contaminated with solvents	32	28	1 [9]	Thermal desorption	Onsite using GJPO MTU
Inorganic debris (with TCLP metals): cadmium sheets or rods, circuit boards with lead or silver solder, batteries, cables, electronic devices, weapons components	42	7	15 [10]	Macroencapsulate	Onsite using Pantex MTU

Heterogeneous debris: contains both organic (combustible) and inorganic (noncombustible) debris	10	29	155 [11]	No data provided	Onsite
Organic liquids II: vacuum pump oils, mixed nonhalogenated solvents, and a grinding sludge with trichloroethylene	1	2.7	<1	Hydrothermal processing	Onsite using LANL MTU (Treatability study at LANL)
Organic debris (with TCLP metals): swipes, wipes, personnel protection equipment, and trash contaminated with metals	3	0.6	<1	Macroencapsulate	Onsite using Pantex MTU
Oxidizers: uranyl perchlorates, uranyl nitrates, thorium nitrates, and uranium oxynitrate	3	0.01	<1	Deactivation	Onsite treatability study
Aqueous liquids (organic contaminants): corrosive liquid with methanol	1	0.01	159 [11]	Evaporation, oxidation	Treatability study at GJPO
Soils <50 percent debris	None	0	89 [11]	No current inventory at SNL	No current inventory at SNL
Cyanide waste: potassium cyanide with uranium-238	None	0.001	0	Oxidation	Treatability study at LANL
Total	114	70.3411	<428	-	-

Table H.2.7-2. Low-Level Waste and Mixed Low-Level Waste Treatment Capability at Sandia National Laboratories

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[12] (m3/yr)	Comment
Radioactive and Mixed Waste Management Facility	Compaction, solidification, neutralization, precipitation, shredding, and stripping	Liquid and solid mixed LLW, solid LLW	Compacted various waste forms, gamma assay of waste packages, mixing and solidification of liquid wastes, performed bench scale treatment of waste, and segregated and repackaged various waste types	Bench scale	Status: under construction Date available: December 31, 1996 Termination date: January 1, 2020

Table H.2.7-3. Low-Level Waste and Mixed Low-Level Waste Storage at Sandia National Laboratories

Storage Unit	Input Capability	Design Capacity [13] (m3)	Comment
Annular Core Research Reactor	Liquid and solid mixed LLW and liquid and solid LLW	29	Currently not storing waste. Part B submitted November 8, 1992; amended August 30, 1993. Date available: unknown. Termination date: January 1, 2020.
Area III Interim Storage Site	Liquid and solid mixed LLW and liquid and solid LLW	2,520	Operational; RCRA interim status: August 31, 1993. Termination date: April 1, 2020.

Building 819	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	259	Operational; RCRA Part B permit application submitted; amended August 30, 1993. Termination date: April 1, 2020.
Building 6502 High Bay	Liquid and solid mixed LLW	424	Nonoperational due to upgrades/major repairs Date available: January 1, 1995. RCRA interim status. Termination date: January 1, 2020.
Building 6596 High Bay Waste Storage Facility	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	916	Nonoperational due to upgrades/major repairs. Termination date: July 16, 2020.
Explosives Storage Igloo	Solid mixed LLW	57	Operational; RCRA interim status: August 31, 1993. Termination date: April 1, 2020.
Manzano Facility (7057)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	183	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7045)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	183	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7063)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	235	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7078)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	235	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.

Manzano Facility (7055)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	235	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7118)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	235	Operational; RCRA Part B permit application submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Sandia Pulse Reactor Dense Pac	Solid mixed LLW and solid LLW	31	Operational; RCRA interim status. Termination date: April 1, 2000.
Sandia Pulse Reactor Nova Vault	Solid and liquid mixed LLW and solid and liquid LLW	19	Operational; RCRA interim status. Termination date: April 1, 2020.

Hazardous Waste. As a research facility, SNL generates a variety of hazardous wastes, many in relatively small quantities. All RCRA-regulated wastes generated (except mixed wastes) are transported offsite for disposal at RCRA-permitted treatment, storage, and disposal facilities. Chemical wastes generated by R&D activities are collected from generator locations, segregated according to DOT hazard class, and transported to the SNL RCRA-permitted Hazardous Waste Management Facility for storage. At the Hazardous Waste Management Facility, the wastes are consolidated and packaged according to DOT and EPA requirements. Packaged wastes are transported by DOT-certified carriers to RCRA-permitted treatment, storage, and disposal facilities or recyclers for final disposition.

During 1994, 691,700 kg (1,524,000 lb) of chemical wastes were managed by SNL's Chemical Waste Management Program, including 86,300 kg (190,300 lb) of RCRA-regulated hazardous waste and 605,000 kg (1,333,800 lb) of solid and recycled materials. A total of 29,780 packages were collected from SNL generators in 1994, packaged into 4,223 containers, and sent to treatment, storage, and disposal facilities and recyclers. The volume of RCRA hazardous waste processed in 1994 decreased from that reported in 1993; however, the quantity of solid and recycled material increases. The volume was influenced by the Kirtland Air Force Base solid waste landfill closure, Environmental Restoration Project remediation activities, and recycling operations (SNL 1995g:3-3).

SNL's Thermal Treatment Facility was issued a treatment permit in November 1994 by the New Mexico Environment Department to thermally treat residual explosives. In 1994, the Thermal Treatment Facility did not treat any residual explosives generated at SNL (SNL 1995g:3-3).

Hazardous waste quantities shipped offsite from SNL in 1994 are shown in table H.2.7-4. A summary of the hazardous waste treatment and storage facilities is shown in tables H.2.7-5 and H.2.7-6.

Table H.2.7-4. Hazardous Waste Quantities Shipped Offsite in 1994, Sandia National Laboratories

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume [14] (m^3)
Aluminum chloride, anhydrous	1	3	< 0.1
Articles, explosive, n.o.s.	7	51	< 0.1
Batteries, wet, filled with alkali	2	5,461	3.6
Cartridges, power device	1	< 1	< 0.1
Combustible liquid, n.o.s.	21	1,179	1.2
Compressed gases, flammable, n.o.s.	18	572	1.1
Compressed gases, flammable, toxic, n.o.s.	2	< 1	<1
Compressed gases, n.o.s.	6	132	0.3
Corrosive liquids, flammable, n.o.s.	2	13	< 0.1
Corrosive liquids, n.o.s.	72	11,266	11.3
Corrosive liquids, poisonous, n.o.s.	5	316	0.3
Corrosive solids, n.o.s.	16	564	0.4
Cyanide solutions	3	224	0.2
Detonators, electric	1	< 1	< 0.1
Environmentally hazardous substances, liquid, n.o.s.	5	1,193	1.2
Environmentally hazardous substances, solid, n.o.s.	3	303	0.2
Flammable liquids, corrosive, n.o.s.	15	403	0.4
Flammable liquids, n.o.s.	87	9,775	9.8
Flammable liquids, poisonous, n.o.s.	3	60	< 0.1
Flammable solids, n.o.s.	24	358	0.2
Formaldehyde solutions	1	184	0.2

Hazardous waste, liquid, n.o.s.	58	18,611	18.6
Hazardous waste, solid, n.o.s.	84	56,202	37.5
Iron pentacarbonyl	1	4	< 0.1
Mercuric cyanide, solid	1	7	< 0.1
Mercury	4	175	0.1
Mercury compounds, liquid, n.o.s.	1	4	< 0.1
Oil	1	780	0.8
Oxidizing substances, liquid, corrosive, n.o.s.	17	677	0.7
Oxidizing substances, liquid, poisonous, n.o.s.	1	5	< 0.1
Oxidizing substances, liquid, n.o.s.	10	89	< 0.1
Oxidizing substances, solid, n.o.s.	12	116	< 0.1
Paint	1	3	< 0.1
Perchloric acid	2	19	< 0.1
Phosphorus pentafluoride	1	< 1	< 0.1
Phosphorus pentasulfide	1	3	< 0.1
Poisonous liquids, n.o.s.	24	1,751	1.8
Poisonous solids, n.o.s.	19	212	0.1
Polychlorinated biphenyls	3	1281	0.9
Propellant explosive, solid	4	1385	0.9
Pyrophoric liquids, n.o.s.	1	< 1	< 0.1
Pyrophoric solids, n.o.s.	1	12	< 0.1
Rocket motors	2	190	0.1
Substances, explosive, n.o.s.	5	22	< 0.1
Substances that when put in contact with water emit flammable gases, liquid	6	35	< 0.1
Substances that when put in contact with water emit flammable gases, solid	26	517	0.3

Table H.2.7-5. Hazardous Waste Treatment Capability at Sandia National Laboratories

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[15] (m^3/yr)	Comment
Elementary Neutralization Unit; (870)	Neutralization	Liquid hazardous waste, corrosive	Neutralized wastewater	Data not available at this time	Nonoperational due to upgrades/ major repairs
Thermal Treatment Facility	Open Burning	Liquid and solid hazardous waste and reactive waste (absorbent materials, filters, paper, and rags)	Gas, solid hazardous waste, listed, TCLP, carbon ash/possible silver contamination	Limited to 9.1 kg/ campaign	Standby mode, RCRA interim status

Table H.2.7-6. Hazardous Waste Storage Capability at Sandia National Laboratories

Storage Unit	Input Capability	Design Capacity[16] (m3)	Comment
PCB Storage Facility (958W)	Liquid and solid hazardous and sanitary waste (also sludge) and PCBs	10	Operational; date available: June 1, 1993
Hazardous Waste Management Facility (959)	Liquid and solid hazardous waste (also sludge and gas)	Data not available at this time	Operational; final RCRA Part B permit application submitted: July 31, 1992
Hazardous Waste Management Facility (958)	Liquid and solid hazardous waste (also sludge and gas)	Data not available at this time	Operational; final RCRA Part B permit application submitted: July 31, 1992

Nonhazardous Waste. SNL liquid sanitary waste is sent to municipal treatment facilities. SNL contains over 24 km (15 mi) of sewer lines interconnected with those of Kirtland Air Force Base. In June 1994, SNL activated the liquid effluent control system to retain process wastewater for radiological screening prior to disposal into the sanitary sewer. SNL's policy prohibits the disposal of radiological material above regulatory levels into the sanitary sewer system. Discharges by SNL to the publicly owned treatment works are regulated by the city of Albuquerque Public Works Department, Liquid Waste Division, under the authority of the city's Sewer Use and Wastewater Control Ordinance (SNL 1995g:6-1). Solid sanitary waste is collected and taken to the Albuquerque Sanitary Landfill on a regular basis. The total solid sanitary waste generated in 1994 as packaged for disposal was 13,600 t (14,990 tons) (SNL 1995f:7).

The classified waste landfill at SNL is a Class D landfill located in Technical Area III. The unit is an outdoor facility, 0.983 ha (2.43 acres) in size, used for the disposal of classified solid waste generated at SNL R&D facilities. The landfill currently operates under a notice of intent, submitted annually to the State of New Mexico Solid Waste Bureau. The industrial wastes (called classified solid waste) disposed of at this landfill originate from the classified reapplication yard. The waste stream consists of toner cartridges, computer tapes, crates and pallets, weapon components, and related hardware. The remaining capacity of this landfill is 9,635 m3 (12,600 yd ^{3}) (DOE 1994k).

H.2.8 Nevada Test Site

After underground nuclear tests, radioactive and hazardous materials were extracted and analyzed. These activities have resulted in the accumulation of low-level, hazardous, and mixed wastes that must be treated, stored, and disposed of. The Site Book for Waste Management< (May 1994), the Waste Management Plan for the Nevada Test Site (February 1995), and the NTS Site Treatment Plan and Federal Facility Compliance Act Consent Order (March 1996) and the NTS EIS (Draft, December 1995) detail waste management activities at NTS.

Radioactive and hazardous wastes (according to the current definition of hazardous wastes) generated from past nuclear testing activities were disposed of at Areas 2, 3, 5, 6, 8, 9, 12, and 23. These were mixed wastes and LLW composed of debris, drilling mud, decontamination wastes, laboratory, and classified wastes. Areas 3 and 5 are still currently active for waste storage and disposal. Area 3 receives offsite and onsite bulk waste for disposal in subsidence craters. A RCRA closure plan has been submitted to the Nevada Division of Environmental Protection for this facility. The Radioactive Waste Management Site in the north of Area 5 contains LLW management units and receives packaged classified and unclassified LLW. It also has TRU wastes from LLNL in storage, and a hazardous waste accumulation site. The NTS is not currently accepting mixed wastes from any locations. Mixed waste could be accepted from defense related generators within the State of Nevada; however, there is no mixed waste ready for disposal that meets the land disposal restrictions of RCRA. Mixed waste has been disposed of from out-of-state generators, and this practice is planned for the future contingent upon approval and permitting (RCRA Part B) of future mixed waste disposal units and on actions resulting from the Record of Decision (ROD) on the Waste Management PEIS.

In the past, waste disposal at NTS was accomplished through landfills, underground injection and leachfields on NTS, and through offsite disposal of hazardous wastes. A goal of the NTS

Environmental Restoration Project is to remove or immobilize hazardous substances, pollutants, and contaminants, while achieving compliance with environmental laws and regulations. Environmental restoration activities will be guided by the ROD from the NTS EIS and be in accordance with the Site Treatment Plan.

Pollution Prevention The Nevada Operations Office is an active participant in DOE's National Waste Minimization and Pollution Prevention Program. A comprehensive Waste Minimization Plan for NTS was completed in 1991, which defines specific goals, methods, responsibilities, and achievements for organizations. A waste minimization organization promotes waste minimization and pollution prevention and assures compliance with DOE orders at NTS. A report on waste generation and waste minimization is published annually. DOE publishes site-wide plans and guidance, and each contractor develops its own implementation plan. Plans and procedures have been developed, limiting the number and types of hazardous materials used on the site.

Since the initiation of the waste minimization program, several steam-cleaning operations have been eliminated, and half of the hazardous solvents used at NTS have been replaced with nonhazardous solvents. Recycling and reclamation activities have been established to reuse lead, silver, lubricating oil, and trichlorotrifluoroethane. Automatic decontamination equipment, recycling fabrication tool coolant systems, and continuous oil change and reburn systems have been placed in service to reduce hazardous waste generation. Closed loop effluent recycling for steam cleaning has eliminated the production of 17.8 million L (4.7 million gal) of wastewater annually and has reduced hazardous waste generation by 90 percent. Two solvent waste stills recycle 85 percent of all solvents and thinners used. Nonhazardous aqueous solution parts cleaners have eliminated the need for parts cleaning solvents.

The procurement of all materials is also reviewed for the opportunity to reduce the purchase of hazardous materials for NTS operations. In addition, an education and training program for all site personnel and for the surrounding community is helping to increase awareness of best practices and lessons learned in waste reduction.

Transuranic Waste TRU and mixed TRU waste is stored at NTS on the TRU waste storage pad in Area 5. This waste was generated at LLNL and shipped to NTS between 1974 and 1990. All NTS TRU and mixed TRU waste is expected to be certified for disposal at WIPP in Carlsbad, NM, or another suitable repository should WIPP prove to be unsatisfactory. The Nevada Operations Office has the option to construct a TRU Waste Certification Building for breaching, sampling, and certifying containers of TRU waste to meet the WIPP Waste Acceptance Criteria which is expected to be finalized by June 1997 (NT DOE 1996b:4-61, 4-62). Other technologies, such as mobile characterization capabilities, are also being considered. This waste inventory consists of 612 m^3 (800 yd^3) of heterogeneous debris. The TRU waste is stored in the TRU Pad Cover Building on the TRU Waste Storage Pad to protect the containers from the environment. In addition, TRU and suspected TRU waste from weapons tests were emplaced in boreholes. Decisions to retrieve this waste or leave it in place will be based on performance assessments required by 40 CFR 191 and/or risk assessments required by CERCLA or RCRA. Table H.2.8-1 lists the mixed TRU waste storage units at NTS.

Low-Level Waste Contaminated soils, created from past atmospheric nuclear weapons tests, occur at various locations on NTS. Some of this surface contamination has been and is planned to be removed and disposed of as waste. Although the debris from underground weapons tests remain underground, samples of this debris are brought to the surface for analysis and then must be disposed of as waste. The majority of LLW generated at NTS is disposed of in subsidence craters in Area 3. This area also receives substantial quantities of containerized bulk waste from other offsite DOE facilities. Some waste disposal units are being closed in this area, while others are being readied for future use. Area 5 receives low-level radioactive waste from both onsite and offsite generators. New disposal capacity is planned for this area, and the offsite generators will be required to meet the NTS Waste Acceptance Criteria (which includes periodic reviews by the Nevada Operations Office) to permit them to ship LLW for disposal at NTS.

Historically, the volume of waste received from offsite is approximately equal to or slightly greater than the volume of waste generated onsite. Recently onsite waste generation (other than environmental restoration waste) has declined due to cessation of nuclear testing. Offsite receipts currently dominate waste disposal activities at NTS. Remediation activities at NTS will produce waste streams that will have to be treated, stored, and disposed of. Offsite waste shipments must meet NTS Waste Acceptance Criteria that require that the waste be approved for disposal at NTS. Fifteen generators currently ship LLW to NTS, and an additional nine are applying for or are awaiting approval (NT DOE 1996c:4-61, 4-62). The LLW disposal capacity in use or planned at NTS is listed in table H.2.8-2.

Mixed Low-Level Waste. Mixed LLW is generated by DP-related support activities, environmental restoration activities, and activities supporting TRU waste disposal at WIPP or another suitable repository should the WIPP prove to be unacceptable. Wastes were generated by the analytical activities supporting weapons tests and consisted of drilling muds and debris generated from tunnel reentry and rehabilitation. Additional wastes result from radiochemical analysis and decontamination of equipment and facilities used in sample extraction and analysis. NTS has received mixed wastes from other DOE sites and may receive additional waste in the future, pending the completion of the site treatment plans for all DOE sites and once proper permits are obtained. Mixed waste generated in the State of Nevada that meets the land disposal restrictions of RCRA can be disposed of in the Area 5 mixed waste disposal unit, Pit 3. Mixed waste not meeting land disposal restrictions can be stored on the TRU waste storage pad. A RCRA Part B permit application for a new mixed waste storage unit was submitted in January 1995.

Mixed LLW streams are being characterized to determine what technologies and capabilities are required for safe, environmentally sound, and compliant disposal. Construction of the Liquid Waste Treatment System, a central facility for treating liquid LLW and mixed LLW (contaminated effluents from environmental restoration and DP activities), has been funded and is being designed. Receiving/ hold- ing and evaporation reservoirs and associated mixed waste processes will be RCRA-permitted.

Table H.2.8-2 lists mixed LLW storage and disposal facilities at NTS. Table H.2.8-3 lists the mixed LLW streams inventory and 5-year projected generation at NTS. The total volume is 296 m^3 (388 yd^3), including a 20,425-kg (45,000-lb) empty spent shipping cask. Table H.2.8-3 lists mixed LLW waste streams at NTS.

Hazardous Waste. Hazardous wastes are generated from ongoing operations at NTS. Wastes consist of solvents, lubricants, fuel, lead, metals, and acids. Hazardous wastes are accumulated at various sites around NTS while they await shipment offsite to a RCRA-permitted facility. Over the next 5 years, addi-tional satellite storage locations are planned. A separate accumulation site across the road from Area 5 is provided to avoid potential cross-contamination with radioactive waste. The generation of hazardous wastes at NTS is expected to decrease significantly because of the cessation of nuclear testing, the com-pletion of environmental restoration activities, and the impact of waste minimization activities. Hazardous waste is stored on a 279-m 2 (3,000-ft 2) covered pad in Area 5 (NT REECO 1995a:33).

*Nonhazardous Waste.*Nonhazardous sanitary wastes are expected to be generated at the current rates for several years into the future, then decline due to the cessation of nuclear weapons testing. Recycling of paper, metals, glass, plastics, and cardboard has already resulted in some decreases in waste quantities.

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5 The quantities are estimates only.

6 The generation rate for lead solids may change significantly as the Lead Bank Program progresses.

7 A small amount may be generated at SNL (Livermore), and managed under the SNL Mixed Waste Site Treatment Plan at the Albuquerque location.

8 Because of the use of nonhazardous scintillation liquids, it is assumed that no organic liquid mixed waste will be generated in the next 5 years.

9 The generation rate of organic debris may greatly decrease because of the reduction of hazardous solvents.

10 It is assumed that the generation of inorganic debris will remain comparable to the current rate.

11 From the Environmental Restoration Program. GJPO - Grand Junction Projects Office, Colorado; MTU - Mobile Treatment Unit; TCLP - Toxicity Characteristic Leaching Procedure. DOE 1995gg; SNL 1995c.

12 Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds and permit issuance. DOE 1994n; DOE 1995gg.

13 Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, etc. DOE 1994n.

14 For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 500 kg/m3 for gases, 1,000 kg/m^3 for liquids, and 1,500 kg/m^3 for solids. n.o.s. - not otherwise specified. DOE 1995h.

15 For those facilities in use, this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, results of treatability studies, and permit issuance. DOE 1994n.

16 Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds and permit issuance. DOE 1994n.

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Appendix I

Units of Measure and Metric Conversions

Units of Measure	
Btu	British thermal unit(s)
Ci	Curie(s)
cm	centimeter(s)
cm^2	square centimeter(s)
dB	decibel(s)
dBA	decibel(s), a-weighted
dpm	disintegration(s) per minute
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
gal	gallon(s)
ha	hectare(s)
hr	hour(s)
in	inch(es)
in^2	square inch(es)
J	joule(s)
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
kph	kilometers per hour
kV	kilovolt
L	liter(s)
lb	pound(s)
µg	microgram(s) (one-millionth of a gram)

µm	micrometer(s)
µs	microsecond(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
m/s	meters per second
MBtu	thousand British thermal unit(s)
mg	milligram(s)
MGY	million gallons per year
MLY	million liters per year
mi	mile(s)
mi^2	square mile(s)
MJ	megajoule(s)
mph	mile(s) per hour
mrem	millirem
MW	megawatts
ng	nanograms
person-rem	radiation dose equivalent to population
ppm	part(s) per million
rad	unit of absorbed dose
rem	unit of radiation dose equivalent
s	second(s)
t	metric ton(s) (1,000
W	watts
yr	year(s)

°C	degree(s) Celsius
°F	degree(s) Fahrenheit

Metric Conversion Chart and Metric Prefixes

To Convert to Metric			To Convert from Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	**2.54**	centimeters	centimeters	**0.3937**	inches
feet	**30.48**	centimeters	centimeters	**0.0328**	feet
feet	**0.3048**	meters	meters	**3.281**	feet
yards	**0.9144**	meters	meters	**1.0936**	yards
miles	**1.60934**	kilometers	kilometers	**0.6214**	miles
Area					
square inches	**6.4516**	sq. centimeters	sq. centimeters	**0.155**	sq. inches
sq. feet	**0.092903**	sq. meters	sq. meters	**10.7639**	sq. feet
sq. yards	**0.8361**	sq. meters	sq. meters	**1.196**	sq. yards
acres	**0.40469**	hectares	hectares	**2.471**	acres
sq. miles	**2.58999**	sq. kilometers	sq. kilometers	**0.3861**	sq. miles

Volume					
fluid ounces	**29.574**	milliliters	milliliters	**0.0338**	fluid ounces
gallons	**3.7854**	liters	liters	**0.26417**	gallons
cubic feet	**0.028317**	cubic meters	cubic meters	**35.315**	cubic feet
cubic yards	**0.76455**	cubic meters	cubic meters	**1.308**	cubic yards
Weight					
ounces	**28.3495**	grams	grams	**0.03527**	ounces
pounds	**0.43560**	kilograms	kilograms	**2.2046**	pounds
short tons	**0.90718**	metric tons	metric tons	**1.1023**	short tons
Temperature					
Fahrenheit	**Subtract 32, then multiply by 5/9**	Celsius	Celsius	**Multiply by 9/5, then add 32**	Fahrenheit

Prefix	**Symbol**	**Multiplication Factor**
exa-	**E**	1 000 000 000 000 000 000 = 10^{18}
peta-	**P**	1 000 000 000 000 000 = 10^{15}
tera-	**T**	1 000 000 000 000 = 10^{12}
giga-	**G**	1 000 000 000 = 10^{9}
mega-	**M**	1 000 000 = 10^{6}

kilo-	**k**	1 000 = 10^{3}
hecto-	**h**	100 = 10^{2}
deka-	**da**	10 = 10^{1}
deci-	**d**	0.1 = 10^{-1}
centi-	**c**	0.01 = 10^{-2}
milli-	**m**	0.001 = 10^{-3}
micro-	**µ**	0.000 001 = 10^{-6}
nano-	**n**	0.000 000 001 = 10-9
pico-	**p**	0.000 000 000 001 = 10^{-12}
femto-	**f**	0.000 000 000 000 001 = 10^{-15}
atto-	**a**	0.000 000 000 000 000 001 = 10^{-18}

Units of Measure

cm	centimeters
ft	feet
ft2	square feet
ft3	cubic feet
gal	gallons
ha	hectares
hr	hour
in	inches
kg	kilogram
km	kilometers
L	liters
lb	pounds
mg	micrograms
m	meters
m2	square meters
m3	cubic meters
mg	milligrams

Metric Conversion Chart and Metric Prefixes

To Convert to Metric			To Convert from Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches

sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.40469	hectares	hectares	2.471	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32, then multiply by 5/9	Celsius	Celsius	Multiply by 9/5, then add 32	Fahrenheit

Prefix	**Symbol**	**Multiplication Factor**
exa-	E	1 000 000 000 000 000 000 = 1018
peta-	P	1 000 000 000 000 000 = 1015
tera-	T	1 000 000 000 000 = 1012
giga-	G	1 000 000 000 = 109
mega-	M	1 000 000 = 106
kilo-	k	1 000 = 103
hecto-	h	100 = 102
deka-	da	10 = 101
deci-	d	0.1 = 10-1
centi-	c	0.01 = 10-2
milli-	m	0.001 = 10-3
micro-		atto- a 0.000 000 000 000 000 001 = 10-18

Units of Measure

Units of Measure	
cc	cubic centimeters
cm	centimeters
eV	electron volts
ft	foot (feet)
ft2	square feet
ft3	cubic feet
g	grams
G	gauss
gal	gallons
hr	hours
Hz	cycles per second
kJ	kilojoules
km	kilometers
L	liters
ms	microseconds
m	meters
m2	square meters
m3	cubic meters
MA	megamperes
mg	milligrams
MJ	megajoules
mi	miles
mph	miles per hour
m/s	meters per second
MVA	mega volt amperes
MW	megawatts
oz	ounces
rem	unit of radiation dose equivalent

rpm	revolutions per minute
yd3	cubic yards
yr	years

Metric Conversion Chart and Metric Prefixes

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Area					
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mega-	M	1 000 000 = 106	
kilo-	k	1 000 = 103	
hecto-	h	100 = 102	
deka-	da	10 = 101	
deci-	d	0.1 = 10-1	
centi-	c	0.01 = 10-2	
milli-	m	0.001 = 10-3	
micro-		atto-	a 0.000 000 000 000 000 001 = 10-18

Acronyms, Abbreviations, and Chemical Symbols used in Appendix I

Acronyms and Abbreviations

ABAG	Association of Bay Area Governments
APCR	Air Pollution Control Regulations (District Board of Clark County)
AQCR	air quality control region
AQMD	Air Quality Management District
BAAQMD	Bay Area Air Quality Management District
BACT	best available control technology
BART	Bay Area Rapid Transit
BEA	Bureau of Economic Analysis
CAA	Clean Air Act
CFR	Code of Federal Regulations
CNR	composite noise rating
CTBT	Comprehensive Test Ban Treaty
CWA	Clean Water Act
D&D	decontamination and decommissioning
DOE	Department of Energy
DOT	Department of Transportation
DP	DOE Office of the the Assistant Secretary for Defense Programs
EIB	Environmental Improvement Board
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ERPG-2	Emergency Response Guidelines-2
FR	*Federal Register*
HLW	high-level waste
HSWA	*Hazardous Solid Waste Amendments* of 1984
ICF	inertial confinement fusion
ICRP	International Commission on Radiological Protection
ISCST2	Industrial Source Complex Short Term Model, Version 2 (computer code)
LANL	Los Alamos National Laboratory

LEPC	Local Emergency Planning Committee
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NAC	Nevada Administrative Code
NEPA	National Environmental Policy Act
NIF	National Ignition Facility
NLVF	North Las Vegas Facility
NMAQCR	New Mexico Air Quality Control Region
NMAQD	New Mexico Air Quality District
NMR	New Mexico Regulations
NMSR	New Mexico State Road
Nova	laser facility at Lawrence Livermore National Laboratory
Novette	laser system at Lawrence Livermore National Laboratory
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NTS	Nevada Test Site
OSHA	Occupational Safety and Health Administration
PEIS	Programmatic Environmental Impact Statement
PSA	Project-Specific Analysis
PSD	Prevention of Significant Deterioration
R&D	research and development
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
ROI	region of influence
SAAQS	State Ambient Air Quality Standards
SARA	Superfund Amendments and Reauthorization Act of 1986
Shiva	laser system at Lawrence Livermore National Laboratory
SNL	Sandia National Laboratories
SR	state road or state route
START I	Strategic Arms Reduction Talks I Treaty
START II	Strategic Arms Reduction Talks II Protocol

TA	technical area
TRU	transuranic
TSCA	Toxic Substances Control Act
UC	University of California
ULI	Urban Land Institute
USC	United States Code

Chemical Symbols

NOx	**nitrogen oxides**
PCB	polychlorinated biphenyl
PM	particulate matter
PM10	particulate matter of aerodynamic diameter equal to or less than 10 micrometers
TNT	trinitrotoluene
TSP	total suspended particulates
VOCs	volatile organic compounds

Acronyms and Abbreviations

AMCCOM:	U.S. Army Armament, Munitions, and Chemical Command
CFF:	Contained Firing Facility
D&D:	decontamination and decommissioning
DOE:	Department of Energy
EIR:	Environmental Impact Report
EIS:	Environmental Impact Statement
FR:	*Federal Register*
FXR:	Flash X-Ray
HEPA:	high-efficiency particulate air
HTO:	tritiated water
LLNL:	Lawrence Livermore National Laboratory
LLW:	low-level waste
MAP:	Mitigation Action Plan
MMRP:	Mitigation Monitoring and Reporting Program
NEPA:	*National Environmental Policy Act*
NESHAP:	National Emissions Standards for Hazardous Air Pollutants
ROD:	Record of Decision
SJVUAPCD:	San Joaquin Valley Unified Air Pollution Control District
TRU:	transuranic
UC:	University of California
VOCs:	volatile organic compounds

Acronyms and Abbreviations

Acronyms and Abbreviations	
AC	alternating current
AQCR	Air Quality Control Regulation
DARHT	Dual-Axis Radiographic Hydrodynamic Test
DC	direct current
DOE	Department of Energy
EIS	environmental impact statement
EMF	electromagnetic force
HE	high explosives
LANL	Los Alamos National Laboratory
NEPA	*National Environmental Policy Act*
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NHMFL	National High Magnetic Field Laboratory
NMEIB	New Mexico Environmental Improvement Board
PEIS	programmatic environmental impact statement
PM10	particulate matter of aerodynamic diameter equal to or less than 10 micrometers
R&D	research and development
RCRA	*Resource Conservation and Recovery Act*
SFE	Special Facilities Equipment
TA	technical area

APPENDIX I: SUMMARY

I-S.1 Introduction

The U.S. Department of Energy (DOE) proposes to construct and operate the National Ignition Facility (NIF). The goals of NIF are to achieve fusion ignition in the laboratory for the first time by using inertial confinement fusion (ICF) technology based on an advanced design solid-state laser and to conduct high-energy-density experiments in support of national security and civilian applications.

The purpose of this project-specific analysis is to assess the environmental impacts of construction and operation of NIF. This document describes the project and its purpose and need, considers site alternatives and project design options, delineates the affected environments, assesses potential environmental impacts, and suggests mitigation measures. This analysis, as an appendix to the Final *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, is equivalent to a stand-alone environmental impact statement on the proposed NIF.

I-S.2 Purpose and Need

NIF would provide a unique capability for DOE's science-based stewardship of the nuclear weapons stockpile. The goal of obtaining fusion ignition and burn would attract and challenge top scientific and engineering talent with a problem containing many of the same elements of physical understanding as those necessary for stewardship of the nuclear stockpile. Planned experiments with NIF, at temperatures and pressures near those that occur in nuclear weapon detonations, would provide the data needed to verify certain aspects of sophisticated computer models. These models are needed to simulate weapons physics and to provide insights on the reliability of the Nation's nuclear weapons stockpile. Specially designed NIF experiments could also address specific issues of modeling or physics that are of concern because of changes in weapons due to aging or remanufacture. Finally, NIF experiments could provide a unique source of radiation for studies on nuclear weapon effects.

NIF experiments could address, to various degrees, certain weapons issues connected with fusion ignition and boosting; weapon effects; radiation transport; and secondary implosion, ignition, and output. Most of these processes occur at very high energy density (i.e., at high temperatures and pressures) and are relevant to a weapon's reliability. NIF would achieve higher temperatures and pressures, albeit in a very small volume, than any other existing or proposed stockpile stewardship facility. It is also the only facility that would achieve fusion ignition. Safety issues principally connected with the high explosive and fissile material implosion in a weapon would not be addressed by NIF.

Present computer codes are not adequate to calculate all the high-energy-density phenomena that occur in an exploding nuclear weapon. The high temperatures and pressures achievable with NIF would be used to measure properties of matter at the extreme conditions expected and, thus, verify aspects of advanced computer models. If an unanticipated change relevant to the high-energy-density phase of weapon operation is observed in the weapon surveillance program, specially designed NIF experiments could aid weapons scientists in validating aspects of their integrated computer models to assess whether that change would adversely impact the weapon's reliability. It is important to have NIF operating well before the period 2005 to 2010, as weapons age beyond their original design lifetime.

As a multipurpose facility, NIF would also be important to the Nation's energy, basic science, and technology missions. Its data would determine whether ICF can be a viable source of electric power in the future. Achieving ignition, optimizing the various target gain curves, and providing initial data on fusion reactor materials would allow sound decisions to be made concerning inertial fusion energy development.

NIF experiments would also achieve the same temperatures and pressures that exist in the sun and other stars, providing new laboratory capabilities for exploring basic high-energy-density sciences such as astrophysics and plasma physics. As the world's largest optical instrument, NIF could spur high technology industries in such areas as optics, lasers, materials, high-speed instrumentation, semiconductors, and precision manufacturing.

Achievement of fusion ignition at NIF would fulfill a major goal of the ICF program. Both the National Academy of Sciences in 1990 and the Inertial Confinement Fusion Advisory Committee have recommended proceeding with an ignition facility based upon solid-state laser technology.

I-S.3 Project Description

Conventional construction techniques would be used to build NIF. The extent and exact nature of such activities as site clearing, infrastructure improvements, and support facility construction required would depend on the specific location selected for NIF. Construction of NIF would be organized in the following sequential phases: (1) initial building construction, (2) special equipment structures installation, (3) final building construction, (4) final installation preparation, (5) clean component installation, and (6) final laser/target systems installation.

Once operational, NIF would provide the capability to perform the full range of target physics experiments leading up to and including ignition and burn. It would also allow researchers to design experiments studying weapons effects, weapons physics, fusion energy, and the basic sciences. NIF would consist of two main components: a collection of 192 laser generation and transport systems and a target area including a target chamber and associated equipment. An advanced, integrated sensor and computer system would control the lasers and collect data from diagnostic equipment. These elements would all be housed in one central facility. Required support facilities, such as assembly areas, maintenance areas, machine and mechanical shops, and offices would be located nearby. General site requirements would include control by DOE Office of the Assistant Secretary for Defense Programs (DP), significant ICF infrastructure, protection of the public and the environment, hazardous and radioactive waste management capability, and transportation services. The total land area requirement for NIF, including direct-support buildings, would be about 20 hectares (ha) (50 acres). Depending on the site selected, many of the NIF needs may be served by existing facilities, reducing the requirements of new land area to 3.2 to 18.2 ha (7.9 to 45 acres.)

I-S.4 Alternatives

The alternatives considered in this analysis consist of 5 candidate locations at four DP sites. (LLNL, LANL, NTS-Area 22 main site location, NLVF, location near NTS, and SNL), the No Action alternative, and two design capabilities. The designs under consideration consist of two operational capabilities, the Conceptual Design Option, and the Enhanced Option.

I.S.4.1 Alternative Sites

DOE has selected one preferred (LLNL) and three alternative (LANL, NTS, and SNL) NIF sites that meet most of the following site criteria: BP-controlled Federal site, significant ICF infrastructure, adequate protection of the public and the environment, hazardous and radioactive waste management capabilities, and adequate transportation services for transport of targets. While the two NTS locations currently do not have ICF infrastructure, they have been included to ensure that DOE examines any potential lost efficiencies that might arise by taking advantage of the infrastructure that must be maintained at these sites in accordance with the presidential mandate to maintain a test-readiness posture.

Lawrence Livermore National Laboratory. LLNL is located about 64 kilometers (km) (40 miles[mi]) east of San Francisco in southern Alameda county. LLNL occupies 332 ha (821 acres). NIF would be situated on 8.1-ha (20-acre) disturbed grassland area in the NE quadrant of LLNL, adjacent to existing ICF facilities.

Los Alamos National Laboratory LANL is located in Los Alamos County in north central New Mexico, approximately 97 km (60 mi) north northeast of Albaquerque. LANL occupies 11,300 ha (28,000 acres). NIF will be located on a 4-ha (10 acre) area in Technical Area (TA) 58, an underdeveloped forested area adjacent to TA-3, the hub for LANL administration and support activities.

Nevada Test Site Area 22 at NTS is located in southern Nye county in southern Nevada, about 105 km (65 miles) northwest of Las Vegas. NTS occupies about 350,000 ha (867,000 acres). NIF will be located on an 18.2 ha (45 acres) area within area 22 in an undeveloped creosote bush habitat, southwest of Mercury Base Camp in the southeastern portion of NTS. NLVF is located in the city of North Las Vegas, Nevada, and occupies 32 ha (80 acres) zoned for general industry within the city. NIF will be lcoated within a 3.2 ha (8 acre) previously disturbed, sparsely vegetated area in the northwestern portion of NLVF.

Sandia National Laboratories, NM DOE SNL site is located 11 km (6.5 mi) east of downtown Albaquerque and Benalillo County, New Mexico. DOE owns 1150 ha (2842 acres) within the boundaries of the Kirtland Air Force Base military reservation and uses additional property through land withdrawals and land-use permits from Kirtland Air Force Base, the State of New Mexico, and the Isleta Pueblo. NIF would be located in an 11-ha (28-acre) disturbed grassland portion of the southern side of Technical Area II. The site is near SNL facilities that would be required for NIF support.

I-S.4.2 No Action

Under the No Action alternative, DOE would not construct and operate NIF. Without the facility, the Stockpile Stewardship and Management Program mission and the Nation's sustainable energy policy mission, as defined in the *National Energy Policy Act* of 1992, would be adversely affected. Key support elements of Stockpile Stewardship and Management, such as the goals of producing ignition and energy gain in ICF targets and performing fusion and high-energy-density physics or weapons-effects experiments in support of the Stockpile Stewardship and Management Program, would not be achieved.

The Stockpile Stewardship and Management Program would continue to use Nova and other facilities for a time, but fusion ignition and the much higher temperatures and pressures of NIF would not be available. Alternatives to achieve higher temperatures and pressures than are presently available may eventually be proposed, but they would not be available when several of the remaining types of nuclear weapons age beyond their original design lifetime, between 2005 and 2010. Thus, issues may arise that decrease confidence in the reliability of these weapons and increase the probability that the United States may need to invoke "supreme National interest" and withdraw from any Comprehensive Test Ban Treaty in effect (based on *Statement by the President on Goal for a Comprehensive Test Ban Treaty* , White House Office of the Press Secretary, August 11, 1995).

Without NIF, efforts to obtain the critical data needed to determine if the ICF approach, based on the neodymium glass solid-state laser design, would be a viable and practical energy source for electric power production would be delayed or abandoned. Other ICF-based methods proposed for achieving ignition (such as heavy ion acceleration, light ion diodes, krypton-fluoride lasers) are not developed to the point of being able to propose an ignition facility. As a result, these potential alternatives for ICF energy source demonstrations would have longer lead times and a higher integrated cost to achieve the mission proposed for NIF.

I-S.4.3 Operational Capability Options

Two operational capability options (Conceptual Design and Enhanced) have been proposed for NIF. The Conceptual Design Option would use an ICF approach called "indirect drive." In indirect drive, laser beams would illuminate and heat the interior surfaces of a small metal case (hohlraum) containing a deuterium-tritium-filled capsule. The beams would cause the case to emit x rays that would strike the fusion target capsule, resulting in compression and heating of the capsule to conditions igniting the fusion reaction. This option also includes basic experiments for weapons physics, nuclear weapons effects on other systems, and other user community needs.

The Enhanced Option would include the indirect drive operations of the Conceptual Design Option and a second approach called "direct drive." The Enhanced Option would provide the capability to perform an increased number of both yield and non-yield experiments to accommodate greater user needs. No hohlraum would be used in the direct drive approach. Instead, a large number of laser beams would be employed to ensure good uniformity of the driving force (laser light) over the face of the target. The laser beams would impinge directly on the deuterium-tritium-filled capsule to drive the fusion reaction. Because it is possible that NIF would be used for direct-drive experiments in its lifetime, operating conditions for both indirect- and direct-drive experiments have been developed and are being assessed.

I-S.5 Environmental Consequences

Table I-S.5-1 compares the potential environmental consequences of the No Action alternative with those of construction and operation of NIF at the alternative candidate sites. The comparison is based on the assessments in section I.4 of this analysis. Factors analyzed include land use and visual resources; air quality and noise; water resources; biotic resources; cultural and paleontological resources; socioeconomics; and radiological and chemical health, safety, and risk. Where they would differ, the potential impacts of the two operational scenarios (Conceptual Design Option and Enhanced Option), are also compared in table I-S.5-1. Table I-S.5-2 compares waste management issues for each candidate site.

The analyses in this appendix indicate that there would be few significant differences in the adverse environmental impacts among the candidate sites analyzed. The maximum 24-hour particulate matter 10 microns or smaller (PM ^{10}) concentration in the air during site clearing would exceed applicable standards at LLNL and NLVF (table I-S.5-1). However, the ambient air quality impacts would be localized and of short duration. Uncommitted land requirements would be greatest at NTS (18.2grassland (LLNL and SNL) or to an area of sparse vegetation (NLVF) (table I-S.5-1). The risk of cancer to members of the public from a facility accident involving the release of radioactive material would be greatest at NLVF and SNL (table I-S.5-1), although the potential for the actual occurrence of such an accident would be extremely low.

NIF will comply with all applicable Federal, state, and local environmental regulatory requirements, including the *California Environmental Quality Act* if NIF is sited in the State of California. The candidate sites have also enacted several mitigative measures for construction actions that would also be applicable to NIF construction. While each of these mitigative measures may be minor, in combination they could significantly reduce impacts to the environmental resources of the selected site. The evaluations of environmental consequences of NIF construction and operation summarized in tables I-S.5-1 and I-S.5-2 are based on the assumption that the mitigative measures would be carried out if the proposed action were undertaken.

Even with mitigation, construction and operation of NIF could result in unavoidable residual adverse effects. These effects would include the disturbance of up to 18.2 regions. Readable adverse socioeconomic impacts would occur in any of the regions of influence for NIF candidate sites. No adverse disproportionate environmental justice concerns would be expected at any of the candidate sites, except for a minor potential to disproportionately impact minority populations in the region of influence for NLVF.

Table I-S.5-1.-- *Comparison of Alternatives for the Proposed National Ignition Facility*

Environmental Resource Parameter	**No Action**	**LLNL**[1]	**LANL** [1]	**NTS** [1]	**NLVF** [1]	**SNL** [1]
Land Resources						
Uncommitted land requirements[2] (hectares)	None	8.1	4.0	18.2	3.2	10.5
Uncommitted land requirements (%)	None	11	1	<1	56	7
Number of buildings to be constructed	None	2	3	5	5	7
Conflicts with site development or land-use plans	No	No	No	No	No	No
Air Quality and Noise						
Predicted maximum 24-hour particulate matter 10 microns or smaller concentration during site clearing	124/150	175/150	183/150	52/150		
Baseline emissions (t/yr)/baseline emissions plus NIF emissions (t/yr) during operation[5]						
Particulate matter 10 microns or smaller	Variable	3.36/3.52	2.56/2.74	86.8/86.9	0.78/0.99	3.76/3.96
Volatile organic compounds	Variable	13.10/13.66	2.89/3.45	ND/NA	3.45/4.02	1.65/2.22

Carbon monoxide	Variable	3.99/4.42	21.58/22.04	ND/NA	0.23/0.79	0.23/0.75
Nitrogen dioxide	Variable	23.50/25.29	53.88/55.79	ND/NA	1.07/3.35	1.07/3.22
Sulfur dioxide	Variable	0.37/0.40	0.70/0.73	71.1/71.1	0.07/0.11	0.07/0.11
Noise (qualitative)	No Effect	Minor[6]	Minor[7]	Minor[7]	Minor[7]	Minor[7]
Water Resources						
Construction						
Water requirement (MLY)	None	2.95	2.95	2.95	2.95	2.95
Water requirement as percent of current usage (%)	None	0.31	0.05	0.12	4.20	0.21
Operation						
Water requirement (MLY)	None	152	152	152	152	152
Water requirement as percent of current usage (%)	None	16	2.8	6.3	220[7]	11
Biotic Resources						
Maximum habitat reduction [8] (hectares)	None	8.1	4.0	18.2	3.2	10.5
Habitat to be impacted	None	Grassland	Forest	Creosote bush desert	Sparse vegetation	Grassland
Wildlife disturbance [9]	None	Minor	Moderate	Moderate	Negligible	Minor
Potential impact to rare, threatened, or endangered species	None	Loss of noncritical, low-quality habitat for several species. Minor risk (mitigable) to white-tailed kite.	Loss of noncritical habitat for several species.	Loss of noncritical habitat for several species. Minor risk (mitigable) to desert tortoise.	None	Loss of noncritical, low-quality habitat for several species.
Cultural Resources (Qualitative)	No impacts	No impacts	No impacts	No impacts	No impacts	No impacts
Socioeconomics						
Construction[10]						
Total jobs	None	2,870	1,130	1,640	1,640	1,770
In-migrating population	None	1,600	2,200	2,340	2,340	3,065
Number of housing units	None	580	800	850	850	1,120
Number of trips generated (per day)	None	902	518	538	538	538
Public finance (% change over 1995 fund balance)	None	-0.03	4.40	0.21	0.21	0.06
Public services (increase in number of workers)	None	15	50	47	47	81
Environmental justice-disproportionate adverse health/environmental impacts on:						
- minority populations	None	None	None	None	Low	None
- low-income populations	None	None	None	None	None	None

Operation[11]						
Total jobs	0 to -153	890	600	620	620	670
In-migrating population	None	360	610	440	440	660
Number of housing units	None	130	220	160	160	240
Socioeconomics (Continued)						
Number of trips generated per day	0 to -190	630	630	630	630	630
Public finance (% change over 1995 fund balance)	None	-0.02	0.71	0.04	0.04	0.01
Public services (increase in number of workers)	None	4	15	7	7	21
Environmental justice-disproportionate adverse health/environmental impacts on:						
- minority populations	None	None	None	None	Low	None
- low-income populations	None	None	None	None	None	None
Human Health (Radiological)						
Public (30-yr life of project)						
MEI dose (mrem)	None	1(3)	0.09 (0.3)	0.003 (0.01)	6 (18)	0.03 (0.1)
Population dose (person-rem)	None	2(6)	0.6 (2)	0.009 (0.03)	6 (18)	2 (6)
Cancer fatalities	None	None	None	None	None	None
Facility Accidents (Radiological)						
Public dose (person-rem)	None	260 (440)	290 (490)	41 (70)	3,000 (4,900)[12]	1,100 (1,800)
Cancer fatalities	None	None	None	None	1 (2)	0 (1)
Facility Accidents (Chemical)						
Distance to end of hazard zone from accident[13] (m)	None	237 (778)	237 (778)	239 (784)	237 (778)	237 (778)
Transportation Accidents[14] (Radiological)						
Public dose risk (person-rem/yr)	None	2.2x10^{-6}	2.6x10^{-6}	2.4x10^{-6}	2.4x10^{-6}	1.6x10^{-6}
		(1.8x10^{-5})	(2x10^{-5})	(1.9x10^{-5})	(1.9x10^{-5})	(1.2x10^{-5})
Cancer fatalities risk	None	1x10^{-9}	1x10^{-9}	1x10^{-9}	1x10^{-9}	8x10^{-10}
		(9x10^{-9})	(1x10^{-8})	(9x10^{-9})	(9x10^{-9})	(6x10^{-9})
Transportation Impacts (Nonradiological) (Fatalities/Year)[15]						
Vehicular emissions	None	1x10^{-3}	8x10^{-4}	8x10^{-4}	8x10^{-4}	2x10^{-3}
		(2x10^{-3})	(2x10^{-3})	(2x10^{-3})	(2x10^{-3})	(4x10^{-3})
Accidents	None	2x10^{-3}	2x10^{-3}	2x10^{-3}	2x10^{-3}	2x10^{-3}
		(4x10^{-3})	(4x10^{-3})	(6x10^{-3})	(5x10^{-3})	(4x10^{-3})

Table I-S.5-2.-- Comparison of Waste Management at the Candidate Sites

	LLNL		**LANL**		**NTS**		**NLVF**		**SNL**	
Category	**Current Capacity (m^3)**	**Adequate Current or Planned Capacity for NIF**	**Current Capacity (m^3)**	**Adequate Current or Planned Capacity for NIF**	**Current Capacity (m^3)**	**Adequate Current or Planned Capacity for NIF**	**Current Capacity (m^3)**	**Adequate Current or Planned Capacity for NIF**	**Current Capacity (m^3)**	**Adequate Current or Planned Capacity for NIF**
Treatment										
Low-level										
Liquid	3,736 (34.1 per treatment episode)	Yes	9,000/yr (45/hr)	Yes	None	Yes	None	Yes[16]	Included in mixed low-level	Yes
Solid	None	Yes[16]	76	Yes	None	Yes	None	Yes[16]	Included in mixed low-level	Yes
Mixed										
Liquid	8,750[17]	Yes	None	Yes	None	Yes	None	Yes[16]	Data not available	Yes
Solid	11,800	Yes	None	Yes	None	Yes	None	Yes[16]	Data not available	Yes
Hazardous										
Liquid	97	Yes	Varies	Variable	None	Yes[16]	None	Yes[16]	Data not available	Yes[16]
Solid	None	Yes[16]	Varies	Variable	None	Yes[16]	None	Yes[16]	Data not available	Yes[16]
Disposal										
Low-level										
Liquid	None	Yes[16]	None	Yes	None	Yes	None	Yes[16]	None	Yes
Solid	None	Yes[16]	24-28 ha area available	Yes	650,000	Yes	None	Yes[16]	None	Yes
Mixed										
Liquid	None	Yes[16]	None	Yes	None	Yes	None	Yes[16]	None	Yes
Solid	None	Yes[16]	None	Yes	90,626	Yes	None	Yes[16]	None	Yes
Hazardous										
Liquid	None	Yes[16]	None	Yes	None	Yes[16]	None	Yes[16]	None	Yes[16]
Solid	None	Yes[16]	None	Yes	None	Yes[16]	None	Yes[16]	None	Yes[16]

Over the 30-year operational life of NIF, the public would be exposed to a very small dose of radiation (table I-S.5-1). No cancer fatalities would be expected to occur from exposures associated with routine NIF operations under either the Conceptual Design or Enhanced options. A radiological accident at NIF would not cause any cancer fatalities to the public except possibly at NLVF (1 and 2 estimated cancer fatalities for the conceptual design option and enhanced option, respectively) and SNL (1 estimated cancer fatality for the enhanced option) (table I-S.5-1). The cancer fatality risk (cancer fatality per year) associated with radiological exposure from an accident involving transport of NIF tritium targets would range from $1x10^{-8}$ to $8x10^{-10}$; whereas the nonradiological fatality risks associated with vehicular emissions and accidents would be in the range of 10^{-3} to 10^{-4} (table I-S.5-1).

Although each candidate site would implement waste minimization practices, the generation of additional wastes would be unavoidable. All candidate sites have current or planned capacity to handle wastes associated with construction and operation of NIF; however, this would entail offsite shipment of some of the wastes for all sites but LANL (table I-S.5-2).

Resources that would be committed irreversibly or irretrievably during construction and operation of NIF include concrete, steel, fuel, and power. Land set aside at disposal facilities to accommodate radiological and hazardous chemical wastes from NIF represents an irreversible commitment of resources because wastes in belowground disposal areas may not be completely removed at the end of the project. This land could be perpetually unusable because the substrata would not be available for other potential intrusive uses, such as mining, utilities, or foundations for other facilities. However, the surface area appearance and biological habitat lost during construction and operation of the disposal facilities could, to a large extent, be restored. Consumption of operating supplies, miscellaneous chemicals, and gases, while irreversible, would not constitute a permanent drain on local resources or involve any material in critically short supply in the United States as a whole. Materials consumed or reduced to unrecoverable forms of waste, such as radioactive waste, are also irretrievable.

Adequate land exists at each of the five candidate location sites to support ongoing programs and other foreseeable short-term uses of undeveloped areas. The use of land for NIF would enhance the long-term productivity of the selected site in two ways. First, NIF represents long-term research and development functions compatible with historic nuclear weapons support and would require a technically competent, skilled, and stable workforce. Second, in light of current reductions in the nuclear weapons stockpile, the lack of new weapons development or production, the moratorium on nuclear testing, and concerns about safety and reliability in the aging stockpile, DOE plans to downsize or consolidate existing facilities and provide upgraded or new experimental and computational capabilities that would enhance the long-term productivity of the selected sites.

Land clearing and construction activities for NIF would eliminate habitat and destroy or displace wildlife. Construction of new facilities could result in short-term disturbances of previously undisturbed biological habitats. These disturbances could cause long-term reductions in the biological productivity of an area.

Cumulative impacts would result from the addition of the incremental effects of the construction and operation of NIF to the effects of other past, present, and reasonably foreseeable future actions at the selected site. PM_{10} emissions from construction of NIF would be an incremental addition to the already existing environmental impact of dust emissions to the atmosphere. Minor changes in stormwater runoff are expected due to removal of grass cover during NIF construction and increased runoff from pavement during facility operations. Construction of NIF would replace natural habitat with areas of pavement and buildings. Depending upon the candidate site selected, this conversion could extend the influence of urbanized/industrial habitats into natural areas, increase fragmentation of natural habitat, and cause minor loss of habitat used by rare species. However, no critical habitat for federally threatened or endangered species would be affected. Radiological doses to the general public from NIF operations would be no more than 20 normal background radiation. The risk of a NIF accident-related cancer fatality occurring to a member of the public over the 30-year lifetime of the facility would be less than 1 in 700,000. NIF would be considered a low-hazard, radiological facility. Such a facility uses radionuclides (for nonreactor purposes) and has other hazards (such as chemicals needed at the facility). Low hazard implies that there are minor onsite and negligible offsite consequences.

I-S.6 U.S. Department of Energy's Preferred Alternative

Council on Environmental Quality regulations require that an agency identify the preferred alternative for a proposed Federal action in a final environmental impact statement (40 *Code of Federal Regulation* s 1502.14[e]). The preferred alternative is the alternative that DOE believes would best fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. The preferred operational option for NIF is the Enhanced Option (indirect and direct drive). The preferred NIF siting alternative is at LLNL. The Record of Decision will describe DOE's decision on the operational capability and siting of NIF.

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1 Value for Enhanced Option is given in parentheses only for parameters that differ from the Conceptual Design Option.

2 Uncommitted land, as defined by each of the sites, is land that is currently open and available for NIF development. An additional 2 hectares would be temporarily required for a construction laydown area at LLNL. Construction laydown areas for the other sites would be located within the area designated for NIF.

3 Estimated by combining baseline concentrations and NIF contributions based on dust control measures using water spray twice a day (with continuous water spraying and/or chemical dust suppressants for LLNL and NLVF sites).

4 The 24-hour California state standards for particulate matter (50site yielding the largest risks.

5 Collective population fatalities were calculated for 145 shipments (Conceptual Design Option) and 335 shipments (Enhanced Design). For example, a reported value of 4x10-3 fatalities suggests that no fatalities are expected for the proposed action. However, one single fatality out of the entire affected population might be expected over the course of 250 years if the same number of shipments were to continue for that length of time.
ND - No data available; NA - Not applicable.
Derived from tables and text contained in appendix I.

6 Shipped offsite.

7 Varies depending on the waste stream.
Source: Andrews and Tobin 1995; Bowers 1995; NTS 1996.

APPENDIX I: NATIONAL IGNITION FACILITY PROJECT-SPECIFIC ANALYSIS

I.1 Introduction

I.1.1 The National Ignition Facility Proposal

As part of its Stockpile Stewardship and Management Program, the U.S. Department of Energy (DOE) proposes to construct and operate the National Ignition Facility (NIF) (DOE 1995b). NIF would contain the world's largest solid-state laser system, which would be used to achieve ignition of nuclear fusion in the laboratory for the first time. NIF would perform fusion, high-energy-density, and radiation-effects experiments in support of stewardship of the Nation's stockpile of nuclear weapons and other basic and applied science objectives.

NIF would consist of 192 laser beams that would be focused into a small target containing a spherical capsule of fusion fuel, positioned in the center of a large spherical target chamber. The energy of the lasers would be deposited into the target in a few billionths of a second, causing the fuel capsule inside the target to implode, thereby compressing and heating the fuel. This process would force atomic nuclei sufficiently close together so that the rate of fusion reactions would become very large. This reaction rate would, in fact, be so rapid that a significant fraction of the fuel would burn up before the target flew apart in a miniature explosion; that is, while the target was held together only by its own inertia. This method for achieving fusion ignition and energy gain is called inertial confinement fusion (ICF). Ignition occurs when the fusion reactions become self sustained; i.e., a significant portion of the fusion reactions result from self heating of the fuel beyond that achievable by the lasers alone. Energy gain occurs when the amount of fusion energy produced by the target exceeds the amount of laser energy supplied to ignite the target. The NIF capsule's fusion yield is expected to be up to 10 times the laser driver energy required to produce fusion ignition.

In January 1993, the Secretary of Energy confirmed the need for NIF and authorized a collaborative effort by the three DOE defense laboratories and the University of Rochester's Laboratory for Laser Energetics to produce the Conceptual Design Report for NIF. The Conceptual Design Report was completed in April 1994. In October 1994, the Secretary of Energy approved initiation of the next phase of the NIF Project, including preliminary design, safety analysis, cost and schedule validation, and *National Environmental Policy Act* (NEPA) analysis preparation that would include public involvement. This NIF Project-Specific Analysis (PSA), prepared as part of the *Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (PEIS), represents that NEPA analysis. This PSA is equivalent to a project-specific EIS. However, it is referred to as a PSA to avoid confusion with the term PEIS. As a part of the Stockpile Stewardship and Management PEIS, this PSA shares certain elements (such as data) common to the main document. However, some of the data described in this PSA are necessarily more detailed than some of the data cited in the Stockpile Stewardship and Management PEIS analysis.

I.1.2 History and Background

Three decades of research and development by U.S. laboratories and private industry has led to the design of NIF. Soon after the invention of the laser in the early 1960s, scientists recognized that the laser might be used to drive an ICF capsule to ignition and that this technology could be used to achieve some of the high-energy-density conditions (such as high temperatures and pressures) that occur in the detonation of nuclear weapons. It was also recognized that if more energy could be produced than that required to ignite a target, such fusion technology might one day also be used to generate electrical power.

Since then, a series of laser systems, each several times more powerful than its predecessor, have been constructed and operated. The first of these laser systems, a single beam system called Longpath, was completed in 1970 and was used experimentally for 5 years, until a two-beam system called Janus was completed in 1974. Janus demonstrated laser-driven compression, heating, and thermonuclear burn of fusion fuel for the first time. Although neither Janus nor any of the subsequent lasers were large enough to produce target ignition, each advanced the state of the art in solid-state laser technology, and each contributed significantly to a sounder understanding of how ICF targets work.

Experimentation on the most recent of these systems, the 10-beam Nova laser, has led to an even greater understanding of ICF targets. Nova has been used not only for target physics experiments, but also for weapons physics experiments of the type that would be done at NIF, although the NIF experiments would be done at much larger energies (a factor of 40 to 50 times more energy available). Thus, the Nova experiments have established the principles and measurement techniques that would be used at NIF. More than 10,000 experiments have been conducted with Nova during its 10 years of operation. DOE is also now conducting target physics research at the Omega Upgrade Facility located at the University of Rochester. This new laser system is similar in energy to Nova but has a larger number of beams and can better address issues of directly driven laser targets than can Nova, which specializes in indirectly driven targets (see chapter 3). In its Enhanced Option mode, NIF would be capable of performing experiments with both types of targets.

During the 1980s, a program to study the physics of ICF capsules with the much larger energies available from underground nuclear explosions was successfully conducted. The very positive results of the Nova program, combined with the positive results from underground nuclear tests in the Halite/ Centurion program, have led to the development of specifications for a future system to create target ignition and energy gain, i.e., for NIF. A 1990 study by the National Academy of Sciences (NAS 1990), which reviewed both the laboratory and the underground nuclear test data, recommended proceeding with an ignition facility based on a solid-state laser as the next step in the ICF program. NIF is proposed as that next step.

Achievement of fusion ignition at NIF would fulfill a major goal of the ICF program. The ICF program was initiated in 1971 to develop capabilities that would support the Nation's nuclear weapons deterrent and that have longer-term potential for commercial energy. Confidence in ignition at NIF is based on 24 years of ICF research and major program reviews, most recently the continuous monitoring of ICF progress by the ICF Advisory Committee. That panel of independent experts tracked the successful accomplishment of the objectives set out by the National Academy of Sciences recommendations in 1990 and advised DOE that the program was technologically ready to proceed with NIF, both from the standpoint of the understanding of target physics and from the standpoint of the readiness of the laser technology (DOE 1990). In 1994, the Beamlet laser, a full-scale prototype NIF beamline, demonstrated that the laser technology selected for NIF would perform as specified.

The ability to predict the performance of ignition capsules is based on similar calculations of physics that predict some aspects of nuclear weapons performance. Ignition is a "first-level" test of our weapons analysis capability. Achieving laboratory ignition with laser-driven inertial fusion is widely recognized as a major scientific challenge that will attract and stimulate highly capable scientists. While much of the science is useful to nuclear weapons analyses, NIF is not a weapon, and the ICF approach cannot be directly extended to become a weapon. Much of the research at NIF can be open to the broad scientific community. Thus, NIF experiments can advance both our weapons analysis capability and civilian science and energy interests.

I.1.3 Environmental Review Process

DOE's NEPA compliance for the Stockpile Stewardship and Management Program includes preparation of the Stockpile Stewardship and Management PEIS. Because NIF would be an integral part of a science-based Stockpile Stewardship and Management Program, the NEPA process for NIF is being conducted as part of the NEPA process for Stockpile Stewardship and Management. This NIF PSA is, therefore, included as an appendix to the Stockpile Stewardship and Management PEIS. The PSA was prepared according to the Council on Environmental Quality's "Regulations for Implementing the Procedural Provisions of the *National Environmental Policy Act* " (40 CFR 1500-1508) and DOE's NEPA implementing procedures and guidelines (10 CFR 1021). The purpose of this NIF PSA is to provide an environmental evaluation of the impacts of construction and operation of NIF as a basis for DOE's decision on whether or not to proceed with such a facility. As discussed in section I.1.1, this document is in the strictest sense a project-specific EIS, but it is referred to as a PSA to avoid confusion with the term PEIS.

The first step in the Stockpile Stewardship and Management PEIS process was to publish a Notice of Intent to prepare an EIS in the *Federal Register* (60 FR 31291, June 14, 1995). The Notice of Intent described the project and solicited comments on preliminary plans for the scope of the Stockpile Stewardship and Management PEIS. The Notice of Intent also announced DOE's plan for gathering scoping comments on the significant issues and concerns related to the proposed action and alternatives that should be addressed in the PEIS. To ensure public input to the planning and preparation of the PEIS, public scoping meetings were held during July and August 1995. At each meeting, representatives of DOE explained the purpose of the meeting, the role of the Federal Government, and the PEIS process. During the remainder of each meeting, DOE received comments from agencies, groups, and individuals and invited interested parties to submit any additional comments by August 11, 1995, the close of the PEIS scoping period. Concerns and suggestions resulting from the scoping process are summarized and evaluated in the Stockpile Stewardship and Management PEIS Implementation Plan, which states how the comments are to be incorporated into the scope of the Stockpile Stewardship and Management PEIS. The Implementation Plan also summarizes the proposed action and alternatives (designs, sitings, and No Action), outlines issues to be addressed in the PEIS, and discusses the subsequent procedures for the PEIS preparation. The Stockpile Stewardship and Management Draft PEIS was subsequently prepared and published in February 1996.

The publication of, and call for comments on, the Stockpile Stewardship and Management Draft PEIS were announced in the Notice of Availability published in the *Federal Register* . DOE invited comments from all interested parties to correct factual errors or to provide insights on any matter related to this environmental analysis. The 60-day public comment period for the Draft PEIS began on March 8, 1996 and ended on May 7, 1996. However, late comments were accepted to the extent practicable.

After considering the comments received, DOE revised the Stockpile Stewardship and Management Draft PEIS, as appropriate. This Final PEIS was distributed to those who received the Stockpile Stewardship and Management Draft PEIS, those who commented on the Draft PEIS, and any other interested parties.

Following completion of the Stockpile Stewardship and Management Final PEIS, but at least 30 days after it is issued, DOE will issue a Record of Decision (ROD). The ROD will explain all factors, including environmental impacts, that DOE considered in reaching its decisions regarding Stockpile Stewardship and Management, including NIF. The ROD will specify the alternatives that are considered to be environmentally preferable. This NIF PSA is a critical element in the ROD and the basis for the environmental comparison of alternatives related to NIF. DOE anticipates that, in addition to considering the environmental impacts as presented in the PEIS, the ROD will be based on cost, national security, and infrastructure considerations. If mitigation measures, monitoring, or other conditions are adopted as part of the agency's decision, they will be summarized in the ROD as applicable and included in a Mitigation Action Plan that would accompany the ROD. The Mitigation Action Plan would explain how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures to judge their effectiveness.

I.1.4 Organization of the National Ignition Facility Project-Specific Analysis

This NIF PSA consists of eight chapters. Chapter I.1 (Introduction) describes the NIF background and the environmental review process. Chapter I.2 (Purpose and Need for the National Ignition Facility) describes mission-related reasons why DOE needs to construct and operate NIF. Chapter I.3 (Proposed Action and Alternatives) describes the facilities required for NIF and the operations that would be associated with NIF. Chapter I.3 also includes a discussion of the No Action alternative and an overview of the four DOE sites, providing five alternate locations for NIF.

Chapter I.4 (Affected Environment and Environmental Impacts) describes the natural and human resources at the alternate NIF locations and identifies the impacts that could occur to these resources from construction and operation of NIF and from the No Action alternative. This chapter also addresses mitigation commitments and recommendations, adverse effects that cannot be avoided, irreversible and irretrievable commitments of resources, the relationship between short-term uses and long-term productivity, and cumulative impacts. Chapter I.5 (Environmental, Occupational Safety and Health Permits, and Compliance Requirements) discusses environmental regulations, Executive Orders, permits, and laws applicable to NIF construction and operation.

Chapter I.6 (List of Preparers) includes a list (including credentials) of the technical staff who prepared the NIF PSA. Chapter I.7 (Glossary) defines selected technical terms used within this PSA. Chapter I.8 includes a list of references.

I.2 Purpose and Need for the National Ignition Facility

I.2.1 General Background

Under the *Atomic Energy Act* of 1954, as amended (42 United States Code 2011 et seq.), the U.S. Department of Energy (DOE) is charged with providing nuclear weapons to support the Nation's nuclear deterrent policy. Thus, DOE must maintain a Complex with sufficient capabilities and capacity to meet current and future weapons requirements. This mission is accomplished in a way that protects the environment and the health and safety of workers and the public.

Recent changes in the global political situation and in national security needs have necessitated corresponding changes in the way DOE must meet its responsibilities regarding the Nation's nuclear weapons. As a result of international arms control agreements (the Strategic Arms Reduction Talks [START I] Treaty and the START II protocol and unilateral decisions by the U.S. Government), the Nation's stockpile will be significantly reduced by 2003. Consequently, the Nation has halted the development of new nuclear weapons, begun closing portions of the DOE weapons complex, and is considering further consolidation and downsizing of the remaining elements in the Complex. In addition, the Nation is observing a moratorium on nuclear testing and is pursuing a Comprehensive Test Ban Treaty (CTBT). However, international nuclear dangers remain and, as the President has emphasized, nuclear deterrence will continue to be an important element of the U.S. national security posture. Thus, DOE's responsibilities for ensuring the safety and reliability of the Nation's nuclear stockpile and for maintaining expertise in nuclear weapons generally will continue for the foreseeable future.

In announcing the indefinite extension of the nuclear test moratorium in July 1993, President Clinton reaffirmed the importance of maintaining confidence in the enduring U.S. stockpile by alternative means and the need to ensure that the Nation's nuclear deterrent remains safe, secure, and reliable during a test ban. In 1994, by Presidential Decision Directive and Act of Congress (Public Law 103-160), DOE was directed to establish a Stockpile Stewardship and Management Program to ensure the continued safety and reliability of the remaining weapons and the preservation of the core intellectual and technical competencies of the United States in nuclear weapons in the absence of nuclear testing. Subsequent Presidential decisions established that the United States would seek a "zero-yield" CTBT (August 1995) and that all three of the Nation's nuclear weapons laboratories would be required to ensure the highest continued confidence in the stockpile.

Thus, DOE was required to develop a Stockpile Stewardship and Management Program that would not include any level of nuclear testing but would support the following objectives:

- Full support at all times of the Nation's nuclear deterrent with safe and reliable nuclear weapons while transforming the current Complex (laboratories and production facilities) to one that is more appropriate for a smaller stockpile
- Preservation of the core of intellectual and technical competencies of the weapons

laboratories. Without nuclear testing, confidence in the Nation's nuclear stockpile will depend largely on the continued availability of competent people who must make the scientific and technical judgments related to the safety and reliability of nuclear weapons
- Ensurance that the activities needed to maintain the Nation's nuclear deterrent are consistent with the Nation's arms-control and nonproliferation objectives

The purpose and need section that follows (section I.2.2) discusses the National Ignition Facility's (NIF) role in supporting objectives 1 and 2 above. Objective 3 (nonproliferation) was evaluated for NIF in a recent DOE study--The National Ignition Facility and the Issue of Nonproliferation (DOE 1995a). That study, prepared by the Office of Arms Control and Nonproliferation of DOE, has been the subject of extensive public involvement, interagency review, and review by outside experts. The study concludes that (1) the technical proliferation concerns at NIF are manageable and therefore can be made acceptable, and (2) NIF can contribute positively to U.S. arms control and nonproliferation policy goals.

To ensure the continued safety and reliability of the enduring stockpile while achieving a CTBT, the President and the Department of Defense have emphasized the importance of a strong science-based stockpile stewardship program, including NIF. It is important to establish a firm commitment to this program before the issue of ratification of a CTBT arises.

I.2.2 Purpose and Need

I.2.2.1 Stockpile Stewardship and Management Program

Although DOE is confident today that the Nation's nuclear weapons stockpile is safe and reliable, it is expected that problems could develop in the future. A recent interlaboratory study, *Stockpile Surveillance: Past and Future* (Johnson et al. 1995), documents the historical evidence. Nuclear weapons, of necessity, contain materials that react with one another slowly even when the weapon is simply being stored. These slow interactions can and have, over time, caused defects in weapons that adversely affect safety and/or reliability. These processes are called "aging." Also, design or manufacturing defects have been found after a weapon enters the stockpile or is remanufactured. The DOE historical database on such incidents shows that there have been hundreds of cases that have necessitated some kind of corrective action because of safety or reliability concerns. Because nuclear weapons in the future will be expected to remain in the stockpile beyond their designed lifetimes, it is to be expected that such incidents will increase.

The *Stockpile Stewardship and Management Program* (DOE 1995b) defines a science-based program intended to satisfy the three program objectives stated in section I.2.1. Science-based stockpile stewardship would provide the expert judgment, underpinned by scientific understanding, advanced calculations, and modern experimental facilities, to predict, identify, evaluate, and render solutions to problems that affect safety and reliability of the remaining stockpile in the absence of underground testing. The stockpile stewardship program would not replace nuclear testing completely because complex interactions between processes cannot be experimentally simulated. However, for weapons that have been tested before (and all the weapons expected to remain in the stockpile have been tested), the previous nuclear test database will provide a benchmark that can be used to evaluate future problems with the stockpile.

Building upon existing capabilities, the DOE science-based stockpile stewardship program includes an accelerated strategic computing initiative and several new experimental facilities that are required to provide the data needed to verify the models and help assess specific problems that arise. The stewardship program consists of three major components that are used to evaluate stockpile surveillance data: (1) experimental capabilities and facilities, (2) scientific evaluation by competent scientists of the information from the experimental capabilities and facilities, and (3) validation of the computer models using the accelerated strategic computing initiative. These three components lead to the development of a corrective action to resolve the identified problem.

I.2.2.2 Physical Processes in Nuclear Weapons

Because nuclear tests would not be available, more sophisticated and comprehensive computer models would be needed to conduct essential evaluations. For confidence to be established in these new models, experimental facilities must be able to provide data on all processes in the relevant physical regimes that occur in weapons. The relevant physical regimes may be divided into the following groups:

1. Detonation of high explosive and implosion of fissile material
2. Conditions for criticality of fissile material
3. Fusion ignition and boosting
4. Radiation transport
5. Secondary implosion
6. Secondary ignition, burn, and output
7. Nuclear weapon effects on other systems

The DOE program proposes a set of experimental facilities, each designed to address one or more of these areas in a complementary fashion.

A general understanding of a nuclear weapon would be helpful to better understand these seven categories and their relationship to stockpile stewardship and management and NIF. Modern thermonuclear weapons consist of two stages: a primary stage (fission trigger) and a secondary stage (fusion). The purpose of the primary is to produce x rays to implode the secondary, thereby causing ignition. The secondary is the stage that produces high yields for modern U.S. strategic weapons-typically hundreds of kilotons. The primary contains a subcritical pit of fissile material, generally plutonium, surrounded by a layer of chemical high explosive. The high explosive is detonated, burns rapidly, and compresses the pit. The implosion of the pit increases the density of the fissile material to super criticality, leading to a fission chain reaction and rapid heating. X rays from the hot exploding primary are then channeled by a radiation case to the secondary, where they implode the secondary, creating temperatures and pressures great enough to ignite a fusion reaction in the secondary.

To increase their efficiency, modern primaries can employ a process called boosting. In boosted primaries, the pit contains the hydrogen isotopes deuterium and tritium gas that is compressed and heated. The deuterium and tritium gas undergoes fusion, producing copious quantities of energetic neutrons that flood the compressed pit. The extra burst of neutrons causes significant additional fission reactions that "boost" the primary yield to a much higher value. If the primary fails to boost properly, its yield may be inadequate to drive the secondary, resulting in weapon failure.

I.2.2.3 The National Ignition Facility as Part of the Stockpile Stewardship and Management Program

NIF would provide an essential capability for the DOE's science-based stewardship of the nuclear weapons stockpile. The basic goal of NIF is to achieve ignition of thermonuclear fusion in the laboratory by imploding and igniting a small capsule containing a mixture of deuterium and tritium. The goal of obtaining fusion ignition and burn at NIF would attract and challenge top scientific and engineering talent with a problem containing many of the same elements of physical understanding as those necessary for stewardship of the nuclear stockpile. Achieving fusion ignition and conducting experiments at such high temperatures and densities in NIF would make it possible to study the properties of material under conditions close to those they would be subjected to in a nuclear weapon detonation. Thus, specific experiments can be conducted with weapons materials to measure relevant equations of state (what pressures are created at high temperature), opacity (how a material absorbs and emits radiation), and hydrodynamics (how a material moves in response to forces applied). These experiments apply to several of the regimes of interest listed in section I.2.2.2. The following discussion focuses on how NIF can be used to evaluate weapons concerns relevant to the physical regimes in that list.

NIF experiments could examine the growth and control of hydrodynamic instabilities, which are important both in making inertial confinement fusion (ICF) targets ignite and burn and in making nuclear weapons perform reliably. Hydrodynamic instabilities ultimately lead to mixing of some quantity of one material with another. This mix can affect both ignition and burn processes (regimes 3 and 6). NIF experiments can determine how fusion fuels ignite and what helps and what hinders the ignition process (such as how much mix is tolerable).

High-temperature transport of radiation in complex geometries and materials (regime 4) can be examined to test the ability of computer models to predict this transport. Deposition and re-emission of radiation and the general transport problem constitute a very complex process. This process must be understood in order to predict the transport of radiation necessary to ignite ICF targets. In addition, radiation transport experiments can be designed to simulate weapons radiation transport conditions more closely than those in the basic ICF ignition target.

Output calculations must be done on the ICF ignition targets so that the performance of the target can be properly measured. Again, however, specific targets can be designed to alter the output radiation. These experiments can be used to test the computer codes used to calculate the output of weapons.

NIF targets, either the basic type for ignition or specially altered ones, would produce copious x rays, neutrons, gamma rays, and other radiation. These emissions can be used to assess the consequences of nuclear effects (regime 7) in electronic systems or other hardware intentionally exposed to these radiations. The survivability of military hardware subjected to various nuclear effects is an important factor in assuring reliability of that hardware.

In addition to its role in attracting and maintaining core scientific and engineering capability and in helping to verify the calculational capability of the more sophisticated computer models, NIF would also play a role in evaluating specific problems that arise in the stockpile, as mentioned in section I.2.2.2. As the stockpile surveillance program reveals an unanticipated change due to aging or remanufacture, a weapons expert will estimate which of the weapons physics processes listed in section I.2.2.3 could be affected. If any of the high-energy-density process (regimes 3 through 7) could be affected, then a NIF experiment may be designed to measure the physical properties of the change. For example, if the chemical composition of a material (such as a glue joint) has changed for some reason, it may be necessary to determine the opacity (how a material absorbs and emits radiation) of the changed material. Computer models are not able to predict the opacity of all materials under all temperatures and pressures. Thus, it may be necessary to put some of the changed material into a NIF target, raise its temperature and pressure to near those that would occur when the weapon is exploded, and measure its opacity (regime 4). These measurements would then be compared with the computer model predictions, and the physics model would be refined until an agreement was reached. The computer model could then be used to evaluate whether the given change in properties causes an integrated change in performance that adversely affects the reliability of the weapon. This evaluation would determine whether the altered weapon could remain in the stockpile (or be placed in the stockpile in the case of a remanufactured weapon).

In conclusion, NIF would address, to some degree, weapons processes that occur in physical regimes 3 through 7 in the list in section I.2.2.2. These processes are the ones that occur at very high energy density (high temperatures and pressures). These processes are very important in assessing a weapon's reliability. NIF would achieve higher temperatures and pressures, albeit in a very small volume, than any other proposed stockpile stewardship facility. It would also be the only facility that would achieve fusion ignition. The principal safety issues for a nuclear weapon that involve the high explosive and fissile material implosion, relevant physical regimes 1 and 2, could not be addressed in NIF.

The nuclear weapons expected to remain in the stockpile will age beyond their original design lifetime between the years 2005 and 2010. It is important to have NIF in place and operating successfully well before this period so that the facility can be used to help verify the new computer models before problems may begin arising more rapidly. The goals of completing construction of NIF in 2002 and achieving ignition by 2005 would allow this to happen, first with nonignition target experiments and later with ignition experiments.

I.2.3 Other Benefits of the National Ignition Facility

NIF would be a multipurpose facility used for both national security and civilian applications. The most significant potential long-term civilian application of ICF is the generation of electric power. DOE is pursuing two distinct approaches to fusion energy: magnetic fusion energy and inertial fusion energy. Development of inertial fusion as a source of electrical power depends upon achieving ignition in NIF. This approach to inertial fusion energy is consistent with the recommendations of the National Academy of Science's *Second Review of the Department of Energy's Inertial Confinement Fusion Program* (NAS 1990) and the *Fusion Policy Advisory Committee Report* (DOE 1990). Many studies (such as Meier 1994; Moir 1994) have described viable power plant designs that could be developed once high-gain targets are understood. Furthermore, the International Atomic Energy Agency report, *Energy from Inertial Fusion* (IAEA 1995), describes possible engineering development paths to a demonstration fusion power plant once ignition is established on NIF. These development paths are most efficiently accomplished if NIF can first be used to (1) determine the beam energy required for ignition, (2) map out the target gain curves, and (3) understand the post-ignition dynamics of the environment inside a reaction chamber. Thus, early achievement of ignition in NIF is needed to allow the pursuit of an efficient, timely, inertial fusion energy development program.

NIF would also establish new capabilities for the basic sciences. Because fusion targets would provide temperatures and pressures similar to those found in the sun and other stars, data from NIF high-energy-density experiments would interest scientists working in such fields as astrophysics, material sciences, nonlinear optics, x-ray sources, plasma physics, and computational physics. For example, astrophysicists could do experiments that study some of the processes that occur during primordial nucleosynthesis (the original formation of all elements), stellar evolution, and spectacular events such as a supernova explosion.

As the world's largest optical instrument, NIF could spur high-technology industries in the areas of optics, lasers, materials, high-speed instrumentation, semiconductors, and precision manufacturing. Past ICF developments, for example, have led to manufacturing capabilities for precision optics that enabled the development of correcting optics to fix the initial problem of the Hubble space telescope. The ICF need for high-speed target diagnostics led to the development of a low-cost micro-impulse radar that has many commercial applications (12 industrial licenses have already been granted). Commercial applications derived from NIF could include flexible, low-cost, laser-based manufacturing; advanced x-ray lithography for integrated circuit manufacturing; high-density information storage; improved flat-panel display technology; advanced health care technologies; new materials; and new scientific instrumentation.

NIF would play a major role in U.S. science and technology early in the next century. Its civilian and defense missions would maintain weapons technology and expertise for continuing national security objectives, assess a new energy option, contribute to the basic high-energy-density sciences, and enhance industrial competitiveness through numerous technology advances.

I.2.4 Relationship of the National Ignition Facility to Other Department of Energy Environmental Impact Statements

DOE prepared this Programmatic Environmental Impact Statement (PEIS) to assess the alternatives for conducting the Stockpile Stewardship and Management Program, including the action described in this NIF Project-Specific Analysis (PSA). The PEIS also evaluates the No Action alternative and provide an assessment of environmental impacts to support programmatic and siting decisions.

However, for NIF and certain other facilities, the PEIS includes both a programmatic assessment and site-specific assessments of the construction and operation impacts at the reasonable candidate sites. The site-specific assessments consider the environmental impacts associated with siting of these facilities and provide a basis for deciding whether or not to proceed with construction.

DOE is currently preparing site-wide EISs for two of the five sites proposed as alternative locations for NIF: the Nevada Test Site (NTS) and the Los Alamos National Laboratory (LANL). The projected completion dates for these EISs are late 1996 for LANL and NTS. A site-wide EIS for the Lawrence Livermore National Laboratory, the preferred NIF location, was issued in 1992. The site-wide EISs address the continued operation of the sites, including near-term (within 5 to 10 years) proposed projects. The sitewide EIS's probide an opportunity to address the cumulative impacts of all reasonably foreseeable activities and provide a mechanism for coordinating site and agency planning for complex facilities by provideing an opportunity for review of the potential collective environmental effects associated with lafge, diverse facilities. The EIS's evaluate a range of different alternatives, including the alternative of continuing current operations.

DOE's *Draft Waste Mangement Programmatic Environmental Impact Statement*, issued in August 1995, addresses the long-term management and safe treatment, storage, and disposal of radioactive, hazardous, and mixed wastes. NIF would generate these types of wastes, and the treatment, disposal, and storage of NIF wastes would be compatible with any decisions resulting from the waste management PEIS. DOE is proceeding with two other actions related to the Stockpile Stewardship and Management Program: the Dual-Axis Radiographic Hydrodynamic Test Facility EIS (DOE 1995c) and the Tritium Supply and Recycling PEIS (DOE 1995d). DOE determined that implementing the ROD on these two facilities will not prejudice any decisions in the Stockpile Stewardship and Management Program.

I.3 Proposed Action and Alternatives

I.3.1 Overview

This chapter describes the alternatives analyzed in this Project-Specific Analysis (PSA) for the construction and operation of the National Ignition Facility (NIF) at one of five candidate locations at four alternate sites: Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), Nevada Test Site (NTS) Area 22 main site location and North Las Vegas Facility (NLVF) location near NTS, or Sandia National Laboratories (SNL). The NIF Conceptual Design Report (LLNL 1994b) describes the proposed action in detail and establishes the technical feasibility of the project. Section I.3.2 describes the proposed action and includes a description of NIF and its operations. Section I.3.3 describes the No Action alternative. Section I.3.4 describes the five locations at the four alternative sites, including their selection, location, infrastructure requirements, and site-specific aspects of NIF construction and operations. Section I.3.5 discusses other alternatives not considered in detail. Section I.3.6 summarizes and compares the impacts of construction and operation of NIF at the four alternative sites.

I.3.2 Proposed Action

The proposed action is to construct and operate NIF, which would be capable of achieving fusion ignition by the inertial confinement fusion (ICF) process. Two options for NIF operations have been proposed. The Conceptual Design Option would use an ICF approach called *indirect drive* . The current research program on ICF has emphasized development of the indirect drive approach, and the experimental program currently planned for NIF uses that approach. In indirect drive, laser beams would illuminate and heat the interior surfaces of a metal case (hohlraum) containing a deuterium-tritium-filled capsule. The beams would cause the case to emit x rays that would in turn strike the fusion target capsule and drive the fusion reaction (figure I.3.2-1). Targets used for indirect drive would contain sub-milligram levels of tritium.

An Enhanced Option would include the above indirect drive operations and a second approach called *direct drive* . The Enhanced Option would also include the ability to perform an increased number of experiments to accommodate greater user needs. No hohlraum would be used in the direct drive ICF method. Instead, a large number of laser beams would impinge directly on the outer surface of the capsule containing the tritium and deuterium (figure I.3.2-1). Targets for direct drive would contain milligram levels of tritium. Achieving ICF by direct drive is theoretically possible, and an experimental feasibility program is currently underway at the Omega Upgrade Facility at the University of Rochester Laboratory for Laser Energetics in New York and at the Naval Research Laboratory in Washington, D.C. Because it is possible that NIF would be used for direct-drive experiments in its lifetime, operating conditions for both indirect- and direct-drive experiments have been developed and are assessed in this PSA.

I.3.2.1 National Ignition Facility Components

NIF would consist of three main elements: a laser system and optical components, a target chamber placed within a target area, and an advanced integrated computer system to control the lasers and diagnostic equipment. These three elements would be housed in a single environmentally controlled building called the Laser and Target Area Building (figure I.3.2.1-1). The entire NIF complex (figure I.3.2.1-2) would require a maximum area of about 20 hectares (ha) (50 acres). Depending on the site selected, many of the NIF needs may be served by existing facilities (see section I.3.4), reducing the requirements for a full 20 ha (50 acres) of new land area.

I.3.2.1.1 *Laser and Target Area Building*

The Laser and Target Area Building would be an environmentally controlled facility housing the laser and target area systems and the integrated computer system. The majority of the building would contain laser optics. This reinforced concrete and structural steel building would be constructed to be vibration isolated, provide radiation confinement and control, and include all necessary machine control and diagnostic systems. It would consist of two laser bays, two optical switchyards, a target chamber in a target area, target diagnostic facilities, capacitor areas, control rooms, and operations support areas (figure I.3.2.1-1). The floor plan would have a U-shaped layout, with the laser bays forming the legs of the "U" and the optical switchyards and target room forming the connection (LLNL 1994b).

I.3.2.1.1.1 *Laser System*

A laser is a device that produces a beam of monochromatic (single-color) "light" in which the waves of light are all in phase. This condition creates a beam that has relatively little divergence (scattering) and has a high concentration of energy per unit area of the beam. The NIF laser system would generate and deliver high-power optical pulses to a target suspended in the target chamber. Multiple laser beams would be used to uniformly irradiate the required target surface area.

The NIF laser would contain 192 independent laser beams, or beamlets. Each beamlet would have a square aperture of slightly less than 40-centimeter (cm) (16-inch [in]) beam width. Beamlets, each of which would have a unique beam path, or beamline, to the chamber, would be grouped in 48 2x2 groupings at the target chamber. The 192 beamlines would require more than 10,000 discrete optical components. Figure I.3.2.1.1.1-1 illustrates a schematic diagram of the path of one beamlet from origin to the target.

I.3.2.1.1.2 *Target Area*

The NIF target area (figure I.3.2.1.1.2-1) would provide confinement of tritium and activation products by providing physical barriers and by controlling air flow. In addition shielding would provide protection from neutron and gamma radiation. The target area would consist of the following major subsystems: target chamber, target emplacement positioner, target diagnostics, target diagnostic control room, support structures, environmental protection, and vacuum and other auxiliary systems (LLNL 1994b). The primary tritium confinement would be provided by the target (vacuum) chamber and tritium collection system, which would be designed to capture tritium exhausted from the test chamber. The secondary tritium confinement would be the Target Area Building structure, which would be provided with a heating, ventilation, and air conditioning system capable of operating at a negative pressure during and immediately after shots of greater than 1 megajoule (MJ). The building structure would act as the confinement for air activation products. The final exhaust release point from the heating, ventilation, and air conditioning system would be elevated. The airborne radiation releases at the building release points would be measured and the target area would have monitors to allow detection of conditions requiring corrective or protective actions.

Environmental protection systems, including tritium-handling systems, target storage, and decontamination equipment used to clean the target chamber components, would be located adjacent to the target chamber and target chamber room. X-ray, optical, and neutron measurement instruments would be arranged around the chamber to help evaluate the success of each target experiment. Structural support of the target diagnostics, as well as of the target positioner, final optic assemblies, and turning mirrors, would be provided by target area structures. The target area would also provide the following subsystems: the target area auxiliary systems, material handlers, the chamber personnel transporter, and the diagnostics and classified control rooms.

I.3.2.1.1.3 *Target Chamber*

The NIF target chamber would be a 10-meter (m) (33-feet [ft]) internal-diameter spherical aluminum shell with walls 10 cm (4 in) thick (figure I.3.2.1.1.3-1), and the exterior of the chamber would be encased in 40 cm (16 in) of concrete to provide neutron shielding. The target chamber would be supported vertically by a hollow concrete pedestal and horizontally by radial joints connected to the cantilevered floors. The aluminum wall of the chamber would provide a vacuum barrier and mounting surface for the first wall panels, which protect the aluminum from soft x rays and shrapnel. The vacuum system would provide a 10^{-6} torr vacuum level for target experiments (LLNL 1994b). The laser beams would enter the chamber in two conical arrays from the top and two conical arrays from the bottom. At the poles and in the equatorial regions of the chamber, diagnostic equipment would be inserted through the chamber wall. Unconverted laser light that hit the opposite wall would be absorbed by the light-absorbing panels located adjacent to and slightly smaller than the opposing beam port. The target chamber would also include the target emplacement and positioning/alignment systems and planned diagnostics.

I.3.2.1.1.4 *Integrated Computer Control System*

The computer control system would be an integrated network of conventional computer systems providing the hardware and software needed to support full operational activities. The system would include the computer controls to manage the complex laser optical system and would have to meet security requirements to handle classified information.

I.3.2.1.1.5 Sequence of Events During an Ignition Shot

A shot would begin as weak laser pulses at four separate frequencies (or colors of light) in the master oscillator room (figure I.3.2.1-1). Each pulse is launched into an optical fiber system that amplifies and splits the pulse into 192 separate fibers, 48 of each color. The four colors are used to smooth the intensity (power per unit area) of the laser spot on the target. The power in the laser pulse at this point is a little less than a watt. Typical pulses are a few nanoseconds long, so the energy is a few nanojoules. The optical fibers carrying the pulses then spread out to 192 preamplifiers. The preamplifiers are located beneath the focal plane at the center of the large transport spatial filters, which are located between the laser components and the target chamber (figure I.3.2.1.1.1-1). Within the preamplifier, the pulse is amplified by a factor of about one million, to about a millijoule. The laser pulse then enters spatial beam-shaping optics and a flashlamp-pumped, four-pass rod amplifier, which converts it to about a 1-joule pulse with the spatial intensity profile needed for injection into the main laser cavity.

The pulse of laser light from the preamplifier reflects from a small mirror (labeled LM0, figure I.3.2.1.1.1-1). The laser light comes to a focus at the focal plane of the transport spatial filter, and passes through booster amplifier 3, reflects from the polarizer, is amplified further in cavity amplifier 2, goes through a second spatial filter (the cavity spatial filter), then passes through cavity amplifier 1, and reflects from the deformable mirror (mirror LM1, figure I.3.2.1.1.1-1). The beam then reflects back through cavity amplifier 1, the cavity spatial filter, and cavity amplifier 2.

In the interim, the Pockels cell (figure I.3.2.1.1.1-1) is energized. This component rotates the plane of polarization of the laser light from horizontal to vertical. Therefore, the laser light pulse passes through the polarizer and strikes cavity mirror LM2, which redirects the pulse back to the Pockels cell, which rotates the polarization back to horizontal. The pulse then continues towards the deformable mirror LM1. It then reflects back from LM1, through cavity amplifier 1, the cavity spatial filter, and cavity amplifier 2 again. By this time the Pockels cell has been de-energized so that it no longer rotates the polarization of the pulse. Thus, the laser pulse reflects from the polarizer and is further amplified by booster amplifier 3 to an energy of about 17 kilojoules for a typical ignition target pulse shape. The pulse then passes through the transport spatial filter on a path slightly displaced from the input path, thus just missing the injection mirror LM0.

The laser pulse then travels through a long beam path reflecting from several transport mirrors (LM 4 through 8) until it reaches the target chamber. (For simplicity, figure I.3.2.1.1.1-1 does not show all of these mirrors.) Mounted on the target chamber is a frequency converter that changes the infrared laser pulses to ultraviolet light. The focusing lens then brings the four color pulses (192 separate fibers or 48 for each color pulse) to a focus at a single spot at the center of the target chamber. The debris shield/phases plate (figure I.3.2.1.1.1-1) protects the focusing lens from any target fragments, and it may also have a pattern etched into its surface to reshape the distribution of laser intensity in the focal spot on the target.

The target would be a small spherical capsule whose hollow interior would contain a thin annular layer of liquid or solid DT fuel (a mixture of deuterium and tritium isotopes of hydrogen). The outer surface of the capsule is rapidly heated and evaporated, either by the absorption of soft x rays under indirect drive or by direct heating by lasers under direct drive (see figure I.3.2-1). The rocket effect caused by the evaporated outer capsule creates an inward pressure causing the capsule to implode in about 4 nanoseconds. The implosion heats the DT fuel in the core of the capsule to about 50 million degrees Celsius (90 million degrees Fahrenheit), sufficient to cause the innermost core of the DT fuel to undergo fusion. The fusion reaction products deposit energy in the capsule, further increasing the fuel temperature and the fusion reaction rate. Core fuel ignition occurs when the self-heating of the core DT fuel due to the fusion reaction product deposition becomes faster than the heating due to compression. The ignition of the core would then propagate the fusion burn into the compressed fuel layer around the core. This will result in the release of much more fusion energy than the energy required to compress and implode the core.

The energy in one pulse would be about equal to the caloric energy in one candy bar (1.8 MJ, or 400 food calories). However, the peak power for a few nanoseconds would be equal to about 500 terawatts (500×10^{12} watts), instantaneously exceeding the steady-state power capacity in the entire United States by about a factor of 1,000 (LLNL 1994a).

I.3.2.1.2 Target Receiving/Inspection Area

NIF would require a facility at which to receive and inspect targets fabricated at another site (LLNL 1995b). This area would require several Class 100 (Airborne Particulate Cleanliness Class) clean rooms and inspection laboratories in a vibration-free environment. This facility would also include cryogenic laboratories and a central chemical waste system. The facility would have to meet security requirements to handle classified equipment.

I.3.2.1.3 *Other Areas*

Optics Assembly Area/Clean Room. The optics assembly area/clean room would be used to clean, coat (for example, with Sol-gel as an optics dielectric), inspect, and assemble the NIF's optics and crystals (LLNL 1995b).

General Assembly Area. The general assembly area would be used to assemble mechanical and electrical components not requiring a clean-room environment (LLNL 1995b). The facility would be equipped to handle large and heavy assemblies. This area would also be used for assembly welding.

Optics Maintenance Area. The optics maintenance area would be used for refurbishing, cleaning, and coating of both laser glass and optical components (LLNL 1995b). This specialized area would require vibration isolation, temperature and humidity controls, and Class 100 clean rooms.

Optics Storage Area. During the NIF operational phase, spare parts would be stored in the optics storage area. Because of the size and mass of many of these components the storage area would provide for truck and forklift access (LLNL 1995b).

Radioactive Storage Area . The radioactive storage area would be an intermediate storage area used to store components that come out of the target area before they can be decontaminated.

Electrical and Mechanical Shops. The electrical and mechanical shops would house the machine tools to be used for repairs, maintenance, and special fabrication required for daily operations of the NIF laser and its auxiliary systems (LLNL 1995b).

Support Facilities. NIF would require the following additional support facilities (LLNL 1995b): (1) shipping, receiving, and central stores; (2) medical building; (3) cafeteria; (4) garage and gas station; (5) fire station; and (6) security and badging. All of these services currently exist within the infrastructures of the candidate sites and could be used by NIF.

I.3.2.1.4 Facility Construction

Conventional construction techniques would be used to build NIF. The extent and exact nature of such activities as site clearing, infrastructure improvements, and support facility construction required would depend on the specific location selected for NIF. Construction of NIF would be organized in the following sequential phases: (1) initial building construction, (2) special equipment structures installation, (3) final building construction, (4) final installation preparation, (5) clean component installation, and (6) final laser/target systems installation.

As conceptually designed, about 20 ha (50 acres) of land area would be required for NIF. Figure I.3.2.1-2 shows an overall conceptual plan of a generic NIF site, including all required buildings and improvements. Within this area, all direct and support buildings for NIF would require 4.7 ha (11.6 acres). There would also be 4.1 ha (10.1 acres) of access roads and 1.9 ha (4.7 acres) of parking space (LLNL 1995b). The remaining 9.3 ha (23.0 acres) would consist of open space (e.g., landscaped lawns). The actual amount of land required at the selected host site would be less, as all of the candidate sites have existing facilities that could meet some of the infrastructure requirements for NIF (see section I.3.4). During construction, about 2.0 ha (4.9 acres) of land would be required for a construction laydown area. The laydown area would be located within or near the location designated for the NIF (see section I.3.4). Following construction, the laydown area would be restored to its preconstruction condition or incorporated into the landscaping design selected for the site.

I.3.2.2 Facility Operations

The NIF experimental plan comprises several stages:

- Start-up experiments to activate core diagnostics and to validate laser performance
- Hohlraum tuning experiments to attain minimum asymmetry in x-ray drive (indirect-drive approach only, laser symmetry experiments for direct drive)
- Cryogenic pre-ignition experiments for detailed study of capsule implosions
- User experiments for weapons physics, weapons effects, and other user groups
- Ignition experiments
- Ignited burn experiments to obtain basic data for inertial confinement energy development,

basic scientific research on high-density plasmas, and research relative to various military-related applications

When the laser "fires" on a target, all 192 laser beams are synchronized such that after grouping in 48 2x2 groupings at the chamber, they simultaneously "hit" the target. The target is compressed and heated, creating intense fusion reactions. Ignition is defined as occurring when heating of the compressed target by fusion products is just adequate to create an advancing front, or wave, of fusion reactions across the target, heating or "igniting" the entire fuel in the target to reaction conditions.

The numbers and types of "shots" needed to achieve ignition have been estimated on the basis of experience with other large laser systems-such as Nova (many of the activities for NIF would have parallels with Nova, such as hohlraum symmetry and plasma diagnostic activation) and the NIF Beamlet Demonstration Project. Relatively low laser energies would be required for most of the early shots; shaped pulses greater than 1 MJ would be required for very few shots before the demonstration of ignition. It is estimated that approximately 1,600 target shots, in addition to approximately three months of downtime for installation of a cryogenic target positioner, would be required to attain ignition (LLNL 1994b). Concurrently, other target experiments would be carried out for various user communities.

I.3.2.2.1 *Conceptual Design Operations*

It is expected that once ignition is achieved, NIF would be operated within the constraints specified for an operational baseline in the Conceptual Design. This baseline, or Conceptual Design Option, is the 192-beam, indirect drive operation mode for NIF. The estimated parameters for the Conceptual Design Option are as follows:

- Maximum design yield: 20 MJ
- Annual total yield: 385 MJ/year (yr)
- Tritium throughput: 600 Curies (Ci)/yr
- Maximum tritium inventory: 300 Ci
- Tritium effluent: 10 Ci/yr

I.3.2.2.2 *Enhanced Option Operations*

The enhanced NIF operational capabilities, or Enhanced Option, would include the indirect drive and user capabilities described above plus direct-drive capabilities and additional test-specific capabilities that might be desired by the user communities. In addition, the Enhanced Option would include the ability to perform an increased number of yield experiments per year to accommodate greater user needs. Enhanced capability operations would involve some design changes to the Conceptual Design Option Facility. By diverting the 24 beamlines (96 beamlets) from the indirect-drive configuration for direct drive, an additional 24 beam ports would be placed evenly spaced half above and half below the chamber equator. Final optics assemblies already modified for direct drive would be placed permanently at these ports. The final turning mirrors that direct the laser beams to their final optics assemblies would be adjusted with motors to direct the selected beams away from their usual final optics assemblies and toward another final mirror that would send the beams through the new final optics assemblies in a direct-drive mode. A different target positioner would be required for direct-drive target insertion and positioning. A new target shroud that could be removed much more quickly than that for indirect drive would also be required. Equipment decontamination systems would also be upgraded for the Enhanced Option. The Enhanced Option Facility would use the same utilities and consumables (for example, electricity, water, fuel, and oil) as the Conceptual Design Option Facility.

Under the Enhanced Option, NIF would have the capability to do both direct and indirect drive target experiments (although several days would be necessary to switch from one mode to another). The facility would also have the capacity to handle more experiments per year (both yield and no-yield types) to accommodate greater user needs than permitted by the Conceptual Design Option operations. The estimated operating parameters for the Enhanced Option are as follows:

- Maximum design yield: 20 MJ[1]
- Annual total yield: 1,200 MJ/yr
- Tritium throughput: 1,750 Ci/yr
- Maximum tritium inventory: 500 Ci
- Tritium effluent: 30 Ci/yr

I.3.2.2.3 *Security*

Both classified and unclassified activities would be conducted at NIF, and appropriate security and badging requirements would be implemented. Because many uncleared visitors are expected to use the facility, security features would be designed to allow easy access for visitors while at the same time maintaining effective physical and technical security where necessary.

Security requirements would include those for physical protection of classified matter; physical protection of Department of Energy (DOE) property and unclassified facilities; protective program operations; and personnel security, including issuance, control, and use of badges, passes, and credentials. In addition, telecommunication services would be designed to be capable of handling both classified and unclassified information.

I.3.3 No Action Alternative

Under the No Action alternative, NIF would not be constructed or operated. NIF's experiments related to science-based stockpile stewardship (see section I.2.2) would not be realized. If NIF were not built, the ability of the Stockpile Stewardship and Management Program to obtain the fusion and high-temperature/density data that would have been available with NIF would be hampered or delayed. The Stockpile Stewardship and Management Program would continue to use Nova and other facilities for as long as they produced useful data, but the existing facilities are not capable of reaching the temperatures and pressures that are anticipated for NIF. If other technologies were proposed to obtain higher temperatures and pressures than those available from existing facilities, such technologies would not be operational by the period 2005 to 2010. When enduring stockpile weapons age beyond their original design lifetimes, confidence in the reliability of such weapons may decrease significantly, and the probability would increase that the United States might have to invoke "supreme National interest" and withdraw from any test moratorium or Comprehensive Test Ban Treaty.

Under the No Action alternative, many operations at LLNL, LANL, SNL, and NTS would continue as described in the existing environment subsections of chapter I.4. However, all existing NIF-dependent functions of the ICF program would be discontinued at LLNL, LANL, and SNL. The number of employees at each of these sites would decrease somewhat as a result. For the purposes of the socioeconomic analysis in this PSA, it is assumed that employment at LLNL would decrease by 100, employment at LANL would decrease by 20, and employment at SNL would decrease by 20. There would be no change in employment at NTS or NLVF related to the No Action alternative.

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1 Maximum credible yield is 45 MJ for bounding accident evaluation.

I.4 Affected Environment and Environmental Impacts

I.4.1 Lawrence Livermore National Laboratory

I.4.1.1 Affected Environment

The following sections describe the affected environment associated with the construction and operation of the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory (LLNL). Land use, air quality and acoustics, water resources, biotic resources, cultural and paleontological resources, socioeconomics, radiation and hazardous chemicals, and waste management are described.

I.4.1.1.1 Location and Land Use

The LLNL 332-hectare (ha) (821-acre) site is east of the city of Livermore, California; immediately to the south is Sandia National Laboratories (SNL), Livermore (figure I.3.4.1.1-1). Although their primary missions are similar, LLNL and SNL are separate facilities. Also located south of LLNL are agricultural areas devoted to grazing, orchards and vineyards, some low-density residential areas, and a business park to the southwest. A very small amount of low-density residential development lies east of LLNL, and a business park is located to the north. A parcel of open space to the northeast has been rezoned to allow development of a center for heavy industry (LLNL 1994d). A high-density residential area lies west of the site. I.4.1.1.1-1 shows generalized land use at LLNL and vicinity.

The majority of the LLNL site is designated "industrial," and the perimeter areas on the western and northern portions of the site are designated "industrial" or "agricultural." The southwestern and southeastern quadrants of the site are the most crowded. The proposed location for NIF at LLNL is in the northeastern quadrant of the site adjacent to existing inertial confinement fusion (ICF) facilities (figure I.3.4.1.1-2).

Slopes at the LLNL site are nearly level. Soils are loamy textured, shallow to very deep soils occur on older fans and floodplains. The erosion potential is slight to moderate. No prime or unique farmland soils are located at LLNL.

I.4.1.1.2 Air Quality and Acoustics

This discussion of existing air quality and acoustics includes a review of the meteorology, climatology, and atmospheric dispersion characteristics near LLNL. No meteorological data were available for the proposed NIF location, so the nearest local and regional monitoring information was used to describe expected site conditions.

I.4.1.1.2.1 Meteorology and Climatology

The climate at LLNL and the surrounding region is characterized by mild, rainy winters and warm, dry summers. The annual average temperature at LLNL is 15.0 degrees Celsius (°C) (59.0 degrees Fahrenheit [°F]); average daily temperatures range from 7.9 °C (46.2 °F) in January to 21.0 °C (69.8 °F) in July. The average annual precipitation is 37.8 centimeters (cm) (14.9 inches [in]) (LLNL 1995a). The prevailing winds are from the southwest to west at an annual average wind speed of 3.3 meters per second (m/s) (7.4 miles [mi] per hour [hr] [mph]) (LLNL 1992). The 1994 annual wind rose for LLNL is shown in figure I.4.1.1.2.1-1. During 1994, unstable conditions occurred approximately 29 percent of the year, neutral conditions occurred about 35 percent of the year, and stable conditions occurred the remaining 36 percent (LLNL 1995d). Atmospheric dispersion improves as the wind speed increases and atmospheric conditions become more unstable.

I.4.1.1.2.2 Ambient Air Quality

National Ambient Air Quality Standards (NAAQS) exist for the criteria air pollutants ozone, carbon monoxide, nitrogen dioxide, sulfur oxides (measured as sulfur dioxide), particulate matter with a diameter of less than microns (PM 10), and lead (40 Code of Federal Regulations [CFR] 50). California has established state ambient air quality standards for these pollutants, as well as standards for suspended sulfates, hydrogen sulfide, vinyl chloride (chloro-ethene), and visibility reducing particles. In addition, the Bay Area Air Quality Management District (BAAQMD) has established a monthly ambient concentration limit for beryllium 1994d), which is the same as the National Emission Standard for Hazardous Air Pollutants for beryllium (40 CFR 61.32). Applicable NAAQS and California state and BAAQMD ambient air quality standards are presented in I.4.1.1.2.2-1.

Table I.4.1.1.2.2-1.-- Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Lawrence Livermore National Laboratory

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Pollutant	Averaging Time	Most Stringent Regulation or Guideline g/m^3)	1993 Baseline Concentration [1] g/m^3)
Criteria Pollutant			
Carbon monoxide	8-hour	10,000[2], [3]	4,600
	1 hour	23,000[3]	7,000
Lead	Calendar quarter	1.5[2]	0.01
	30-day	1.5[3]	0.01
Nitrogen dioxide	Annual	100[2]	36
	1 hour	470[3]	210
Ozone	1 hour	180[3]	250[4]
Particulate matter 10 microns or smaller	Annual arithmetic mean	50[3]	24.3
	Annual geometric mean	30[3]	20.9
	24-hour	50[3]	84 [4]
Sulfur dioxide	Annual	80[2]	ND [5]
	24-hour	105[3]	ND
	3-hour	1,300[2]	ND
	1 hour	655[3]	ND
Mandated by State			
Hydrogen sulfide	1 hour	42	ND
Suspended sulfates	24-hour	25	6.9
Vinyl chloride (chloroethene)	24-hour	26	ND
Visibility-reducing particles	8-hour (10 a.m.-6 p.m. PST)	[6]	ND
Mandated by BAAQMD			
Beryllium	30-day	0.01	0.000137
Other Air Pollutants			
Particulate ammonium-10mm	24-hour	NS [7]	1.50
Particulate chloride-10mm	24-hour	NS	3.61
Particulate nitrate-10mm	24-hour	NS	20.8
Particulate sulfate-10mm	24-hour	NS	4.7
Suspended nitrates	24-hour	NS	22.5
Total suspended particulates	24-hour	NS	93.0

LLNL is located within the San Francisco Bay Area Basin, designated by the Federal Government as the San Francisco Bay Intrastate Air Quality Control Region (AQCR 30). The Bay Area Basin is in attainment for all national ambient air quality standards except carbon monoxide in an urban area that includes the northern tip of Alameda County (40 CFR 81.305). This nonattainment area does not include LLNL. The Bay Area Basin is designated nonattainment for the state ozone and PM 10 and has an unclassified state designation for hydrogen sulfide and visibility reduction (CARB 1994). (With the exception of one county designated as attainment and four counties and part of a fifth county designated as unclassified, all of California is designated as nonattainment for the state 24-

hour PM 10 .) In general, pollutant emission increases in an area designated nonattainment for a specific pollutant are subject to more stringent permitting requirements than if the area is designated as attainment.

The BAAQMD is responsible for air pollution control from stationary sources and attainment of air quality standards in the San Francisco Bay Area, including Alameda County. The district operates ambient air monitors throughout the San Francisco Bay Area Air Basin to determine compliance with national and state ambient air quality standards. The BAAQMD monitor closest to LLNL is the Livermore Old First Street Station located in downtown Livermore. In addition, LLNL maintains onsite and 11 offsite particulate monitors that measure airborne beryllium concentrations. The most recently published data show violations in calendar year 1993 of the state and national ozone standards and the state 24-hour PM 10 standard (see table I.4.1.1.2.2-1 and Lazaro et al. 1996).

Federal Prevention of Significant Deterioration (PSD) regulations limit increases in criteria pollutant concentrations resulting from emissions from new sources above a baseline concentration. The allowable concentration increases (called increments and presented in Lazaro et al. 1996), depend on the PSD classification of the area. Class I areas allow the smallest increases. The area surrounding LLNL contains several PSD Class I areas. The closest such areas are Point Reyes National Wilderness Area, approximately kilometers (km) (55 miles) to the west-northwest; Desolation National Wilderness Area and Mokelumme National Wilderness Areas (160 to km [100 to 110 mi]) to the northeast; and Emigrant National Wilderness Area, Hoover National Wilderness Area, and Yosemite National Park (215 to km [135 to 145 mi]) to the east-northeast and east.

The primary emission sources of criteria pollutants at LLNL are numerous boilers, solvent cleaning operations, stand-by electric generators, and various experimental, testing, and process sources. Emissions estimates for these sources are presented in section I.4.1.2.2.

I.4.1.1.2.3 Acoustic Conditions

Major noise emission sources within LLNL include various experimental facilities, equipment, and machines. LLNL is bordered by highways along its entire boundary. In the vicinity of a highway, traffic contributes to ambient noise levels, especially during peak hours. Across the highways bordering the site, the main land uses are light industrial to the north and south, urban residential to the west, agricultural to the southwest, and open rangeland to the east. The acoustic environment along the LLNL boundary is generally assumed to be that of an urban location, with typical average daytime sound levels of 55 to 65 decibel A-weighted (dBA).

I.4.1.1.3 Water Resources

The LLNL site is in the eastern Livermore Valley. Only intermittent streams flow into the eastern Livermore Valley from the surrounding uplands and low hills. Two intermittent streams flow through the LLNL site: Arroyo Las Positas and Arroyo Seco (figure I.4.1.1.3.-1). The proposed NIF location is in the drainage of Arroyo Las Positas. Arroyo Las Positas drains an area of 13.3 square kilometers (km2) (5.16 square miles [mi2]) east of the LLNL site. The channel is not well defined and usually carries only storm runoff. The channel enters the site from the east, is diverted along a ditch around the northern edge of the site, and exits the site at the northwestern corner. Arroyo Seco has a drainage area of 36.3 km2 (14.0 mi2) upstream of Sandia National Laboratories, Livermore. The headwaters of the arroyo are in the hills southeast of the LLNL site. The channel is well defined in the LLNL area and is dry for at least six months of the year.

Surface drainage and infiltration at LLNL are generally good, but infiltration decreases locally with increasing clay content in soils (U. S. Department of Energy [DOE] and University of California [UC] 1992). About one-fourth of stormwater runoff within the LLNL site drains into the Central Drainage Basin (figure I.4.1.1.3.-1), which collects runoff from the southeastern quadrant of the LLNL site. During extreme wet weather, the basin can overflow through culverts into storm drains that discharge into Arroyo Las Positas. The remainder of the site drains either directly or indirectly into the two arroyos through storm sewers and ditches (DOE and UC 1992; LLNL 1994d).

Groundwater at the LLNL site occurs in an unconfined zone overlying a series of semiconfined aquifers. The two geologic units containing the most important aquifers are the surface valley-fill deposits and the Livermore Formation. The aquifers in the Livermore Valley are locally recharged by precipitation, irrigation, stream runoff from precipitation, and controlled releases from the South Bay Aqueduct and gravel pits west of the city of Livermore. Groundwater withdrawal from the Livermore Valley is mainly for agricultural use, municipal use, and gravel quarrying. In the vicinity of the LLNL site, agricultural withdrawal is still a major source of groundwater drawdown. Depth to groundwater at the LLNL site varies from about m (110 feet [ft]) in the southeast corner to m (30 ft) in the northwest corner (DOE and UC 1992).

Water used at LLNL (including Sandia National Laboratories, Livermore) is primarily surface water purchased from the city of San

Francisco Hetch Hetchy Aqueduct and from the Alameda County Flood and Water Conservation District, 7. A small amount of treated groundwater is used for irrigation and cooling tower makeup. In 1990, 983 million liters (L) (260 million gallons [gal]) and 74.1 L (19.6 million gal) of water were obtained from the two sources, respectively. The water is primarily used for industrial cooling processes, the sanitary system, and irrigation. The LLNL site (excluding Sandia National Laboratories, Livermore) currently uses 970 liters per year (MLY) (256 million gallons per year [MGY]) annually (LLNL 1995c) and used an average of 990 MLY (262 MGY) from 1986 through 1990 (DOE and UC 1992).

Beginning in 1988, LLNL started implementing water conservation measures such as reducing landscape watering by 35 percent below the projected 1989 level, reducing blowdown from cooling towers to minimal operable levels, limiting use of water for car washes, and eliminating the washing of sidewalks and driveways (DOE and UC 1992).

The city of Livermore Water Reclamation Plant handles sewage from the LLNL site and Sandia National Laboratories, Livermore. The plant currently receives an average of 6.205 MLY (1.643 MGY). The facility is being expanded to treat 11.753 MLY (3.103 MGY) (DOE and UC 1992). LLNL discharges about 402 MLY (110 MGY) of wastewater to the city of Livermore sewer system. This volume includes wastewater from Sandia National Laboratories, Livermore, which is discharged into the LLNL sewer system. LLNL tests and pretreats all wastewater before it leaves the site.

I.4.1.1.4 Biotic Resources

LLNL is within the Southern and Central California Plains and Hills Ecoregion (Omernik 1986). This ecoregion is dominated by annual grasslands. A generalized overview of the habitats and biota that occur at LLNL are provided by DOE and UC (1992). Agricultural, industrial, and residential developments have limited the diversity of wildlife in the area of LLNL. About 259 ha (640 acres) percent) of the 332-ha (821-acre) LLNL site is developed. The developed portions of LLNL are planted with ornamental vegetation and lawns; the undeveloped lands in the security areas (including the proposed NIF and laydown locations) are primarily dominated by non-native grasses and forbs. Common plant species include ripgut brome, slender oat, star thistle, Russian thistle, turkey mullein, sweet fennel, and Italian ryegrass (DOE and UC 1992). Relatively small areas of other habitats at LLNL hold a special significance, either because of their uniqueness or because of their importance as habitat to biota. These areas are primarily limited to remnant riparian habitats in Arroyo Seco along the southwestern corner of LLNL. These areas contain native tree species such as red willow and California walnut and introduced species such as black locust and almond (DOE and UC 1992). No wildlife refuges or sanctuaries occur at LLNL.

The wildlife of LLNL consists primarily of species adapted to habitats that have been disturbed by humans and that are tolerant of human presence (DOE and UC 1992). Common species at LLNL include the western fence lizard, western meadowlark, American crow, American robin, Anna's hummingbird, white-throated swift, California quail, house sparrow, scrub jay, European starling, house finch, house sparrow, desert cottontail, black-tailed jackrabbit, feral house cat, and California ground squirrel. Raptors that have been observed at LLNL include the red-tailed hawk, Cooper's hawk, sharp-shinned hawk, ferruginous hawk, red-shouldered hawk, black-shouldered kite, American kestrel, burrowing owl, turkey vulture, and golden eagle. Red and gray foxes, coyotes, and raccoons are also known to exist throughout LLNL (DOE and UC 1992).

Wetlands at LLNL are limited to three small areas totaling 0.15 ha (0.36 acre) located at, and downstream from, culverts (DOE and UC 1992). Saltgrass and sedge dominate the two wetlands that exist along Arroyo Las Positas; the other wetland is dominated by cattails, with saltgrass and sedge also existing. Other plant species existing in these wetlands include willow, curly dock, ryegrass, and Hooker's evening primrose. These wetlands are located m (1,000 ft) and more from the proposed NIF construction area.

Aquatic habitats are limited to intermittent drainages (in the two arroyos that cross the site), ditches, and a 1.6-ha (4-acre) water retention basin at LLNL. The water retention basin, located southwest of the proposed NIF location near the center of LLNL, is the only water body that contains fish (mosquito fish). It also could provide habitat suitable for waterfowl, tricolored blackbirds, sensitive amphibians, and sensitive aquatic invertebrates. Runoff from this basin could eventually increase riparian habitat within Arroyo Las Positas (DOE and UC 1992). Kingfishers and pied-billed grebes have been observed at the basin (LLNL 1994d).

A list of rare, threatened, and endangered Federal and state species that could exist at LLNL is provided in Lazaro et al. (1996). Most of the listed species would be more likely to exist in the less disturbed habitats of LLNL, although several of the species could forage or inhabit the grassland habitat identified for NIF and/or laydown locations (such as western burrowing owls). During detailed surveys conducted in 1991, no sensitive species were encountered at LLNL (DOE and UC 1992). During the summer of 1994, a nesting pair of white-tailed kites, a state-protected species, was noted in a stand of eucalyptus trees near the East Gate (LLNL 1994a). No designated critical habitats for federally listed species exist at LLNL.

I.4.1.1.5 Cultural and Paleontological Resources

No prehistoric or historic archaeological sites or historic structures exist on the proposed locations for NIF at LLNL. The uppermost 0.6 to m (2 to 4 ft) of sediment at the proposed site is composed of redeposited fill that would not contain any undisturbed archaeological remains. Results of an intensive pedestrian survey (employing 15 m [50 ft] transects) conducted in July 1990 noted the disturbed character of the surficial sediment and absence of archaeological remains (Bennett 1994). The fill unit overlies alluvium of Pleistocene age that was deposited at least 15,000 years ago (Dresen and Weiss 1985) and thus antedates the earliest documented human settlement in the region (therefore, has little or no probability of containing archaeological remains). Paleontological remains (which would represent late Quaternary fauna) have not been recovered from the alluvium (Dresen and Weiss 1985). Consultation is in progress with Native American groups to identify any important cultural resources on LLNL.

I.4.1.1.6 Socioeconomics

Socioeconomic characteristics discussed here include the regional economy, population and housing, public finance and public service infrastructure, and local transportation. Regional economic statistics are based on a regional economic study area that encompasses counties around LLNL, as defined by the U.S. Bureau of Economic Analysis (BEA). The economic study area is a broad labor and product market-based region linked by trade among economic sectors within the region. Statistics for population and housing, public finance, and public service infrastructure are based on the region of influence (ROI), a three-county area (Alameda, Contra Costa, and San Joaquin counties) in which nearly percent of all LLNL employees reside. Lazaro et al. (1996) lists counties included in the economic study region and the counties included in the ROI. Assumptions, assessment methodologies, and supporting data for each technical area are also presented in Lazaro et al. (1996).

I.4.1.1.6.1 Regional Economy

The regional economic study area for LLNL includes the San Francisco-Oakland-San Jose Consolidated Metropolitan Statistical Area, consisting of the following Primary Metropolitan Statistical Areas: Oakland, San Francisco, San Jose, Santa Cruz, Santa Rosa-Petaluma, and Vallejo-Fairfield-Napa. Between 1988 and 1995, employment in the economic study area was projected to increase from 4,555,600 to 5,117,400. BEA projects a compounded average annual rate of growth of percent from 1995 to 2003 jobs) (BEA 1990). The unemployment rate in the area is expected to decrease from 6.5 percent in 1995 to 4.4 percent in 2010 (Association of Bay Area Governments 1993).

In 1995, LLNL employed approximately 8,300 people, accounting for percent of employment in the regional economic study area. The distribution of LLNL employees by place of residence in the ROI is presented in Lazaro et al. (1996).

I.4.1.1.6.2 Population and Housing

The ROI has experienced significant population growth between 1980 and 1990, with an average annual increase of about percent, bringing the 1990 total to about 2.5 million. By the year 2000, population in the ROI is expected to grow to approximately 2.9 million Department of Commerce 1994; BEA 1990).

Between 1980 and 1990, the number of housing units in the ROI increased approximately 19 percent, from 832,559 to 986,553 (see I.4.1.1.6.2-1). The number of housing units in Alameda County increased from 444,607 units in 1980 to 504,109 units in 1990 (13.4 percent). Housing units in Contra Costa County increased from 251,917 units in 1980 to 316,170 units in 1990 (25.5 percent). Housing units in San Joaquin County increased from 136,001 units in 1980 to more than 166,274 units in 1990 percent). The number of housing units in the ROI is expected to increase about percent over the period 1990 to 2000. The rental vacancy rate in the ROI is approximately percent Department of Commerce 1994; Urban Land Institute [ULI] 1995).

The residential building permit volume within the ROI remained strong between the mid- to late-1980s; however, with the national and local recession and a slowing of new household formation, permit volume in the region dropped between 1990 and 1993. The market rebounded somewhat in 1994. The largest percent of new construction within the ROI since 1989 has been within Contra Costa County, where most NIF employees would reside (ULI 1995).

Contra Costa County has historically been the Bay Area's strongest market for residential development, followed by Alameda County. Most new construction has been within southern Alameda County and eastern Contra Costa County, a trend that is likely to continue. Substantial new construction is also planned within central Contra Costa County east of San Roman and north of Dublin (ULI

The rental apartment market, which experienced some overbuilding in the 1980s, has improved in the 1990s. Production has declined sharply since 1989, reflecting a market adjustment to overbuilding and changes in the Federal tax code. Because of the public construction volume during the 1980s and the subsequent slow economy, rental rate increases since 1985 have generally been lower than the rate of inflation. With high land and construction costs, rental rates do not justify new construction. Despite the lack of new construction, vacancy rates remained about percent in 1993 and 1994. Vacancy rates have not declined because of the doubling up that has occurred in the depressed economy and the large number of renters who have taken advantage of favorable prices and interest rates to purchase homes.

Table I.4.1.1.6.2-1.-- Population and Housing Data for the Lawrence Livermore National Laboratory Area

Category	1980	1990	1996	1997	1998	1999	2000	2001	2002	2003
Estimated ROI population	2,109,052	2,538,312	2,767,679	2,795,646	2,823,903	2,852,453	2,881,300	2,905,074	2,929,049	2,953,227
Estimated total housing units	832,559	986,553	1,078,949	1,094,349	1,109,748	1,125,148	1,140,547	1,155,946	171,346	1,186,745
Estimated vacant owner units	23,722	28,541	31,750	32,075	32,579	33,048	33,589	34,094	34,598	35,103
Estimated vacant renter units	16,585	19,238	21,357	21,731	22,088	22,444	22,800	23,156	23,513	23,869
Estimated total vacant units in ROI	40,307	47,779	52,945	53,806	54,667	55,528	56,389	57,250	58,111	58,972
Source: Historical data from U.S. Department of Commerce 1994; projections by Halliburton-NUS 1995.										

The counties within the ROI are far more receptive to residential development than the San Francisco area on the western side of the bay. The ROI is likely to continue to experience strong residential development activity. Substantial inventories of suitable land remain, particularly in the southern portion of Alameda County and the eastern portion of Contra Costa County near LLNL (ULI 1995).

I.4.1.1.6.3 Public Finance and Public Services Infrastructure

Public financial characteristics of the local jurisdictions in the ROI that are most likely to be affected by construction and operation of NIF at LLNL are summarized in this section. The data reflect total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and (as applicable) debt service, capital project, and expenditure trust funds. Major revenue and expenditure categories and revenues less expenditures for counties and cities are presented in I.4.1.1.6.3-1. I.4.1.1.6.3-2 summarizes public service levels for community services, health care, and education.

Table I.4.1.1.6.3-1.-- Public Finance--Lawrence Livermore National Laboratory Area

Revenues and Expenditures[8]	Alameda County	City of Livermore	City of Pleasanton	Contra Costa County	San Joaquin County	City of Manteca	City of Tracy
Local sources (percent)	43	90	94	35	26	86	86
State sources (percent)	36	10	6	65	74	14	14
Federal sources (percent)	21	0	0	0	0	0	0
Total revenues (dollars)	988,275,000	28,841,041	33,901,086	598,723,000	381,106,067	12,086,164	14,375,044
General government (percent)	6	19	21	12	6	10	14

Public safety, health, and community services (percent)	93	75	79	87	94	88	84
Debt service (percent)	0	6	0	1	0	2	0
Other (percent)	1	1	0	1	0	0	2
Total expenditures (dollars)	1,037,595,000	29,572,914	31,449,570	609,924,000	373,471,380	11,283,214	14,697,326
End-of-year fund balance (dollars)	120,596,000	13,129,925	10,803,206	27,014,000	13,607,115	3,327,880	2,243,365

Table I.4.1.1.6.3-2.-- Public Services--Lawrence Livermore National Laboratory Area

Part I: Education				
County/School District	**Enrollment**	**Pupil-Teacher Ratio**	**Per Pupil Expenditure ($)**	
Alameda County	188,076	28.4:1[9]	4,538	
Contra Costa County	132,951	22.9:1[9]	4,192	
San Joaquin County	119,115	NA	4,347	
Part II: Level of Service per 1,000 Population				
County/Jurisdiction	Police Protection	Fire Protection	General Government	Physicians
Alameda County	0.5	0.1	7.9	2.7
City of Livermore	1.0	0.8	5.5	NA
City of Pleasanton	1.2	0.8	6.6	NA
Contra Costa County	0.6	0.4 [10]	7.7	2.6
San Joaquin County	0.3	NA [11]	12.8	1.6
City of Manteca	1.0	0.6	5.9	NA
City of Tracy	1.1	0.6	5.1	NA

I.4.1.1.6.4 Local Transportation

Vehicular access to LLNL is primarily from Interstate 580 by the Vasco Road and Greenville Road interchanges. LLNL can be entered through security gates along Vasco Road, East Avenue, and Greenville Road. Specific access points include Westgate Drive, Mesquite Way, Southgate Drive, J, and East Gate Drive (DOE and UC 1992). I.4.1.1.6.4-1 lists the site access roads at LLNL, the average daily traffic volumes for each route, and the estimated levels of service at key local intersections.

Traffic concerns in the ROI have reinforced attempts to restrict residential development. However, these restrictions have pushed residential development to the urban fringes, worsening traffic congestion. Among the solutions being instituted for the region's transportation problems are numerous improvements now under way or planned for the region's public transit systems. Several extensions of the Bay Area Rapid Transit (BART) system are currently under construction, including a new line of Dublin and Pleasanton and an extension of the Concord line to Pittsburgh (ULI 1995).

Freeway improvements are also under way in the region, including replacement of Cypress Freeway, improvements to major interchanges in Walnut Creek, and construction of a high-occupancy vehicle ramp from 80 to the Bay Bridge. There are numerous ongoing seismic retrofit projects (California Department of Transportation 1995). With general political resistance to infill housing development, most affordable housing is being produced in remote locations within the region and beyond in Solano and San Joaquin counties. These areas are poorly served by public transportation and are located along increasingly congested traffic arteries, such as Interstate 205. With the focus of new housing development likely to continue in these areas, traffic congestion is projected to worsen (ULI 1995).

LLNL is served by several public transportation providers. San Joaquin County provides bus access to LLNL from the San Joaquin Valley, Wheels Transit Service serves LLNL from the Tri-Valley region, and BART provides express buses during peak commuting hours (ULI 1995).

Table I.4.1.1.6.4-1.-- Baseline Traffic on Lawrence Livermore National Laboratory Access Roads

Route	From	To	Estimated 1995 AADT	Estimated 1995 LOS
Patterson Pass Road	Vasco Road	Greenville Road	1,040	A
East Avenue	Vasco Road	Greenville Road	11,250	A
East Avenue	Buena Vista Avenue	Vasco Road	13,800	A
East Avenue	Hillcrest Avenue	Buena Vista Avenue	18,700	A
Telsa Road	Vasco Road	Greenville Road	2,600	A
Telsa Road	Buena Vista Avenue	Vasco Road	6,400	A
First Avenue	N. Mines Road	Las Positas Road	28,300	B
Vasco Road	Brisa Street	Patterson Pass Road	18,300	A
Vasco Road	Westgate Drive	Mesquite Way	13,500	B
Vasco Road	East Avenue	Telsa Road	4,150	A
Greenville Road	Patterson Pass Road	Lupin Way	5,200	A

Note: AADT - average annual daily trips; LOS - level of service
Source: DOE and UC 1992.

Major railroads in the ROI are the Atchison, Topeka, and Santa Fe Railroad, the Southern Pacific Transportation Company, and the Union Pacific Railroad. The Union Pacific passes within km (1 mi) of LLNL; however, there is no direct rail access to LLNL.

The ROI is served by several airports, including Oakland International, San Jose International, Stockton Metropolitan, and San Francisco International Airport. The Livermore Municipal Airport serves local air traffic.

I.4.1.1.6.5 Environmental Justice

Environmental justice concerns the potential for high and adverse environmental or human health impacts to disproportionately affect minority or low-income populations. For this assessment, environmental justice is evaluated for impacts within the site region, defined as an 80 km (50 mi) radius around the site, and within the local area. Lazaro et al. (1996) presents the demographic analysis of minority and low-income population distributions on a regional and local basis.

In the LLNL site region in 1990, percent of the population was low income and percent was minority. These values are lower percentages of both low-income and minority persons than the California state averages percent low income and percent minority). However, within that area, census tracts closer to LLNL tend to have a higher proportion of minority population but a lower proportion of low-income population than do census tracts farther from the site.

I.4.1.1.7 Radiation and Hazardous Chemicals

I.4.1.1.7.1 Radiation Environment

Many of the activities that take place at LLNL involve handling radioactive materials and operating radiation-producing equipment. A detailed discussion of the radiation environment, including background, radiological releases, and doses to members of the public is presented in the publication Environmental Report 1993 (LLNL 1994d). The concentrations of radioactivity in various environmental media (air, water, soil) in the site region are also presented in that report.

Calculated radiological doses were used to estimate the potential health impacts to the public and onsite workers at LLNL from any releases of radioactivity. The annual doses to an individual, the surrounding population (within km [50 mi]), and workers are summarized in I.4.1.1.7.1-1; corresponding health risks are also presented in the table. These values are in addition to those from natural background, consumer products, and medical sources, which total about 365 millirems (mrem) per year. Background radiation doses are unrelated to LLNL operations. Regulatory limits that specify the maximum effective dose equivalent to individual members of the public and occupational workers are also presented in table I.4.1.1.7.1-1. The doses to the public presented in table I.4.1.1.7.1-1 are within regulatory limits (DOE 1990) and are small compared to background radiation. The onsite worker doses are also within regulatory limits.

Table I.4.1.1.7.1-1.-- Annual Radiation Doses to the General Public and Onsite Workers from Normal Operations at Lawrence Livermore National Laboratory

	Atmospheric Releases		Liquid Releases		Total		
Receptor	**Regulatory Limit** [12]	**Calculated**	**Regulatory Limit**	**Calculated** [13]	**Regulatory Limit**	**Calculated**	**Risk** [14]
Individual Dose							
Average exposed individual [15] (mrem)	10	1.3x10^{-4}	4	0.0	100	1.3x10^{-4}	6.5x10^{-11}
Maximally exposed individual (mrem)	10	6.5x10^{-2}	4	0.0	100	6.5x10^{-2}	3.3x10^{-7}
Population Dose [16]							
Population within 80 kilometers (person-rem)	[17]	7.6x10^{-1}	[17]	0.0	[17]	7.6x10^{-1}	3.8x10^{-4}
Worker Dose [18]							
Average worker (mrem)	NA	NA	NA	NA	5,000	2.1	8.4x10^{-7}
Maximally exposed worker (mrem)	NA	NA	NA	NA	5,000	1,300	5.2x10^{-4}
Total worker [19] (person-rem)	NA	NA	NA	NA	None	18.3	7.3x10^{-3}

I.4.1.1.7.2 Hazardous Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous particulates or vapors that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, soil through contact or via the food pathway). Exposure pathways to LLNL workers during normal operation may include inhaling the workplace atmosphere, drinking LLNL potable water, and possibly other contact with hazardous materials associated with work assignments. The maximum daily quantities of hazardous materials stored in 1992 are listed in I.4.1.1.7.2-1. The potential for health impacts varies from facility to facility and from worker to worker, and depends on the operations performed, as well as the materials handled. However, workers are protected from hazards specific to the workplace through appropriate training, engineering controls, work practices, administrative controls, monitoring, and protective equipment. LLNL workers are also protected by adherence to Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operation processes, ensures that these standards are not exceeded.

Table I.4.1.1.7.2-1.-- Maximum Daily Quantities of National Ignition Facility-Related Hazardous Materials Stored at Lawrence Livermore National Laboratory

Hazardous Material	Quantity
Acetone	3,577 kg
Alumina	3,345 kg
Ammonium hydroxide	2.23 kg
Copper	55.8 kg
Ethyl alcohol	13,244 L
Hafnium oxide	1,115 kg
Mercury	1,238 kg
Sodium hydroxide	9,455 kg
Tetraethyl orthosilicate	1,904 kg

kg - kilograms; L - liters.
DOE and UC 1992.

I.4.1.1.8 Waste Management

LLNL currently operates four waste management facilities. The Area 514 and Area 612 facilities contain treatment and storage units for hazardous and mixed wastes. The Building 693 facility is currently a container storage unit for mixed hazardous waste, Toxic Substances Control Act (TSCA)-regulated waste (such as polychlorinated biphenyls), and radioactive waste. The Building 233 container storage unit is currently used to store mixed waste, low-level waste (LLW), and transuranic (TRU) waste.

The current waste management practices at LLNL are outlined in table I.4.1.1.8-1. Wastes relevant to NIF that are managed at LLNL from research activities include LLW, mixed wastes, and hazardous and nonhazardous wastes. The exact nature of some of the LLNL waste is classified information. The NIF project is expected to generate low-level, mixed, hazardous, and nonhazardous wastes during operation; none of these wastes would be classified.

Table I.4.1.1.8-1.-- Current Waste Management at Lawrence Livermore National Laboratory

Category	1994 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity [20] (m^3)	Disposal Method	Disposal Capacity (m^3)
Low-Level							
Liquid	181	Neutralization, filtration, solidification, precipitation, oxidation, flocculation, blending	3,736 (34.1/ treatment episode)	Hazardous Waste Management Division Facilities	627	Treated wastewater discharged to city of Livermore sanitary sewer if within approved limits	None

Solid	307	Shredding, drum crushing, compaction	NA	Hazardous Waste Management Division Facilities	2,297	Shipped to Nevada Test Site	NA
Mixed Low-Level							
Liquid	51	Neutralization, filtration, solidification, precipitation, oxidation, flocculation, blending	8,750	Hazardous Waste Management Division Facilities	627	Treated wastewater discharged to city of Livermore sanitary sewer if within approved limits	NA
Solid	20	Shredding, drum crushing, compaction	11,800	Hazardous Waste Management Division Facilities	2,297	None	None
Hazardous							
Liquid	342	Shipped to offsite RCRA-permitted treatment, storage, and disposal facility, except for silver recovery	97	Hazardous Waste Management Division Facilities	76.9	Shipped to offsite RCRA-permitted treatment, storage, and disposal facility	NA
Solid	237	Shipped to offsite RCRA-permitted treatment, storage, and disposal facility, except for silver recovery	NA	Hazardous Waste Management Division Facilities	98	Shipped to offsite RCRA-permitted treatment, storage, and disposal facility	NA
Nonhazardous (Sanitary)							
Liquid	456,000	None	NA	Retention tanks	829 (spill control capacity 882,622 L)	Discharged to city of Livermore sanitary sewer system	NA
Solid [21]	6,425 t	None	NA	Hazardous Waste Management Division Facilities	NA	Offsite landfill	NA

I.4.1.1.8.1 Low-Level Waste

Both liquid and solid LLW are generated and managed by LLNL. LLW solids at LLNL consist of gloves, absorbent paper, plastics, glass, and other solid materials contaminated with low-level radioactive materials. Liquid and solid LLW are processed or stored at the Building 514 and 612 complexes. Wastewater from retention-tank systems that exceed site radiological discharge limits or any special limits established for that tank, and that cannot be adjusted for discharge or released to the sanitary sewer, is treated as LLW. Smaller quantities of liquids may be accumulated in containers of various sizes and types. Nonreleasable wastewater is pumped into portable tanks for treatment at the Wastewater Treatment Tank Farm at the Building 514 Facility, where it is containerized and transferred into one of six 7,003-L (1,850-gal) treatment tanks for chemical treatment. These tanks are used to treat both radioactive and mixed liquid wastes. After treatment, if the analysis indicates that the contents of a treatment tank are within established sewer discharge limits, the liquid is discharged to the sanitary sewer. If the contents are not within discharge limits, they are retreated.

I.4.1.1.8.2 Mixed Low-Level Waste

Some of the generated mixed liquid LLW is treated at the Area 514 Wastewater Treatment Tank Farm before discharge to the sanitary sewer system so that hazardous constituents and radionuclides can be removed and this wastewater can be discharged within the allowable limits of the National Pollutant Discharge Elimination System (NPDES) permit. The residual solids from this treatment process may contain hazardous constituents such as oils and solvents, toxic metals, decontamination solutions, and dyes. Mixed LLW is treated or stored at the Area 514 Wastewater Treatment Tank Farm and Building 612 complexes.

I.4.1.1.8.3 Hazardous Waste

Hazardous wastes are generated by the numerous research and development (R&D) activities conducted at LLNL. Storage areas for nonradioactive and radioactive (or mixed) wastes are located at Area 612, Area 514, Building 233, and Building 833. Wastes that contain polychlorinated biphenyls and other wastes regulated by the TSCA are stored in Building 693. Nonradioactive, hazardous liquid waste may be stored in drums and portable tanks, pending consolidation and/or offsite transportation. A commercial waste handler transports the nonradioactive solid and liquid hazardous waste drums to an appropriately permitted disposal, treatment, or recycle facility. LLNL hazardous waste management units operate under Resource Conservation and Recovery Act (RCRA) interim status with an approved Part A Permit. Building 693 operates under interim standards and is used to store containerized RCRA-, TSCA-, and California-only regulated waste.

Wastewater may be accumulated in retention tanks, carboys, or drums at the various source locations throughout LLNL. The materials are then analyzed, and the determined waste contaminant levels are compared to LLNL and city of Livermore discharge limits. If the contaminant levels are below the regulatory limits, the material is released to the sanitary sewer. Industrial wastewater that contains constituents at concentrations greater than allowed by the city of Livermore discharge limits is managed as hazardous waste.

Hazardous wastes may be shipped through licensed commercial transporters to various offsite commercial RCRA-permitted treatment, storage, and disposal facilities.

The newly redesigned Decontamination and Waste Treatment Facility is planned to replace and upgrade current facilities used to process, treat, and store hazardous, radioactive, and mixed wastes. The Decontamination and Waste Treatment Facility would receive LLNL and other Oakland, California, generated medical waste, hazardous waste, LLW, and mixed LLW for consolidation, processing, treatment, and packaging before shipment and disposal offsite at a commercial RCRA-permitted facility.

I.4.1.1.8.4 Nonhazardous Waste

Solid nonhazardous wastes generated by LLNL consist of paper, plastics, glass, organic, and other wastes. LLNL does not have onsite solid waste disposal facilities. Solid wastes are collected in dumpsters and similar containers in such a manner as to ensure that they do not contain hazardous or radioactive wastes and transported to the Vasco Road Landfill for disposal.

If industrial wastewater generated by LLNL operations exceeds permissible discharge limits and is treatable by permitted LLNL waste treatment units, the water is processed to meet the release criteria and then monitored as it is discharged to ensure that permissible discharge limits are not exceeded. These wastes enter the city of Livermore's sewer system and are then processed at the city's Water Reclamation Plant. The treated wastewater is piped to San Francisco Bay for discharge, except for a small volume that is used for summer irrigation of the municipal golf course adjacent to the Livermore Water Reclamation Plant. Sludge from the treatment plant is disposed of in offsite landfills.

LLNL has an onsite sewage diversion and retention system that is capable of containing approximately 757 cubic meters (m^3) (26,700 cubic feet [ft3]) of potentially contaminated sewage until it can be analyzed and appropriate handling methods implemented. If the liquids cannot be processed for discharge, they are packaged for treatment or disposal at an offsite facility. Treatment residues, or solids generated from the treatment process, are also packaged for treatment or disposal at an offsite facility.

I.4.1.2 Environmental Impacts

The following sections describe the potential environmental impacts for land use and visual resources, air quality and noise, water resources, ecological resources, cultural and paleontological resources, and socioeconomics from constructing and operating NIF at

LLNL. In addition, impacts associated with radiation, hazardous chemicals, and waste management are described.

I.4.1.2.1 Land Use and Visual Resources

I.4.1.2.1.1 Land Use

Impacts to land use at LLNL from construction and operation of NIF would be limited to the clearing of land, minor and temporary disruptions to contiguous land parcels, and a slight increase in vehicular traffic. No significant impacts to onsite or offsite land uses are anticipated from the project. The proposed location for the two buildings requiring construction for NIF would occupy a large parcel of relatively flat, vacant land in the northeastern corner of LLNL (figure I.3.4.1.1-2). The proposed location is in a section of LLNL where similar types of research and experimentation already occur. Therefore, no conversion of existing land use would result. The NIF buildings would require the clearing of an estimated 8 ha (20 acres) of land for structures, walkways, building access, and buffer space. Such acreage would account for approximately 11 percent of the land currently available for development inside the LLNL site boundaries (Gawronski 1995). An additional 2.0 ha (4.9 acres) would be cleared for a construction laydown area (figure I.3.4.1.1-2). This area would be restored after NIF construction is completed. No impacts to land use (including zoning) on land outside of LLNL or in nearby communities would be expected.

With appropriate erosion and sediment control measures, soil impacts during construction of NIF would be short term and minor. Seismic risks would be taken into account during construction and operation of NIF.

I.4.1.2.1.2 Visual Resources

With the exception of minor, temporary impacts (fugitive dust, equipment exhaust, etc.) associated with construction activities, no impacts to the visual character of LLNL or to surrounding visual resources would be expected. The Laser and Target Area and the Optics Assembly buildings would be constructed in a sector of LLNL that has similar structures. The plot that would contain the two new facilities consists of grassland and a few trees that are visually uniform and not distinct or unique. Because so much of LLNL is developed, views into the installation from surrounding points would not be altered by the two new buildings.

I.4.1.2.2 Air Quality and Acoustics

I.4.1.2.2.1 Air Quality

The potential air quality impacts resulting from construction and operation of NIF are discussed separately because the air pollutant emissions generated during construction would not occur during NIF operations.

Construction Emissions . Estimated construction emissions, including site-clearing emissions and emissions associated with facility construction, are listed in table I.4.1.2.2.1-1. The construction emission estimates are based on characteristics of the proposed LLNL location and on construction vehicle exhaust and fugitive emissions. Site clearing would occur the first year, followed by facility construction during the next four years (LLNL 1995b).

Table I.4.1.2.2.1-1.-- Estimated National Ignition Facility Construction Emissions for the Lawrence Livermore National Laboratory Location

Pollutant	Total Emissions (t/yr) [22]
Particulate matter 10 microns or smaller	14.51 [23]
Volatile organic compounds	0.44
Carbon monoxide	1.23
Nitrogen dioxide	3.76
Sulfur dioxide	0.43
Lead	Negligible

The site-clearing phase of construction, which would continue for about one month, would produce the greatest amount of fugitive dust (particulate matter of 10 microns or less [PM10]) emissions. The Industrial Source Complex, Short-Term Model, Version 2 (ISCST2, Version 93109 [EPA 1992a-b]) was used to determine the impact of site-clearing activities on ambient air quality. The Industrial Source Complex dispersion model is the EPA's preferred regulatory modeling tool for most applications in simple terrain (EPA 1995a). The ISCST2 Model was chosen because the general area from NIF location to nearby receptors of concern is relatively flat and is characterized as simple terrain. The data selected for modeling air quality were 1994 surface meteorological data from the LLNL site (LLNL 1995d). The surface wind speeds and directions are summarized in an annual wind rose (see figure I.4.1.1.2.1-1). In addition, a constant mixing height of 600 m (1,970 ft) was used throughout the year (LLNL 1995d). Detailed emission inventories associated with site clearing and facility construction; meteorological data used; and air quality model, assumptions, and model input parameters are presented in Lazaro et al. (1996).

The national and state 24-hour PM 10 standards are 150 and 50 micrograms g)/m^3, respectively. The 24-hour average PM 10 background concentration of 84 g/m^3 is already above the State Ambient Air Quality Standard (SAAQS) of 50 g/m^3 (see table I.4.1.1.2.2-1). Accordingly, site clearing should be conducted so as to minimize further impacts on ambient air quality. With a conventional water-spraying dust control system (that is, 50-percent control for excavation and 60-percent control for traffic on unpaved roads), maximum 24-hour average PM 10 concentrations of 104 g/m^3 over background are predicted at the site boundary (about 350 m [1,150 ft] east of the proposed NIF location). Operation with additional dust control measures that involve continuous water spraying and/or use of a chemical dust suppressant, would reduce PM 10 dust emissions from excavation by 75 percent and PM 10 emissions from traffic on unpaved roads by 90 percent. These measures would bring maximum 24-hour average PM 10 concentrations down to 46 g/m^3 over the background concentration. Including background concentration, maximum 24-hour concentrations would still be higher than the SAAQS for PM 10 . The ambient air quality impacts associated with site clearing would be limited to the area just outside the site boundary, which the general public is expected to occupy infrequently. In addition, site clearing at LLNL would be expected to last for only a month, so ambient air quality impacts associated with site clearing would be local and temporary.

Modeling efforts showed that over a year, the six highest 24-hour PM 10 concentration levels in descending order would be 62, 50, 43, 43, 43, and 36 g/m^3 above the background concentration. These levels were predicted for an area near the eastern boundary, which is the closest to the NIF location. In addition, annual average PM 10 concentrations were estimated for the entire one-year construction period, which consists of one month for site clearing, followed by facility construction. The estimated highest annual arithmetic mean PM 10 concentration level of 5 g/m^3 above the background concentration is well below the state standard of 30 g/m^3 in terms of geometric mean. (Note that the arithmetic mean is greater than or equal to the geometric mean.) As a consequence, long-term ambient air quality impacts associated with NIF construction would be minor. However, short-term ambient air quality impacts resulting from site clearing could be moderate, although local and temporary in extent. Additional regulatory information is provided in section I.5.2.1.

Emissions During Operations. Air pollutant emissions from operation of NIF at LLNL are expected to occur primarily from fuel combustion and solvent cleaning of the debris shields. Emissions of solvent volatile organic compounds (VOCs) (ethanol) from debris shield cleaning are estimated at about 0.50 metric tons per year (t/yr) (0.55 ton/yr) (LLNL 1995b). Other potential air pollutant emission sources not considered significant are target destruction under either the Conceptual Design or Enhanced options, emissions from vehicles used for freight shipments and employee commuting, and emissions from welding operations at the Fabrication Facility.

As indicated in table I.4.1.2.2.1-2, estimated air pollutant emissions due to NIF operation are well below 1 t/yr (1.1 ton/yr), except for nitrogen dioxide, which is below 2 t/yr (2.2 ton/yr). Estimated air pollutant emissions from NIF operations are less than 10 percent of LLNL 1994 emissions, except for carbon monoxide, which is approximately 11 percent of 1994 emissions. Existing ambient concentrations for these pollutants (see section I.4.1.1.2.2, table-I.4.1.2.2.1-1) are well below the ambient air quality standards except for PM 10 and ozone. The increase of 0.16 t/yr (0.18 ton/yr) PM 10 is less than 5 percent of LLNL 1994 emissions and is not expected to cause a measurable increase in the 24-hour and annual average ambient concentrations. VOC emissions related to NIF operations are estimated to increase by less than 5 percent for the existing emissions at LLNL. Estimated NIF VOC operating emissions at LLNL are 0.56 t/yr (0.61 tons/yr). Total 1995 VOC emissions for the BAAQMD are 269,248 t/yr (296,173 tons/yr) and from fuel combustion are 6,654 t/yr (7,319 tons/yr). Therefore, NIF contribution of VOCs to production of ozone would be almost insignificant (Mangat 1995). On the basis of this information, it can be concluded that NIF operations would have no adverse impact on air quality and would not contribute to a violation of the ambient air quality standards.

Table I.4.1.2.2.1-2.-- Annual Emission Increases with National Ignition Facility Operation at Lawrence Livermore National Laboratory

Pollutant	1994 Emissions [24] (t/yr)	Projected NIF Emissions (t/yr)[24]	1994 Emissions Plus NIF (t/yr)	NIF Percent of 1994 Emissions
Particulate matter 10 microns or smaller	3.36	0.16	3.52	8.8
Volatile organic compound	13.10	0.56	13.66	4.3
Carbon monoxide	3.99	0.43	4.42	11
Nitrogen dioxide	23.50	1.79	25.29	7.61
Sulfur dioxide	0.37	0.03	0.40	9
Lead	0.01	Negligible	0.01	Negligible

The NIF annual energy requirements based on heat and hot water demand for the Laser and Target Area Building and all necessary support facility buildings are listed in table I.4.1.2.2.1-3. All candidate sites would require construction of the Laser and Target Area Building. None of the candidate sites would require construction of the full complement of support facilities that are represented by the annual support facilities energy demand in table I.4.1.2.2.1-3. Therefore, NIF annual energy demand and resulting air pollutant emissions differ among sites based on the area of new buildings required. The ratio of the sum of new support building construction area to the sum of the area for all NIF required support buildings was used to adjust support building energy demand for each candidate site (see table I.3.4-1 for a listing of new buildings required by NIF for each candidate site).

Table I.4.1.2.2.1-2 lists the estimated LLNL annual air pollutant emissions on the basis of the anticipated NIF annual energy requirements provided in table I.4.1.2.2.1-3, adjusted to recognize that at LLNL only one new support building (area of 1,858 square meters [m2] [20,000 square feet {ft2}]) would be required out of the total complement of support buildings (area of 26,722 m2 [287,643 ft2]) indicated in table I.3.4-1. Published emission factors (EPA 1995b) were used to estimate the emissions. Emissions of VOCs from solvent cleaning are included. For comparative purposes, table I.4.1.2.2.1-2 includes the LLNL 1994 site-wide emissions. More detailed information on emission estimates is provided in Lazaro et al.

Table I.4.1.2.2.1-3.-- Estimated Annual Energy Requirements for the National Ignition Facility

Facility	Use	Fuel Type	Annual Energy Consumption
NIF Laser and Target Area Building	Heating, ventilation, and air conditioning	Natural gas	2.11x107 MJ
	Domestic hot water	Natural gas	3.11x105 MJ
	Stand-by power	Diesel	320 L
NIF Support Facilities [25]	Heating, ventilation, and air conditioning and hot water	Natural gas	1.95x107 MJ
	Stand-by power	Diesel	5,500 L

The BAAQMD may require that NIF external combustion facilities (boilers) be equipped with the best available control technology (BACT) for criteria and organic pollutants (Regulation 2, Rule-301) (BAAQMD 1995). BACT will be determined by the permitting process. EPA New Source Performance Standards would limit boiler nitrogen oxide air pollutant emissions according to the boiler-rated heat input. Gas-fired boilers with rated heat input greater than 105,600 megajoules per hour (MJ/hr) (100 million British thermal units per hour [Btu/hr]), but not over 264,000 MJ/hr (250 million Btu/hr), are limited to New Source Performance Standard nitrogen oxide emissions ranging from 43 to 86 nanograms per joule (ng/J) (depending on the heat release rate, which is a function of the furnace volume [40 CFR 60.44b]). There are no New Source Performance Standard emission limits for gas-fired boilers with a rated heat input at or less than 105,600 MJ/hr (40 CFR 60.40c).

VOC emissions, primarily ethanol (see Lazaro et al. 1996), from solvent cleaning of debris shields and treatment/refurbishment of optics and laser components would require no controls but might require emission offsets from the Small Facility Banking Account (Regulation 2, Rule 2-302). The Small Facility Banking Account was established by BAAQMD to provide emission offsets for small air pollutant emission facilities such as NIF. Additional regulatory information is presented in section I.5.2.1.

I.4.1.2.2.2 Acoustics

During the site-clearing phase of construction of NIF at the LLNL site, noise from construction equipment would cause an increase of 14 decibels (dB) (from 55-dBA to 69 dBA) in the average outdoor daytime sound level at the location of the maximally exposed individual 800 m (2,600 ft) east-northeast of the NIF target chamber room location on the eastern side of Greenville Road. The Composite Noise Rating (CNR) rank, adjusted for the estimated preexisting background level and for temporal and conceptual characteristics of the sound, is expected to be "F." Noise with CNR ranks "A" through "D" is generally considered to be acceptable, with "A" representing essentially no impacts. Rankings above "D" are usually addressed with mitigative measures unless the source is temporary.

The average outdoor daytime sound level at the nearest laboratory building would be expected to increase by 4 dB, to 59 dBA. The adjusted CNR rank for the resulting sound would be "B." This "B" rating for modified CNR refers to general activity outside the nearest laboratory building, as compared to ambient background levels. Noise from NIF construction is not included in the "B" rating. The average daytime sound level at the residential area approximately 1.6 km (1.0 mi) west of the construction site would not be expected to increase over the existing average daytime sound level, estimated to be 61 dBA.

These noise level predictions are estimates based on the assumptions given in Lazaro et al. (1996). The noise levels produced during construction are not expected to have a significant impact on LLNL employees or on staff working inside the veterinary hospital (nearest offsite public receptor). Complaints of annoyance may be expected from hospital employees working outside the hospital during heavy construction periods. However, noise levels are not expected to result in hearing loss or interference with speech.

I.4.1.2.3 Water Resources

Construction of NIF at LLNL would be expected to have minor to negligible effects on water quality. The current water supply and wastewater treatment capacities are expected to be sufficient to meet the requirements of NIF.

During construction, about 2.95 MLY (0.78 MGY) of water would be required (LLNL 1995b). The wastewater generated during construction would be handled by the existing sewer and treatment systems. The wastewater volume would be less than the water requirement of consumptive uses, such as incorporation into concrete and evaporation. Sanitary sewer discharges from LLNL go to the city of Livermore wastewater collection system, which is currently being renovated to reduce infiltration and inflow experienced during periods of heavy rainfall.

Water and wastewater utility requirements for NIF operations at LLNL are shown in table ,a href=#ti41231>I.4.1.2.3-1. The total raw water supply required for NIF would be about 152 MLY (40 MGY), of which about 18 MLY (4.7 MGY) would be for domestic use. The additional sanitary wastewater volume from NIF operations is estimated to be 18 MLY (4.7 MGY). A sewer diversion facility protects against accidental release of contaminants not usually associated with sewage into the Livermore treatment plant (LLNL 1994d). The wastewater volume at the LLNL site would increase about 4.5 percent as a result of NIF operations. The sewer diversion facility is capable of handling the projected increase. Wastewater containing nonsewage-related contaminants would be pretreated before release to the Livermore treatment

Table I.4.1.2.3-1.-- Water and Wastewater Utility Capacity at Lawrence Livermore National Laboratory

Utility System	Current Usage	NIF Requirement [26]	Projected Usage, Including NIF [27]	Current Capacity b
Water supply (MLY)	967[27]	152	1,119	3,980
Wastewater treatment (MLY)	402 [28]	18	420	2,340

Potential impacts of stormwater runoff from both the NIF and construction laydown locations on surface water quality are expected to be minor because NIF would be operated under the Livermore Site Industrial Activity Stormwater Pollution Prevention Plan to be developed in accordance with California Department of Transportation specification Section 7-1.0G and LLNL's General Construction Activity Stormwater Permit. The proposed bridge spanning Arroyo Las Positas to the staging area (option I) would be constructed so that its structure and supports would not increase the risk of a 100-year flood breaching the banks of the arroyo. The proposed NIF location has minimal flooding potential because it is outside the 500-year floodplain of Arroyo Las Positas although the staging area (option I) would be within the 500-year floodplain (figure I.4.1.1.3.-1). The staging area (option I) would not be used to store highly volatile, toxic, or water reactive materials. Therefore, locating the staging area in the 500-year floodplain would pose no environmental risk.

However, the proposed NIF location is within the 2000-year floodplain for Arroyo Los Positas. Nevertheless, severe flooding at NIF due to overflow of the arroyo would be relatively slow to develop. This would allow the opportunity to secure radioactive and hazardous material inventories and move them to a safe location. A severe flood could result in facility and equipment damage, but the likelihood of such an event would be small over the 30-year operational lifetime of NIF.

Potential effects of NIF on groundwater would be minor to negligible. No groundwater would be used for NIF, and no wastewater would be discharged to aquifers. Groundwater recharge at the LLNL site might be slightly reduced because of additional paved surface areas. Potential impacts of stormwater runoff on groundwater quality are expected to be negligible because NIF would be operated under the Industrial Activity Stormwater Pollution Prevention Plan.

I.4.1.2.4 Biotic Resources

I.4.1.2.4.1 Terrestrial Resources

The NIF location at LLNL would occupy a 8.1-ha (20.0-acre) parcel of grassland. The 2.0 ha (4.9 acres) areas designated as optional sites for the temporary staging area contain grassland (option I) or maintained lawns (options II and III) (I.3.4.1.1-2). Vegetation within these areas would be eliminated by construction and spoils disposal, resulting in a minor loss of habitat. This loss would be considered a slight adverse impact. Construction could also affect nearby vegetation through the deposition of dust and other particulates from soil disturbance and from the operation of vehicles and large machinery. This deposition could inhibit photosynthesis and, if chronic, result in a limited amount of plant mortality. In addition, soil compaction caused by heavy machinery could destroy the plants and indirectly damage roots of plants from adjacent areas by reducing soil aeration and altering soil structure. However, impacts from dust and compaction would be temporary, localized, and limited to common species that are found in disturbed areas. The quality of the vegetative community at the proposed NIF location is marginal, and since construction would occur in an area of previous disturbance, potential impacts are considered negligible.

Impacts to wildlife from NIF construction would include (1) loss and alteration of habitat and (2) disturbance of individual animals by noise and human activity. Suitable alternative habitats, and escape pathways to those habitats, exist for displaced individuals. However, these animals could face stronger competitive pressures, potentially resulting in the loss of individual animals. It is unlikely that construction activities would be a threat to the continued survival of any local wildlife populations.

The areas occupied by NIF buildings, equipment, access roads, and parking lots would be unavailable to wildlife for the life of the project. The construction laydown area would be unavailable to wildlife during the construction period. It would be restored to existing conditions following construction. Vegetation should be reestablished within a few growing seasons. Some portions of the NIF site, particularly those around the main buildings, would be landscaped with lawns and scattered bushes and trees. Such habitat currently exists around other LLNL facilities and is of limited use to many wildlife species. Nevertheless, species adapted to suburban areas would readily inhabit or utilize these areas.

Few impacts would occur to terrestrial biota during operation of NIF. Increased traffic and local disturbances could lead to increased losses of road-killed individuals of some species, but this impact is not considered significant.

I.4.1.2.4.2 Wetlands and Aquatic Resources

It is DOE policy (10 CFR 1022) to avoid impacts to wetlands to the maximum extent practicable, in compliance with Section 404 of the Clean Water Act and Executive Order 11990 (Protection of Wetlands). Because the proposed NIF location is nearly 300 m (1,000 ft) from the nearest wetland, the construction and operation of NIF would not be expected to affect wetlands at LLNL. The location of the temporary access bridge across Arroyo Las Positas for the option I staging area would be about 100 m (328 ft) east of the nearest wetland, and, thus, would not impact wetland habitat. The option I staging area would be the closest alternate laydown area to the wetland. It would be at least 23 m (75 ft) from the nearest wetland. Temporary barriers would be used to prevent inadvertent impacts to the wetland.

The potential for adverse impacts to aquatic resources would be extremely low because no waterbodies are located in the immediate vicinity of the construction area. Generally, impacts to surface waters from construction activities occur as a result of (1) habitat destruction or modification from construction activities within the waterbody or (2) increases in turbidity, sedimentation, or chemical contamination from runoff. Overall, construction impacts to aquatic resources at LLNL would not be considered significant because (1) critical habitats (such as spawning or rearing areas) for important species (recreational, commercial, or listed species) do not occur at the proposed NIF location and therefore would not be affected and (2) increased sedimentation, habitat removal or modification, or potential spills (such as of fuel) would be localized, short term, and mitigable. The increase in impervious land surface associated with NIF could increase runoff, which could accelerate erosion of unstable soils and add to the contaminant load entering nearby waterbodies. However, a stormwater pollution prevention plan would be implemented to control such events (section I.4.1.2.3). Landscaping around new NIF buildings would also minimize surface erosion and site runoff.

I.4.1.2.4.3 Rare, Threatened, and Endangered Species

No deleterious impacts to listed species would be expected from construction or operation of NIF. NIF would be located on previously disturbed grassland habitat that is surrounded primarily by developed laboratory facilities. Thus, NIF location does not provide suitable habitat for the listed species that could exist at LLNL. White-tailed kites have nested near the East Gate of LLNL. Mitigative measures that would be taken so that NIF construction traffic would not affect this species (that is, rerouting traffic during nesting) are discussed in section I.4.7. However, construction of the option I staging area and its access road could impact the western burrowing owls by reducing potential foraging habitat or disrupting resident individuals. Nevertheless, loss of foraging area is not expected to adversely affect this species, and burrows of this species would be avoided during construction.

I.4.1.2.5 Cultural and Paleontological Resources

Construction and operation of NIF would have no effects on archaeological sites or historic structures listed on or eligible for the National Register of Historic Places (NRHP) or important paleontological remains because these resources are absent in the affected area. Consultation is in progress to determine whether the proposed project could affect Native American cultural resources.

I.4.1.2.6 Socioeconomics

Locating NIF at LLNL would have a minor impact on socioeconomic conditions in the economic study region and in the ROI described in section I.4.1.1.6. This is because LLNL is located in a diverse regional economy with extensive inter- and intraregional, national, and global economic interactions and linkages. Also, because the NIF partnership would include representatives from government, industry, and the academic sectors throughout the United States, procurement and investment would be dispersed over a number of different regions, damping the concentration of economic effects of the program.

The following sections describe the effects of constructing and operating NIF on the host region's economy and employment, and on population and housing, public finances, public services, and local transportation in the ROI.

I.4.1.2.6.1 Regional Economic Impacts

Slight changes in employment and levels of economic activity in the economic study region would occur from local spending of employee wages, procurement of goods and services (including construction materials), and other local investment associated with constructing and operating NIF. In addition to creating new jobs (direct) at the site, indirect job opportunities, such as community support services, would also be created in the economic study area as a result of these new direct jobs. The total new jobs created (direct and indirect) would contribute slightly to reduce unemployment and increase income and economic output in the regional economy during both the construction and operation of NIF. Table I.4.1.2.6.1-1 presents the potential impacts to the regional economy if NIF were located at LLNL.

The construction force for NIF at LLNL would peak at approximately 470 direct jobs in 1998. Construction-related procurement would indirectly create nearly 2,400 additional jobs in the economic study area. Employment for operation would begin phasing in as construction neared completion. Direct employment related to operations is projected at 330, with more than 560 indirect jobs created throughout the economic study area. As a result of constructing and operating NIF, the baseline compounded average annual growth rate from 1995 to 2003 would increase by 0.002-percentage points.

Peak earnings associated with the 470 direct jobs created in 1998 are projected at approximately 27.1 million dollars. Construction-related procurement would indirectly create more than 60 million dollars in regional earnings. Direct earnings related to operations are projected to reach nearly 14 million dollars, with 16.5 million dollars in indirect earnings added to the regional economy.

Table I.4.1.2.6.1-1.-- Potential Socioeconomic Impacts in the Lawrence Livermore National Laboratory Area

	NIF Alternative Change Over Reference Baseline		**Reference Baseline**	
Parameters	**Peak Construction 1998** [29]	**Operations 2003** [30]	**1996 to 2002**[29]	**2003**[30]
Regional Employment				
Direct jobs	470	330		
Indirect jobs	2,400	560		
Total jobs	2,870	890	70,000 additional jobs projected annually	50,000 additional jobs projected
Regional Aggregate Earnings [31]				
Direct earnings	27.07	13.81		
Indirect earnings	62.08	16.47		
Total earnings	89.15	30.28		
Regional Population Migration				
ROI in-migrating population	1,600	360	29,000 additional people annually	24,200 additional people
Regional Housing Demand				
Number of housing units in the ROI	580	130	55,000 vacant housing units (annual average)	59,000 vacant housing units
Local Transportation				
Number of trips generated at site per day	902	630		
Public Finance				
Percent change over 1995 fund balance (Alameda County)	-0.03	-0.02	NA [32]	NA
Public Services (LOS)				
Change in service demand (Alameda County)				
Police	0	0	762[32]	832
Fire	0	0	92[32]	100
General	7	2	11,230[32]	12,264
Physicians	3	1	3,923[32]	4,285
Teachers	5	1	7,001[32]	7,646

I.4.1.2.6.2 Population and Housing

Construction. Population in-migration resulting from NIF construction phase demands would begin in 1996 and peak in 1998, with a projected cumulative total of nearly 1,600 people moving into the ROI over the 3-year period (table I.4.1.2.6.1-1). This population increase would result in demand for an additional 580 housing units in the ROI. Baseline projections of the ROI housing market from 1996 (NIF construction start date) through 1998 indicate that nearly 54,000 housing units would be available over the 3-year period. The demand for additional housing units in the LLNL region for NIF-related in-migration would absorb approximately 1 percent of the estimated supply of vacant housing stock in the ROI. Most of this housing demand would be temporary and would primarily affect the renter segment of the ROI housing market. The NIF project would stimulate little demand for new housing construction because of the number of vacant housing units within the ROI and the proximity of LLNL to many communities in northern California with the ability to provide both temporary and permanent housing for in-migrating workers.

Operations. Population in-migration resulting from NIF operation phase demands could result in an additional 360 people moving into the ROI. While additional demand for housing would be longer term relative to construction, no perceptible strain on the market is expected, assuming that the general conditions associated with the housing market continue.

I.4.1.2.6.3 Public Finance

Construction. Given the population and economic growth associated with NIF during the construction phase, fiscal balances (revenues and expenditures) are expected to increase slightly for all the jurisdictions within the ROI. Short-term public financial impacts would peak during 1998 and would then decline as construction neared completion in 2002. Since the largest percentage of socioeconomic impacts are expected to occur in Alameda County (assuming current residential patterns), that county would experience larger fiscal impacts than elsewhere in the ROI (table I.4.1.2.6.1-1).

Operations. The increase in population and economic growth as a result of NIF operations would slightly increase fiscal balances (revenues and expenditures) for all counties within the ROI, with the greatest impact in Alameda County. Fiscal impacts would remain relatively stable from the initial impact in 2003 through the duration of NIF operations.

I.4.1.2.6.4 Public Services

By 1998, Alameda County would need to hire five additional teachers and three additional doctors to maintain its current level of service. By 2003, when operations start, Alameda County would only need one additional teacher and one additional doctor over the baseline conditions to maintain their level of service (table I.4.1.2.6.1-1).

I.4.1.2.6.5 Local Transportation

In 1995, LLNL employed about 8,300 persons. Direct employment generated by the NIF project at LLNL for the life cycle of the project (1996 to 2033) would range from a maximum of 470 new jobs in 1998 to a minimum of 80 new jobs in 2001. The 470 new jobs at LLNL have the potential to generate up to 902 new vehicle trips per day (table I.4.1.2.6.1-1). These additional trips could increase congestion on roads around LLNL, particularly East Avenue (table I.4.1.2.6.5-1).

Indirect jobs could affect traffic flow within the LLNL region, depending on where those jobs were located. However, if the new indirect jobs were sufficiently dispersed, the road network in the San Francisco metropolitan area would likely handle new trips generated by indirect jobs associated with NIF.

Table I.4.1.2.6.5-1.-- Future Traffic Impacts from National Ignition Facility Project on Lawrence Livermore National Laboratory Access Roads

Route	From	To	Estimated 1995 AADT	Estimated Background and Peak Project Year AADT (1998)	Estimated Percent Change in AADT Between 1995 and Peak Construction Year (%)	Estimated 1995 LOS	Estimated Background and Peak Construction Year LOS (1998)
Patterson Pass Road	Vasco Road	Greenville Road	1,040	1,145	10	A	A
East Avenue	Vasco Road	Greenville Road	11,250	11,520	2	A	B
East Avenue	Buena Vista Avenue	Vasco Road	13,800	14,080	2	A	A
East Avenue	Hilcrest Avenue	Buena Vista Avenue	18,700	19,000	2	A	A

Telsa Road	Vasco Road	Greenville Road	2,600	2,700	4	A	A
Telsa Road	Buena Vista Avenue	Vasco Road	6,400	6,590	3	A	A
First Avenue	N. Mines Road	Las Positas Road	28,300	28,850	2	B	B
Vasco Road	Brisa Street	Patterson Pass Road	18,300	18,900	3	A	A
Vasco Road	West Gate Drive	Misquitte Way	13,500	14,200	5	B	B
Vasco Road	East Avenue	Telsa Road	4,150	4,400	6	A	A
Greenville Road	Patterson Pass Road	Lupin Way	5,200	5,370	3	A	A
AADT - annual average daily trips; LOS - level of service. DOE and UC 1992.							

I.4.1.2.6.6 Environmental Justice

Minorities, but not low-income persons, are clustered disproportionately in the local vicinity of the LLNL site (section I.4.1.1.6.5). Thus, the local area impacts from the construction and operation of NIF could disproportionately affect minorities. However, none of the local area environmental or health impacts from the construction and operation of NIF would be highly adverse or significant. Therefore, no environmental justice issues for local area impacts have been identified for this site.

For the population in the region within 80 km (50 mi) of LLNL, both minorities and low-income populations are in lower proportion to other populations than in California as a whole (section I.4.1.1.6.5). Thus, no environmental justice issues for regional impacts are identified for this site.

I.4.1.2.7 Radiation and Hazardous Chemicals

This section describes potential radiological and hazardous chemical impacts that could result from normal operations and postulated accidents of NIF at LLNL. Methods, data, and assumptions used in estimating these impacts are presented in Lazaro et al. (1996).

I.4.1.2.7.1 Normal Operations

The general public living in areas surrounding the LLNL site and workers at LLNL may be exposed to small quantities of radionuclides released and radiation emitted from routine NIF operations; however, the expected level of radioactive releases and radiation emissions would be well within regulatory limits. No impacts from hazardous chemicals should occur because only minute quantities of hazardous VOCs are expected to be emitted during routine NIF operations. Impacts from routine transportation of tritium targets would also not be expected, because there would be no detectable levels of radiation outside the packages carrying the low-energy beta-emitting tritium targets.

Table I.4.1.2.7.1-1 summarizes the potential impacts of radiation exposures from the Conceptual Design and the Enhanced options of NIF operations at LLNL.

Table I.4.1.2.7.1-1.-- Potential Radiological Impacts from Normal Operations of the National Ignition Facility at Lawrence Livermore National Laboratory

Receptor	Conceptual Design Option	Enhanced Option
Maximally Exposed Individual		
Dose (mrem/yr)	0.04	0.1
Percent of natural background	0.01	0.03

30-year fatal cancer probability	6x10 -7	2x10 -6
Population Within 80 Km		
Dose (person-rem/yr)	0.07	0.2
Percent of natural background	3x10 -6	8x10 -6
30-year fatal cancers	0	0
Workers Onsite		
Dose (person-rem/yr)		
Non-NIF workers	0.06	0.2
NIF workers	10	10
30-year fatal cancers	0	0
Model results.		

Impacts to the Public . For the Enhanced Option, the estimated radiation dose from all NIF sources to a maximally exposed member of the public located about 400 m (1,300 ft) east of NIF is 0.1 mrem/yr, which is much less than the dose limit of 100 mrem/yr resulting from all pathways combined (DOE 1990). The likelihood of the maximally exposed individual contracting a fatal cancer would be 1 in 500,000 for the entire operational life of NIF (dose/yr x 30-yr x fatal cancer risk factor of 5x10^{-4}/rem). The estimated radiation dose to the surrounding public is 0.2 person-rem/yr; no cancer fatalities would be expected to occur in the public for the entire NIF operations at LLNL. For the Conceptual Design Option, estimated radiation impacts would be about one-third the impacts of the Enhanced Option; therefore, no adverse health effects would result.

Impacts to Workers. In addition to exposure to the radionuclides, the general LLNL workers outside NIF could be exposed to direct radiation resulting from high-yield experiments at NIF. For the Enhanced Option, the estimated radiation dose to these non-NIF workers at LLNL is 0.2 person-rem/yr. No cancer fatalities would be expected to occur among workers for the entire NIF operations at LLNL. For the Conceptual Design Option, estimated radiation impacts would be about one-third the impacts for the Enhanced Option and would carry extremely low risk of adverse health effects.

Potential radiation exposures inside NIF would be kept as low as reasonably achievable through facility design, material selection, shielding, and administrative controls. The design objective is to keep the individual radiation worker dose equivalent to or less than 500 mrem/yr. On average, it is estimated that a NIF worker would receive approximately 30 mrem/yr.

I.4.1.2.7.2 Postulated Accidents

Radionuclides and hazardous chemicals could be released by accidents either at NIF or during the transportation of tritium targets from the site of production to NIF. Tables I.4.1.2.7.2-1 and I.4.1.2.7.2-2 summarize potential radiological and transportation impacts to the public and workers from postulated facility and transportation accidents, respectively. A description of each accident scenario evaluated is provided in Lazaro et al. (1996).

Table I.4.1.2.7.2-1.-- Potential Radiological Impacts from Postulated Bounding Accident Involving the National Ignition Facility at Lawrence Livermore National Laboratory

Receptor	Conceptual Design Option	Enhanced Option
Maximally Exposed Individual		
Dose (rem)	0.1	0.2
Fatal cancer probability	5x10 -5	8x10 -5
Risk (cancer fatalities/yr)	1x10 -12	2x10 -12
Population Within 80 Km		
Dose (person-rem)	260	440
Fatal cancers	0	0
Risk (cancer fatalities/yr)	3x10 -9	4x10 -9

Workers Onsite		
Dose (person-rem)	29	49
Fatal cancers	0	0
Risk (cancer fatalities/yr)	2x10 -10	4x10 -10
Model results.		

Table I.4.1.2.7.2-2.-- Potential Radiological Risks and Consequences of Transporting Tritium Targets from Manufacturing Facilities to Lawrence Livermore National Laboratory

Manufacturing Facility	Conceptual Design Option	Enhanced Option
General Atomics		
Dose risk (person-rem/yr)	9.0x10 -7	7.1x10 -6
Fatality risk (cancer fatalities/yr)	5x10 -10	4x10 -9
Nonradiological accident [33] (fatalities/yr)	6x10 -4	1x10 -3
Nonradiological vehicular emissions (fatalities/ yr)	1x10 -3	2x10 -3
Los Alamos		
Dose risk (person-rem/yr)	2.2x10 -6	1.8x10 -5
Fatality risk (cancer fatalities/yr)	1x10 -9	9x10 -9
Nonradiological accident [35] (fatalities/yr)	2x10 -3	4x10 -3
Nonradiological vehicular emissions (fatalities/ yr)	4x10 -4	9x10 -4
Savannah River		
Dose risk (person-rem/yr)	1.8x10 -6	1.4x10 -5
Fatality risk (cancer fatalities/yr)	9x10 -10	7x10 -9
Nonradiological accident [35] (fatalities/yr)	6x10 -4	1x10 -3
Nonradiological vehicular emissions (fatalities/ yr)	4x10 -4	9x10 -4
University of Rochester		
Dose risk (person-rem/yr)	1.9x10 -6	1.5x10 -5
Fatality risk (cancer fatalities/yr)	9x10 -10	7x10 -9
Nonradiological accident [35] (fatalities/yr)	3x10 -4	8x10 -4
Nonradiological vehicular emissions (fatalities/ yr)	4x10 -4	9x10 -4
Maximum Consequence Accident		
Population [34], [35]		
Dose (person-rem)	0.33	3.3
Fatal cancers	2x10 -4	2x10 -3
Maximally Exposed Individual ,[34] , [36]		
Dose (rem)	1.2x10 -4	1.2x10 -3
Fatal cancer probability	6x10 -8	6x10 -7

Radiological Impacts

Impacts to the Public. The public could be exposed to radionuclides released from a postulated accident at NIF. The bounding accident assumes an earthquake occurring at the time of a maximum-yield experiment with an accidental release frequency of 2x10-8/yr. For the Enhanced Option, the estimated radiation dose to the maximally exposed member of the public is 0.2 rem. The likelihood of the maximally exposed individual contracting a fatal cancer from this exposure is 1 in 12,000. The estimated radiation dose to the surrounding public is 440 person-rem. No cancer fatalities would be expected to occur among the public following an accident at NIF. For the Conceptual Design Option, estimated radiation impacts are about one-half the impacts from the Enhanced Option. No adverse health effects would be expected to result.

Table I.4.1.2.7.2-1 also indicates that the risk of radiation-caused cancer fatalities from the postulated accident at LLNL would be essentially zero when the anticipated extremely low accident frequency during NIF operations is taken into account. The risk is the product of the estimated radiation dose, fatal cancer risk factor of 5x10-4, and accident release frequency of 2x10-8/yr.

Impacts to Workers. For the Enhanced Option, the estimated radiation dose to all workers at LLNL is 49 person-rem. No cancer fatalities would be expected to occur to workers following the postulated accident at LLNL. For the Conceptual Design Option, the estimated radiation impacts are about one-half the impacts of the Enhanced Option. No adverse health effects would be expected. The risk of radiation-caused cancer fatalities would be essentially zero considering the extremely low frequency potential for the postulated accident to occur. LLNL has a comprehensive emergency plan, which would be expanded to incorporate NIF, to ensure protection of workers in case of an accident or natural disaster.

Transportation Impacts. Radiological impacts associated with the transportation of tritium targets would result from a release of tritium into the environment following a transportation accident. Since tritium is a pure beta emitter with no associated gamma radiation, radiological risks associated with routine (incident-free) transportation operations are considered to be negligible. The potential radiological impacts of transporting tritium targets were calculated for truck and air travel. Trucks were assumed to be used to transport the tritium targets from the manufacturing sites to the nearest major airport, while cargo aircraft were assumed to be used to transport the targets to Oakland International Airport. After arriving at the airport, the targets would be transferred to a truck for shipment to NIF at LLNL.

Table I.4.1.2.7.2-2 presents the risks associated with the transportation of tritium targets from each of the tritium manufacturing facilities to NIF at LLNL. Radiological risk from transportation activities is defined as the product of the accident consequence (dose) and the probability of the accident occurring, and is calculated by considering a wide range of accidents, from high-probability, low-consequence events to low-probability, high-consequence events (see Lazaro et al. 1996). Estimated latent cancer fatality risks are obtained by multiplying the dose risk by 0.0005 latent cancer fatalities per person-rem (International Commission on Radiological Protection [ICRP] 1991). Latent cancer fatality risks range from 5x10-10 to 9x10-9 per year for all cases. Nonradiological impacts associated with the ground transport of tritium targets are calculated under both routine (incident-free) and accident conditions. Nonradiological population risks for routine operations are calculated by multiplying the distance traveled by truck in urban population density zones by a risk factor for latent mortality from pollutant inhalation (Rao et al. 1982). Nonradiological population risks resulting from vehicular accidents are calculated in a similar manner by multiplying the state-specific accident fatality rate by the distance traveled by truck in the state.

Maximally exposed individual and population doses were calculated for a transportation accident involving the release of the entire tritium cargo (assumed to be five tritium targets). Radiological impacts resulting from a potential maximum consequence accident were assessed for a general population located in an urban population density zone. Maximally exposed individuals were assumed to be exposed and unshielded as the plume passed at a distance resulting in the largest dose to the individual. Radiological consequences were assessed using worst-case weather conditions (Pasquill Stability Class F) for both the collective population and the maximally exposed individual. For assessment purposes, it was assumed that the entire tritium cargo was released to the environment in oxide form. The estimated number of latent cancer fatalities from the maximum-severity transportation accident was calculated by multiplying the population-committed effective dose equivalent by 0.0005 latent cancer fatalities per person-rem (ICRP 1991). Table I.4.1.2.7.2-2 summarizes the impacts resulting from a maximum-consequence accident involved in the transportation of tritium targets.

Hazardous Chemical Impacts. A number of possible chemical accidents were studied in terms of their potential impacts on workers and the public outside the LLNL site boundaries. The four possible accidents likely to have the greatest impacts were studied in detail. The range of accidents considered (including an aircraft crash) and the four selected for more detailed study are discussed in Lazaro et al. (1996). The four accident scenarios considered in detail were as follows:

- A mercury release from the ignitron switches
- A combined alumina/silica release from the target chamber
- A carbonyl fluoride release from the optics treatment area
- A hydrogen fluoride release from the optics treatment area

The nearest public facility to the release points for accidents 1 and 2 is the veterinary hospital to the east. The nearest public facility to the release points for accidents 3 and 4 is the industrial park to the north.

A modeling study was conducted for each of the four release scenarios. More details, including predicted concentrations, are provided in Lazaro et al. (1996). The modeling study applied a dispersion model to each of the releases and used a health criterion representative of acute impacts from an exposure that might happen once in a lifetime. The health criterion (Emergency Response Planning Guidelines-2 [ERPG-2] level) was the concentration below which, if exposure occurred for an hour, would still allow the exposed individual to avoid irreversible health effects by taking emergency action. The results of the modeling yield the following conclusions:

- The threat zone from each of the four accidents would not extend to the boundary with the public under either typical or extreme meteorological conditions
- Nearby buildings and personnel outside would be at risk if any of the four accidents occurred. The assumption was made that the release would not be inhibited by walls of the NIF Laser and Target Area Building, and the wind would take the plume away from the building. The distances beyond which concentrations would fall below the ERPG-2 level for each of the accidents are as follows:
    - Mercury scenario--237 m (778 ft) for both the Conceptual Design and Enhanced options
    - Alumina/silica scenario--171 m (561 ft) for Conceptual Design Option and 231 m (758 ft) for Enhanced Option
    - Carbonyl fluoride scenario--99 m (325 ft) for both the Conceptual Design and Enhanced options
    - Hydrogen fluoride scenario--101 m (331 ft) for both the Conceptual Design and Enhanced options

The personnel in nearby buildings would likely be protected because the release (typically lasting 15 minutes) would pass by the buildings with little infiltration. Personnel in the Laser and Target Area Building and those outside in the immediate vicinity might be affected.

I.4.1.2.8 Waste Management Impacts

This section evaluates potential effects of wastes that would be generated by NIF on current waste management practices at LLNL during construction, normal operation, and the decommissioning of NIF at LLNL.

I.4.1.2.8.1 Waste Generation and Management During Construction and Operation

The estimated amounts and types of wastes that would be generated during construction of NIF are listed in table I.4.1.2.8.1-1. Most construction wastes would be nonhazardous and would be handled under conventional construction regulations. Adequate capacity exists at LLNL to handle these wastes. Any hazardous wastes would be handled accordingly, as discussed below.

Table I.4.1.2.8.1-1.-- Estimated Amounts and Types of Wastes Generated During Construction of the National Ignition Facility at Lawrence Livermore National Laboratory

Waste Type	Amount Generated (m 3)
Nonhazardous (sanitary liquid)	14,000
Nonhazardous (sanitary solid)	500
Other nonhazardous (liquid)	900
Other nonhazardous (solid)	900
LLNL 1994b.	

Table I.4.1.2.8.1-2 lists the quantities of wastes generated by category for both the Conceptual Design and Enhanced options (Andrews and Tobin 1995). The following discussions describe the proposed disposition of the wastes (using current practices) shown in that table. During operation, various low-level, mixed, hazardous, and nonhazardous wastes would be handled at NIF. Treatment or storage of NIF waste stream would not affect current treatment and/or storage capacities. The quantities of these waste streams at LLNL are presented in tables I.4.1.2.8.1-2 and I.4.1.2.8.1-3. Waste handling methods would be the same for both the Conceptual Design and Enhanced options. While total waste quantities would be somewhat higher for the Enhanced Option, no changes in handling methods would be necessary. Successive sections cover how developing technologies might be applied to minimize waste streams and, finally, disposition of wastes from decommissioning.

Table I.4.1.2.8.1-2.-- National Ignition Facility Waste Estimates for Low-Level, Mixed, and Hazardous Wastes for Both the Conceptual Design and the Enhanced Options (Per Year of National Ignition Facility Operation)

							Hazardous			
			Low-Level		**Mixed**		**LTAB**		**OAA**	
	Source of Waste	**Cleaned [37] (m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**
1.	Vacuum pump oil					0.20				
	Chamber pump down					0.20				
2.	Molecular sieves		0.37							
	Tritium processing system		0.98							
3.	Personal protective equipment and wipes	1.88	0.18	0.60	0.34	0.40				
	General cleaning	4.88	0.46	1.56	0.88	1.04				
4.	Pre- and HEPA filters		0.02							
	Chamber Ventilation		0.02							
	Target chamber decontamination									
	Chamber hardware decontamination									
5.	Hardware from chamber	0.06	0.25							
	Diagnostics target positioner	0.06	0.25							
6.	Debris shield	0.24 ea				1.40				
		0.63 ea				3.74				
7.	Capacitors, oil filled						7.5		0.5	
							7.5		0.5	
8.	General chemicals							0.50		1.80
								0.50		4.10
	Conceptual design total/yr		0.82	0.60	0.34	2.00	7.5	0.50	0.5	1.80
	Enhanced total/yr		1.71	1.56	0.88	4.98	7.5	0.50	0.5	4.10

Table I.4.1.2.8.1-3.-- National Ignition Facility Waste Estimates for the Conceptual Design and the Enhanced Options After Implementation of Waste Minimization Techniques

							Hazardous			
			Low-Level		**Mixed**		**LTAB**		**OAA**	
	Source of Waste	**Cleaned [38] (m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**
1.	Vacuum pump oil					0				
	Chamber pump down					0				
2.	Molecular sieves		0.04							
	Tritium processing system		0.09							

3.	Personal protective equipment and wipes	1.88	0.18	0.30		0.25	0.30						
	General cleaning	4.88	0.46	0.78		0.65	0.78						
4.	Pre and HEPA filters		0.02										
	Chamber Ventilation		0.02										
	Target chamber decontamination												
	Chamber hardware decontamination												
5.	Hardware from chamber	0.06	0.12										
	Diagnostics target positioner	0.06	0.12										
6.	Debris shield	0.24 ea					0						
		0.63 ea					0						
7.	Capacitors, oil filled								1.38			0.5	
									1.38			0.5	
8.	General chemicals									0.5			0.18
										0.5			0.41
	Conceptual design total/yr		0.36	0.30		0.25	0.30		1.38	0.5		0.5	0.18
	Enhanced total/yr		0.69	0.78		0.65	0.78		1.38	0.5		0.5	0.41

Low-Level Waste . The solid LLW processed during NIF operations would be disposed of at the Nevada Test Site (NTS). LLNL presently generates waste streams similar to those that would be produced by NIF, and those wastes are currently approved for disposal at NTS. Further details and a discussion of low-level liquid waste handling are presented in section I.4.1.1.8.1.

Mixed Waste . Solid mixed wastes would be sent to an appropriately licensed commercial mixed waste disposal site. LLNL presently has a contract with a commercial handler for disposal of certain mixed waste streams that meet the waste acceptance criteria, and this agreement would be extended to include NIF mixed wastes.

If an acceptable mixed waste stream contained only "characteristic" hazards (non-listed hazards specific to NIF) and it met the appropriate treatment standards listed in 40 CFR 268, the waste would be approved for shipment to NTS. However, if the mixed waste stream contained a listed hazard, it would be shipped to an approved commercial handler after being stabilized and meeting land requirements. The mixed aqueous waste from cleaning the debris shield would be neutralized, stabilized, and shipped to NTS for disposal as an approved waste stream. If this waste were found to be contaminated with listed solvents not approved for NTS disposal, the stabilized waste would be sent to a commercial handler instead.

Hazardous Waste. LLNL currently disposes of large quantities of hazardous waste by a well-established system using onsite consolidation and shipment to commercial handlers. Capacitors and general chemicals are currently disposed of under this procedure. Under this approach, NIF solid hazardous wastes would be shipped to an approved commercial RCRA treatment, storage, and disposal facility.

Nonhazardous Waste . Storm drains would be available in the NIF site with a capacity adequate for local rainfall at a design-basis flood level. This capacity would be based on a low-hazard-use building under DOE Standard 1020-94, Section 6.1.3. Nonhazardous solid waste generation at the NIF site is estimated to total 6,000 m^3/yr (7,848-yd3/yr). This solid waste would be handled following general regulations.

Possible Waste Minimization During Operation . Several actions or technologies have been identified that, if successfully implemented, could significantly reduce or even eliminate certain forms of waste now projected for NIF (Andrews and Tobin 1995). In addition, some steps might be taken to reuse or recycle waste material. The proposed technology and procedures are briefly described here, and an estimate of the possible reduced waste streams is shown in table I.4.1.2.8.1-3. These estimates assume successful development of various new methodologies that are proposed to minimize the waste streams. As such, they represent an optimistic lower limit of waste generation at NIF. Comparing these projections to those in table I.4.1.2.8.1-2 indicates that wastes might be reduced significantly (by a factor of 2 to 10). The following discussion identifies some important aspects of the minimization plan.

The lifespan of a molecular sieve could be extended if subatmospheric chamber flushing were employed. The use of lower flushing pressure would reduce vapor loading. Further reductions might be achieved if chamber tritium (following laser beam target strikes) were pumped directly to liquid helium cryo panels.

Minimizing the scrap hardware removed from the chamber would be accomplished by concentrating on three design areas: utilizing activation-resistant materials, minimizing-weight and volume of structures, and discouraging the use of temporary setups.

Implementation of an oil-less vacuum roughing pump system would eliminate 200 L (52.8 gal) of liquid mixed waste. Such pumps have only recently become available and would be evaluated for use at NIF; however, their cost and dependability remain uncertain.

Cleaning of the debris shields with carbon dioxide pellets could remove the anti-reflective coating and activated particulate matter. If successful, this procedure could significantly reduce or even eliminate the production of radioactive sodium hydroxide, which is currently listed as liquid mixed waste.

A large fraction of the general chemical waste from the Optics Assembly Area would involve the anti-reflective coating solution. One method for reducing this waste would be to distill the ethanol from the waste solution and reuse it as a cleaner.

Capacitors in the Laser and Target Area Building would be the predominant source of hazardous waste. This source could be reduced by purchasing advanced capacitor units with a longer service life. This decision, however, would depend on the development and cost of such capacitors.

In addition to reducing or eliminating the liquid LLW from debris shield cleaning, carbon dioxide cleaning might also further reduce solid LLW. Far fewer wipes would be needed for general decontamination purposes if a "general decontamination carbon dioxide station" were developed and functional. Other liquid LLW streams, as well as solid mixed and liquid mixed streams, might also be reduced with such a system because carbon dioxide could possibly remove activated particulates, as well as tritium contamination, and eliminate the need for solvents.

Existing Waste Management Capabilities at LLNL . Comparison of the waste volumes that would be generated by NIF (see table I.4.1.2.8.1-2) with current waste handling at LLNL provides an indication of the capability of the existing facilities at LLNL to accommodate the various waste management tasks associated with NIF.

For reference, table I.4.1.1.8-1 shows the current waste management capacity at LLNL. Table I.4.1.2.8.1-4 summarizes, in broad categories, the total yearly NIF waste generation estimates for the Conceptual Design and Enhanced options. Table I.4.1.2.8.1-4 is a condensed version of the earlier detailed flows given in table I.4.1.2.8.1-2.

Table I.4.1.2.8.1-4.-- Impact of Estimated National Ignition Facility-Generated Waste on Waste Storage at Lawrence Livermore National Laboratory

Category	NIF-Generated Waste/Year (m^3)		Years to Fill Storage with NIF Flow Alone [39]		Is Existing or Planned Storage Capacity Adequate
	Solid	Liquid	Solid	Liquid	
Low-Level [40]					
Conceptual design total	2.98	0.60	2,000	500	Yes
Enhanced total	7.25	1.56	800	200	Yes
Mixed					
Conceptual design total	0.34	2.0	7,000	300	Yes
Enhanced total	0.88	4.98	2,600	100	Yes
Hazardous [41]					
Conceptual design total	8.0	2.3	12,250	30	Yes, Marginally (liquid)
Enhanced total	8.0	4.6	12,250	20	Yes, Marginally (liquid)

Table I.4.1.2.8.1-5.-- Comparison of National Ignition Facility Waste to Annual Treatment Capacity at Lawrence Livermore National Laboratory

Category	Ratio of NIF Waste Generation to Annual Treatment Capacity [42]	Treatment Capacity (m 3 /yr)	Is Treatment Capacity Adequate
Low-Level			
Liquid			
Conceptual design total	3.7x10-2	3,736 (34.1 m^3/treatment episode)	Yes
Enhanced total	9.7x10-2		Yes
Solid			
Conceptual design total	NA	Shipped offsite	Yes [43]
Enhanced total	NA	Shipped offsite	Yes
Mixed			
Liquid			
Conceptual design total	2.2x10-4	8.75x103	Yes
Enhanced total	5.6x10-4		
Solid			
Conceptual design total	3x10-5	1.18x104	Yes
Enhanced total	7x10-5		Yes
Hazardous			
Liquid			
Conceptual design total	2.3x10-2	9.7x101	Yes
Enhanced total	4.74x10-2		Yes
Solid			
Conceptual design total	NA	Shipped offsite	NA
Enhanced total	NA	Shipped offsite	NA

Table I.4.1.2.8.1-4 shows the potential impact of NIF on waste storage at LLNL. Existing storage capacity (except for hazardous waste) appears to be adequate to handle NIF waste for a number of years. Table I.4.1.2.8.1-5 compares the NIF waste generation rate to the annual handling/treatment capacity at LLNL. This table indicates that NIF waste could generally be treated by current LLNL facilities without a large adverse impact.

In summary, the information presented in tables I.4.1.2.8.1-4 and I.4.1.2.8.1-5 indicates that the added NIF wastes would not represent a significant impact on the existing waste storage capacity nor on the waste treatment capacity at LLNL, since the management of NIF wastes at LLNL would not represent a significant extension of current practices or capabilities. The added impact of NIF wastes on the environment would be minimal and would fall within present regulatory requirements.

I.4.1.2.8.2 Waste Management at Lawrence Livermore National Laboratory During National Ignition Facility Decommissioning

The decontamination and decommissioning (D&D) activities for NIF would not add a significant burden to operations at LLNL. This type of activity is common throughout the DOE complex, and LLNL has experienced staff capable of carrying out these types of activities. The procedures proposed by LLNL for decommissioning NIF after its projected 30 years of operation are summarized below (Tobin and Latkowski 1995). The major activated/contaminated components would be located in the target area, so this facility would pose the most complex operation.

Decommissioning of NIF Laser . All assemblies and equipment would be removed from the laser bays, pulse power bays, master oscillator room, and control room. The support systems, piping, and wiring in the laser bays would also be removed. Minimum disassembly would be done on laser components. Glass would be stored in the simplest, least costly manner. Detached assemblies or subassemblies would fall into three categories: those immediately transferable to other DOE projects, those of possible use in the future, and those not likely to be reused. The items in the first category would be reassigned; the items in the second category would be packaged and stored; and the items in the third category would be disposed of through salvage. Several components, namely ignitrons and capacitors, would be handled as wastes. As shown in table I.4.1.2.8.2-1 the volume of the resulting waste would total about 313 m^3 (409 yd3).

Table I.4.1.2.8.2-1.-- Estimated Quantities of Waste from Laser Decommissioning

Item	**Volume (m^3)**	**Mass (t)**
500 ignitron switches - required recycle, Hg, 0.44 L, 6 kg each; EPA 40 CFR 268.42	1.0	3.0
4400 Capacitors - low hazard waste; castor oil on dielectric paper, 140 kg, 0.07 m^3 each	312	616
Total	313	619

Hg - mercury.

Tobin and Latkowski 1995.

Decommissioning of NIF Target Area . Two issues dominate the complexity or ease with which structures in the target area would be decommissioned at the end of NIF operation: (1) the extent of tritium contamination and (2) the contact dose due to long-lived activation products induced in large structures such as the target chamber, space frame/mirror support frames, and concrete.

Semipermanent facility features that contain materials of concern for neutron activation, such as cable runs and diagnostics, would be maintained during NIF operations in such a way that contact dose rates would allow their reuse in other facilities. This condition would be achieved through a combination of periodic change-out, radioactive decay time, and shielding. If proven successful, the carbon dioxide system proposed for waste minimization would be adapted to meet NIF decontamination needs. As proposed, frequent cleaning of equipment and inner chamber surfaces exposed to tritium and activated debris would significantly reduce (if not virtually eliminate) the need for major end-of-life decontamination. NIF operations would be designed both to minimize the quantity and extent of contamination and to reduce the hazard level of wastes. NIF decommissioning operations would be designed to maximize reuse and recycle of all components of the target area. For present estimates, it is conservatively assumed that the tritium decontamination levels required to allow material to be reused in uncontrolled areas or to be scrapped is 10-disintegrations per minute per square centimeter (dpm/cm^2) (62.5-dpm/square inches [in^2]) of removable tritium or 50-dpm/cm^2 (312.5-dpm/in^2) of removable and fixed tritium (generally in compliance with DOE 1990). Material from NIF would be decontaminated to this level before being disposed of or reused in an uncontrolled area. It is assumed that items useful for other DOE facilities that contain or use tritium would be packaged and shipped to those locations rather than undergo extensive decontamination, pending cost/benefit safety analysis. LLNL assumed that the contact dose rate level required to allow material with induced radioactivity to be reused in uncontrolled areas or to be scrapped is the level permitted by DOE O 441.1. Such material would be held in storage at the NIF site until the contact dose rate level decayed to this level or until it could be disposed of as radioactive waste. The waste quantities are listed in table I.4.1.2.8.2-2. Values are provided for both a minimal case, which assumes a 385-MJ annual release over the projected 30-year operational period, and an expanded case, with a 1,200-MJ annual release. The chamber support structures represent the largest volume (3,058 m^3 [4,000 yd3]) to be handled, with a total volume of all components being about 4,400 m^3 (5,755 yd3).

Table I.4.1.2.8.2-2.-- National Ignition Facility Target Area Low-Level Radioactive Waste Quantities from Decommissioning

Item	**Volume (m^3)**	**Mass (t)**
Vacuum system	34	54
Tritium system	16	36
Diagnostics manipulators	12	3.6
Target positioner	2 (4)	1 (2)
Chamber shielding	282 (567)	310 (620)
Chamber plates	6.3	8.5
Laser light absorbers	1.3 (2.0)	1.9 (3.0)
Chamber support structures	3,058	3,364
Target area beam transport	220 (330)	111 (161)
Final optics hardware	754 (1,204)	545 (815)
Total	4,386 (5,233)	4,425 (5,057)

Values shown assume a 30-year life with 385-megajoule yields. Values in parentheses assume 1,200-megajoule annual yields.

Tobin and Latkowski 1995.

Handling of these components would require careful application of as low as reasonably achievable practices. Estimated dose rates encountered during decommissioning for these components are shown in table I.4.1.2.8.2-3. Assuming careful planning and handling of the disassembly, it is estimated that the occupational exposure involved would be on the order of background rates (table I.4.1.2.8.2-4). The operations required would be unique, but would be within the capability of LLNL personnel, considering LLNL's prior experience with decommissioning large facilities and LLW handling.

Table I.4.1.2.8.2-3.-- Estimated Contact Dose Rates of Key National Ignition Facility Components

Component	**30-day Dose Rate (mrem/hr) (385 MJ/1,200 MJ)**	**3-year Dose Rate (mrem/hr) (385 MJ/1,200 MJ)**
Final transport mirror mounts/motors	0.006/0.019	0.004/0.012
Final optics hardware	<3.1/9.7	<0.29/0.9
Diagnostics manipulators	3.4/10.6	0.31/0.97
Target positioner	0.08/0.25	0.007/0.022
Target chamber plates	0.17/0.53	0.015/0.047
Unconverted laser light absorbers	0.005/0.016	0.0013/0.004
Borated "shotcrete" chamber shielding	0.2/0.62	0.052/0.16
Chamber support concrete rods	0.12/0.37	0.004/0.012
	(w/1 at% B) [44]	(w/1 at% B)
Vacuum system	28.7/89.5 (if steel)	3.14/9.8 (if steel)
	7.04/2.2 (if aluminum)	1.32/4.1 (if aluminum)

Mirror support structure	0.003/0.009	0.001/0.003
Chamber shell	0.84/2.6	0.074/0.23
Concrete walls		
Direct shine areas	0.14/0.44	0.014/0.044
	(w/1 at % B)	(w/1 at % B)
Behind shielding	0.02/0.062	0.001/0.003
	(w/1 at % B)	(w/1 at % B)
Concrete chamber pedestal	0.12/0.37	0.004/0.012
	(w/1 at % B)	(w/1 at % B)

Table I.4.1.2.8.2-4.-- Estimated Decommissioning Effort and Occupational Exposure for the National Ignition Facility Target Area for 385- and 1,200-Megajoule Annual Yields

Component	Description	Effort (Person months)	Dose Rates (mrem/hr)	Dose (mrem)	Dose per worker (mrem, average)
Target Area Beam Transport					-
Support structures	80 t	22.1	1 (3)	3.9 (12.1)	-
Tubes	14 t	4	0 (0)	0 (0)	-
Mirrors/motors	388 (582) ea	18 (27)	4 (12)	12.7 (57)	-
Final Optics Assemblies					-
Optics	768 ea	13.2	0 (0)	0 (0)	-
Hardware	48 (72) ea	14.1 (21.6)	290 (900)	735 (3,421)	-
Target Diagnostic Systems					-
Diagnostics	12 ea	3.6	310 (970)	196 (612)	-
Support systems and TIM	12 ea	1.2	310 (970)	65 (204)	-
Vacuum	1 ea	1.2	310 (970)	65 (204)	-
Target positioner	1 ea	0.4	7 (22)	0.5 (1.5)	-
Target Chamber					-
Spherical shell	87 t	50	74 (230)	651 (2,030)	-
Plates	325 ea	18.3	15 (47)	48 (151)	-
Laser light absorbers	192 (288) ea	14.4 (21.6)	1.3 (4)	3.3 (15)	-
Shielding	283 (567) t	5.7 (11.4)	52 (160)	52 (326)	-
Concrete Supports	3,364 t	67.3	4 (12)	47 (148)	-
Vacuum System	3 ea	2.4	1,320 (410)	558 (1,738)	-
Totals	-	235.9	-	2,437 (8,920)	122 (446)

Tobin and Latkowski 1995.

FOOTNOTES

1: For short-term standards, baseline concentration is highest concentration for year for state standards, second highest for Federal standards.

2: Federal standard (40 CFR 50).

3: State standard.

4: Exceeds most stringent regulation or guideline.

5: ND - no data available.

6: In sufficient amount to produce an extinction coefficient of 0.23 per km due to particles when the relative humidity is less than 70 percent.

7: NS - no data available. BAAQMD - Bay Area Air Quality Management District. CARB 1993; Lazaro et al. 1996; LLNL 1994a.

8: If reporting body did not distinguish between state and Federal revenue sources, the total for all intergovernmental revenue was combined and reported under the "State sources" heading. Alameda County 1994; Contra Costa County 1994; San Joaquin County 1994; city of Livermore 1994; city of Pleasanton 1994; city of Tracy 1994; city of Manteca 1994.

9: Pupil-teacher ratio is for grades 1-8.

10: Contra Costa Fire Protection District is the largest fire protection district in Contra Costa County; however, other districts also provide service throughout the county.

11: General Government number includes firefighters. Fire services in San Joaquin County are provided by approximately 27 fire protection districts, including city fire departments. NA - not applicable.
Contra Costa County 1994; Alameda County 1994; Contra Costa County School Districts 1994; American Medical Association 1994; Federal Bureau of Investigation 1993; San Joaquin County Schools 1995a; San Joaquin County Schools 1995b; city of Pleasanton Personnel Department 1995; city of Manteca Personnel Department 1995; city of Manteca Fire Department 1995; Contra Costa Fire Protection Department 1995; Alameda County Fire Department 1995.

12: The regulatory limits for individuals are given in DOE Order 5400.5. The 10 mrem/yr limit from airborne emissions is required by the Clean Air Act . The 4 mrem/yr limit is required by the Safe Drinking Water Act , and the total dose of 100 mrem/yr is the limit from all pathways combined. The occupational limit for workers is 5,000 mrem/yr (10 CFR 835).

13: The calculated dose values listed in this column conservatively include all water pathways, not just the drinking water pathway.

14: Based on latent fatal cancer risk factors of 5x10-7/mrem for individuals, 5x10-4 /person-rem for population, and 4x10-7/mrem for workers (ICRP 1991).

15: Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.

16: Estimated for a population of approximately 6 million.

17: No regulatory limit exists for population doses; however, a 100 person-rem value for the population is found in proposed 58 FR 16268 (10 CFR 834).

18: Worker doses were estimated on the basis of readings from monitoring devices called thermoluminescent dosimeters.

19: The number of badged workers in 1994 was approximately 8,700. NA - not applicable. LLNL 1994d.

20: Storage capacity may include several storage units that may be permitted for several waste types.

21: This waste is not tracked by volume, and the weight of material is too variable to reliably convert. NA - not applicable. Andrews and Tobin 1995; Bowers 1995.

22: Metric tons (1,000 kg) per year.

23: Includes 4.17 t/yr (4.60 ton/yr) of fugitive emissions for site clearing, using water spray control that occurs during a 30-day period in the first year and 10 t/yr (11.02 ton/yr) of facility construction emissions that occur for 11 months during the first year of construction. Lazaro et al. 1996.

24: Emissions based on site-estimated natural gas external combustion, diesel internal combustion, and volatile organic compound solvent cleaning (0.5 t/yr [0.55 ton/yr]) and emission factors (EPA 1995c; Lazaro et al. 1996). EPA 1993; Zahn 1995.

25: Represents energy consumption for all required NIF support facilities. See table I.3.4-1 for a list of NIF support facilities.

MJ - megajoule(s); L -liter(s).

LLNL 1995b; White 1995e.

26: From LLNL 1995b.

27: From LLNL 1995b and Paisner 1995.

28: From LLNL 1994d.

29: Construction period would be 1996 to 2002, with peak construction projected to occur in 1998.

30: Operating period would be 2003 to 2033, with impacts throughout the period projected to remain stable.

31: Regional earnings are in millions of constant 1994 dollars.

32: Projected 1998 fund balance for Public Finance, and projected 1998 level of service (LOS) for Public Services. Model results.

33: Collective population fatalities were calculated for 145 shipments (Conceptual Design Option) and 335 shipments (Enhanced Option). For example, a reported value of 4x10-3 fatalities suggests that no fatalities are expected for the proposed action. However, one single fatality out of the entire affected population might be expected over the course of 250 years if the same number of shipments were to continue for that length of time.

34: The most severe accidents assume that 100 percent of the target tritium is released in an oxide form during an accident. Accident consequences results were determined using RISKIND computer program which is described in Yuan et al. 1993. Stable weather conditions (Pasquill stability class F) with a wind speed of 1 m/s (2.2 mph) were assumed.

35: The maximum consequences would result from an accident occurring in an urban environment. The population was assumed to extend at a uniform density of 3,861 persons/km 2 (10,000 person/mi 2) to a radius of 80 km (50 mi) from the accident site. The population exposure pathways for urban environments include inhalation and resuspended inhalation. Urban environments were not assumed to produce food for local use or export, hence no ingestion dose was included.

36: The maximally exposed individual was assumed to be at the location of maximum exposure. The location of the maximally exposed individual was assumed to be 380 m (1,247 ft) from the accident under stable weather conditions. Individual exposure pathways include acute inhalation during passage of the plume. No ingestion dose was considered.

The transportation risk assessment assumed 100 percent of the tritium targets are manufactured and transported to NIF from each site. In practice, tritium targets would be produced and transported from more than one manufacturer. The transportation risk assessment was performed for offsite transportation only. Transportation risks from onsite tritium targets were assumed to be negligible compared with risks from offsite transportation. Model results.

37: Articles cleaned by wiping, carbon dioxide blasting, and other decontamination methods. These materials would be handled as solid low-level radioactive wastes. Numbers in bold italics refer to waste estimates for the Enhanced Option; LATB - Laser and Target Area Building; OAB - Optics Assembly Building; HEPA - high-efficiency particulate air.
Andrews and Tobin 1995; Bowers 1995.

38: Articles cleaned by wiping, carbon dioxide blasting, and other decontamination methods. These materials would be handled as solid low-level radioactive wastes. Numbers in bold italics refer to waste estimates for the Enhanced Option; LATB - Laser and Target Area Building; OAB - Optics Assembly Building; HEPA - high-efficiency particulate air. Andrews and Tobin 1995; Bowers 1995.

39: In order to translate the solid waste mass into an expression of volume and to calculate the values shown for the number of years to fill storage capacity with NIF flow alone, the following values for the densities of the materials were assumed: molecular sieves: density of diatomaceous earth (0.22 g/cm^3); personal protective equipment and wipes: density of paper (0.4 g/cm^3); pre- and high-efficiency particulate air filters: density of charcoal (1.8 g/cm^3); paper capacitors: density of paper (0.4 g/cm^3); hardware from the chamber: density of 50 percent aluminum and 50 percent stainless steel (5.3 g/cm^3).

40: The total amount of the low-level waste was found by adding the values in the column "Cleaned" of table I.4.1.2.8.1-2 to the column "Low-Level" of the same table. The density of the debris shield was assumed to be the density of iron (7.87 g/cm 3). The density of low-level liquid waste was assumed equal to 1.0 g/cm 3 . The amount of the "cleaned" personal protection equipment and wipes/general cleaning was added to the solid low-level radioactive waste.

41: The values for the hazardous waste are the sum of the Laser and Target Area Building and Target Area Building and Optics Assembly Area values. Calculated from table I.4.1.1.8-1 and Tobin 1995.

42: The following values for the densities of the materials were assumed: molecular sieves: density of diatomaceous earth (0.22 grams per cubic centimeter [g/cm^3]); personal protective equipment and wipes: density of paper (0.4 g/cm^3); pre- and high-efficiency particulate air filters: density of charcoal (1.8 g/cm^3); paper capacitors: density of paper (0.4 g/cm^3); hardware from the chamber: density of 50 percent aluminum and 50 percent stainless steel (5.3 g/cm^3).

43: Shipped offsite.

NA - not applicable.

Calculated from table I.4.1.1.8-1 and Tobin 1995.

44: w/l at% B - with 1 atom % boron. Values shown assume 30-year life with 385-megajoule yields and 1,200-megajoule annual yields.
Tobin and Latkowski 1995.

I.5 Environmental, Occupational Safety, and Health Permits and Compliance Requirements

I.5.1 Introduction

This chapter identifies the major laws, regulations, Executive Orders, and compliance instruments that apply to the National Ignition Facility (NIF) proposed action and alternatives. Various Federal environmental statutes impose environmental protection and compliance requirements upon the Department of Energy (DOE). Further, certain state and local environmental authorities are also applicable because they are delegated to the state for enforcement or implementation under Federal law. It is DOE policy to conduct its operations in an environmentally safe manner in compliance with all applicable statutes, regulations, and standards. Although this chapter does not address pending legislation or regulations that may become effective in the future, DOE recognizes that the regulatory environment is rapidly changing and that the construction and operation of NIF must be conducted in compliance with the applicable statutes, regulations, and standards in effect at the time.

Under the *National Environmental Policy Act* (NEPA) of 1969 (42 *United States Code* [U.S.C.] 4321 et seq.), Federal agencies are required to prepare an environmental impact statement (EIS) for proposed major Federal actions that might significantly affect the quality of the human environment. DOE has determined that the proposed siting, construction, and operation of NIF is such an action. Therefore, this project-specific analysis has been prepared as a part of the *Stockpile Stewardship and Management Programmatic Environmental Impact Statement* in accordance with the Council on Environmental Quality (CEQ) Regulations (40 *Code of Federal Regulations* [CFR] 1500-1508) implementing NEPA and DOE NEPA Implementing Procedures (10 CFR 1021).

Under the California Environmental Quality Act (California Statutes, Public Resources Code, Division 13 - Environmental Quality, Section 21000 et seq.), any California state public agency taking any action that may cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment must consider qualitative factors, economic and technical factors, long-term benefits and costs, and alternatives to the proposed action. Public agency actions include the issuance of a state permit, license, certificate, or other entitlement. The public agency must determine whether it will prepare an environmental impact report to identify the significant effects of the proposed project on the environment. All applicants for permits, license, certificates, or other entitlements from a public agency in support of the NIF proposed action may be required to submit data and information necessary to enable the public agency to determine whether the proposed project may have a significant affect on the environment and whether to prepare an environmental impact report.

The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) authorized DOE to establish standards to protect health or minimize dangers to life or property for its facilities and operations. DOE has established an extensive system of standards and requirements through DOE orders to ensure safe operation of its facilities.

Executive Order No. 12088, Federal Compliance with Pollution Control Standards, requires Federal agencies--including DOE--to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the *Clean Air Act* (section I.5.2.1), the *Noise Control Act* (section I.5.2.1.4), the *Clean Water Act* (section I.5.3.1), the *Safe Drinking Water Act* (section I.5.3.2), the *Toxic Substances Control Act* (section I.5.7.2), and the *Resource Conservation and Recovery Act* (section I.5.8.1).

I.5.2 Air Quality and Noise Requirements

I.5.2.1 *Clean Air Act*

Construction and operation of NIF would result in air emissions of criteria and noncriteria pollutants, including sulfur dioxide, nitrogen dioxide, volatile organic compounds (VOCs), carbon monoxide, and particulates (PM *10*). These emissions would be subject to the *Clean Air Act* (CAA) (42 U.S.C. 7401 et seq.), as amended. NIF would also be a source of radionuclide emissions, also subject to the CAA. No other emissions of hazardous air pollutants would be anticipated during construction or operation of NIF.

CAA requires the U.S. Environmental Protection Agency (EPA) to establish national primary and secondary ambient air quality standards as necessary to protect public health with an adequate margin of safety from any known or anticipated adverse effects of a pollutant. CAA also requires promulgation of national standards of performance for new major stationary sources, setting emissions limitations for any new or modified building, structure, facility, or installation that emits or may emit an air pollutant (42 U.S.C. 7411) and standards for emission of hazardous air pollutants (42 U.S.C. 7412). CAA also requires that specific emission increases from major sources be evaluated so as to prevent a significant deterioration in air quality (42 U.S.C. 7470). In addition, CAA requires EPA to promulgate rules to ensure that Federal actions conform to the appropriate state implementation plans (42 U.S.C. 7506).

Pursuant to such direction, EPA promulgated the primary and secondary National Ambient Air Quality Standards, including standards for emissions of sulfur oxides (measured as sulfur dioxide), nitrogen dioxide, carbon monoxide, PM10, ozone, and lead (40 CFR 50); the standards of performance for new stationary sources within specific source categories enumerated in 40 CFR 60.16, including electric steam generating units, industrial-commercial-institutional steam generating units, and stationary gas turbines (40 CFR 60); the National Emission Standards for Hazardous Air Pollutants, including radionuclides (40 CFR 61); and the Prevention of Significant Deterioration (PSD) of Air Quality review regulations (40 CFR 52.21).

On November 30, 1993, EPA published its final rule for Determining Conformity of General Federal Actions to State or Federal Implementation Plans (58 Federal Register [FR] 63214). This rule requires states to file revisions to their state implementation plans to include conformity requirements (40 CFR 51.850-860). Once the state plans are revised, Federal agencies are subject to those revised state implementation plans. Until such revisions are submitted and approved, however, the rule adopts conformity requirements applicable to all Federal agencies (40 CFR 93.150-160). Only New Mexico and the Albuquerque/Bernalillo County Air Quality Control Board have revised their regulations to require conformity determinations for Federal actions (New Mexico Regulations, Title 20, Part 98 [uncodified]; Board Regulation No 43). The regulations apply to all nonattainment and maintenance areas for criteria pollutants for which the area is designated.

Under the new rules, a Federal agency must make a formal determination that a Federal action conforms to the applicable implementation plan before such action may be taken. For Federal actions, a conformity determination is required for each pollutant when the total of direct and indirect emissions in a nonattainment or maintenance area caused by a Federal action would equal or exceed certain limits (40 CFR 51.853 or 93.153) (table I.5.2.1-1).

The direct and indirect emissions from the construction and operation of NIF at any site would not exceed these limits (sections I.4.1.2.2, I.4.2.2.2, I.4.3.2.2, I.4.4.2.2, and I.4.5.2.2). In addition, the total of direct and indirect emissions of any pollutant from a Federal action must not equal or exceed 10 percent of a nonattainment or maintenance area's total emissions of that pollutant. If it does, it is defined as a regionally significant action and a conformity determination is required. It is not expected that emissions from NIF would equal or exceed this 10 percent limit.

CAA provides that each state must develop and submit for approval to EPA implementation plans for controlling air pollution and air quality in that state. Under EPA regulations, California, Nevada, and New Mexico all have approved state implementation plans; however, not all parts of the CAA requirements are met in such plans and, in some cases, dual Federal/state regulations must be implemented.

Table I.5.2.1-1.-- Conformity Determination Exceedance Limits

Pollutant	Limit (tons/yr) 1
Nonattainment Areas	
Ozone (volatile organic compounds or nitrogen oxides)	
Serious Nonattainment Areas	50
Severe Nonattainment Areas	25
Extreme Nonattainment Areas	
Other ozone nonattainment areas outside an ozone transport region	
Marginal and moderate nonattainment areas inside an ozone transport region	

Volatile organic compounds	50
Nitrogen oxides	100
Carbon monoxide	100
Sulfur dioxide or nitrogen dioxide	100
Particulate matter 10 microns or smaller	
Moderate Nonattainment Areas	100
Serious Nonattainment Areas	70
Lead	25
Maintenance Areas	
Ozone (nitrogen oxides), sulfur dioxide or nitrogen dioxide	100
Ozone (volatile organic compounds	
Maintenance areas inside an ozone transport region	50
Maintenance areas outside an ozone transport region	100
Carbon monoxide	100
Particulate matter 10 microns or smaller	100
Lead	25

a To determine metric tons/year (t/yr), multiply values by 0.90718.

40 CFR 51.853 and 93.153.

California and Nevada have not been delegated the authority to regulate the emission of radionuclides from DOE facilities, and, therefore, Federal regulations would apply to such emissions at the Lawrence Livermore National Laboratory (LLNL) and the Nevada Test Site (NTS). In Nevada, the District Board of Health of Clark County and the Albuquerque/Bernalillo County Air Quality Control Board have adopted the Federal regulations, which would then be applicable to radionuclide emissions from the North Las Vegas Facility (NLVF) and Sandia National Laboratories/New Mexico (SNL). New Mexico has adopted the Federal standards for the emission of hazardous air pollutants (40 CFR 61); however, it has excluded from adoption Subparts H (National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities) and Q (National Emission Standards for Radon Emissions from Department of Energy Facilities). Therefore, Federal regulations would apply in New Mexico for the Los Alamos National Laboratory (LANL).

The Federal regulations for emissions of radionuclides and radon-222 from DOE facilities are set in 40 CFR 61, Subparts H and Q. Pursuant to 40 CFR 61.07, an application for approval of construction must be filed before construction begins (with Region IX for LLNL and NTS, with Region VI for

LANL, with the District Board of Health of Clark County for NLVF, and with the Albuquerque/ Bernalillo County Air Quality Control Board for SNL). Further, DOE must provide written notification to EPA (or appropriate authority) no more than 60 nor less than 30 days before the anticipated date of initial start-up of operations (40 CFR 61.09). However, if it is estimated that radionuclide emissions from the new construction or modification would be less than 1 percent of the effective dose equivalent of 10 mrem/yr to any member of the public, no application for approval of construction or notification of start-up is necessary (40 CFR 61.96). <>

I.5.2.1.1 *Clean Air Act* Requirements for California

The LLNL site is within the Bay Area Air Quality Management District (BAAQMD), and the district's regulations would apply to air emissions from NIF. NIF is not expected to have sufficient emissions to meet the definition of a major facility under California air regulations. The definition of one facility, however, includes related sources on a single property or contiguous properties, even though under different ownership, and related sources on noncontiguous properties under the same ownership. For this review, facilities under the same ownership that are located within a distance of 4.8 kilometers (km) (3 miles [mi]), property line to property line, are considered one facility if the facilities have the same first two digits in the Standard Industrial Classification code. However, current calculations show that LLNL's existing sources do not meet the definition of a major facility under the California regulations. Therefore, there is no requirement for a PSD review or major facility review for the construction and operation of NIF at LLNL (Regulation 2, Rules 2 and 6). New Source Performance Standards (40 CFR 60, Subpart D, as adopted by BAAQMD Regulation 10) would have to be met for the operation of steam boilers constructed as or modified to be support facilities for NIF. Under such requirements, any fossil-fueled steam boilers exceeding 73 megawatts (MW) input rate (250 British Thermal Units per hour [BTU/hr]) must meet the standards for PM10, nitrogen oxides, sulfur dioxide, and opacity.

Under BAAQMD regulations, any person responsible for the emission of air contaminants must register with the district (Regulation 1, Rule 1-410). In addition, any person who builds, installs, modifies, alters, or replaces any article, machine, equipment, or other contrivance, the use of which might cause, reduce, or control the emission of air contaminants, must first apply for and obtain an authority to construct from the Air Pollution Control Officer (Regulation 2, Rule 1-301). Also, any person wishing to use or operate such article machine, equipment, or other contrivance must obtain a permit from the Air Pollution Control Officer (Regulation 2, Rule 1-302).

Any facility that must obtain an authority to construct must be reviewed as a new source. Under the new source review rules (Regulation 2, Rule 2), the aggregate sum of all increases in emissions from a new or modified source must be calculated. These calculations will provide mechanisms, including the identification of best available control technology (BACT) and emission offsets, by which the District will grant the new or modified source the authority to construct (Regulation 2, Rule 2-101). Fugitive emissions of PM10 from temporary construction activities are not included in the calculation of the total potential to emit for the facility (DeBoisblance 1995). BACT must be applied to any new or modified source that will result in emissions of precursor organic compounds, non-precursor organic compounds, nitrogen oxides, sulfur dioxide, PM10, or carbon monoxide in excess of 4.5

kilograms (kg) (10 pounds [lb]) per highest day (Regulation 2, Rule 2-301). Estimated emissions from boiler operations may exceed 4.5 kg (10 lb) per day, and BACT may have to be applied as determined by the permit process.

If the facility will emit more than 45 metric tons (t) (50 tons) per year of precursor organic compounds or nitrogen oxides, federally enforceable emission offsets will be required before a permit will be granted (Regulation 2, Rule 2-302). If the facility will emit more than 13.6 t (15 tons) per year but less than 45 t (50 tons) per year of precursor organic compounds or nitrogen oxides, the district will provide the emission offsets from the Small Facility Banking Account (Regulation 2, Rule 2-302). Offsets for PM10 and sulfur dioxide are mandatory only for major facilities with emissions over 91 t (100 tons) per year. A facility that emits less than 91 t (100 tons) per year of PM10 or sulfur dioxide may voluntarily provide emission offsets for all or any portion of their cumulative increase.

I.5.2.1.2 *Clean Air Act Requirements for Nevada*

NTS is located in Nye County and air emissions for the construction and operation of NIF would be governed by the Nevada State Air Pollution Control Regulations (NAC 445B.001 through 445B.395). NIF at NTS is not expected to be a major facility under Nevada regulations. The District Board of Clark County Air Pollution Control Regulations (APCR) are approved as part of the Nevada state implementation plan, and these regulations would govern air emissions from the construction and operation of NIF at NLVF. NIF is not expected to be a major facility under Clark County regulations. New Source Performance Standards (40 CFR 60, Subpart D, as adopted by NAC 445B.308 and Clark County APCR, section 14) would have to be met for the operation of steam boilers constructed as, or modified to be, support facilities for NIF. Under such requirements, any fossil-fueled steam boilers exceeding 73 MW heat input rate (250 million Btu/hr) must meet the standards for PM10, nitrogen oxides, sulfur dioxide, and opacity.

In Clark County, all new, reconstructed, or modified stationary sources of volatile organic compounds, lead, PM10, particulate precursors, and carbon monoxide that are proposed to be located in the Las Vegas Valley must register with the District (APCR, section 15.14). Under Clark County Air Pollution Control regulations, any person who proposes to install or construct any new stationary source of air emissions must apply for an "Authority to Construct" certificate before construction is begun (APCR, section 12.1.1.1).

Certain requirements must be met for specific air contaminants before a permit will be issued. NIF project, as a nonmajor source of PM10 in Las Vegas Valley (with a potential to emit less than 64 t [70 tons] per year), must incorporate BACT (APCR, section 12.2.1.1). The applicant must also provide documentation of emission reduction credits against other emissions if the total potential to emit for the new source will exceed 23 kg (50 lb) per day of total suspended particulates (APCR, section 12.2.1.3). Qualified road paving projects approved by the local public works department are recognized by the Control Officer as emission reduction credits for PM10 (APCR, section 12.4.1). Such credits are good for seven years. A one-year emission reduction credit is available by payment to the closest local participating public works department (APCR, section 12.4.2).

As a nonmajor source of VOCs in Las Vegas Valley (VOC emissions under 45 t [50 tons] per year), NIF must incorporate emissions controls that are designed for BACT (APCR, section 12.2.4.1). The applicant must also provide documentation of emission reduction offsets to all anticipated annual emission increases (APCR, section 12.2.4). The applicant must also apply BACT for sulfur dioxide and lead emissions and demonstrate that the total potential to emit will not cause, or contribute to, ambient concentrations that exceed ambient air quality standards for sulfur dioxide or lead (APCR, sections 12.2.8 and 12.2.10).

An applicant must apply BACT for all emissions of nitrogen oxides and must demonstrate that the total potential to emit will not cause, or contribute to, ambient concentrations exceeding the ambient air quality standard for nitrogen oxides (APCR, section 12.2.10.1). Emission credits equivalent to twice the new source's potential to emit are required (APCR, section 12.2.10.4). As a nonmajor source of carbon monoxide in Las Vegas Valley (potential to emit less than 64 t [70 tons] per year), NIF must incorporate emission controls that are designed with the BACT (APCR, section 12.2.11.1), and emission reduction credits must be greater than twice the potential to emit for the new source (APCR, section 12.2.11.4).

In addition, an operating permit is required for the operation of any emission unit in a stationary source (APCR, section 16). Such an operating permit might contain conditions, including emission limits, production rates, control methods, or operation limitations, subject to annual review.

For construction activities at NIF within Clark County, a Permit for Construction Activities is required (APCR, section 17) to satisfy the Authority to Construct requirements of APCR, section 12.2.1. As a condition of such a permit, the applicant must present and agree to implement an acceptable method to prevent particulate matter from becoming airborne. In addition, any person engaged in the operation of machines and equipment, the grading of roads, and the operation and use of unpaved parking facilities must take all reasonable precautions to abate fugitive dust from becoming airborne. Reasonable precautions may include, but are not limited to, the conditions agreed upon in the permit for the project, sprinkling, compacting, enclosure, chemical and asphalt sealing, cleaning up, sweeping, or other such measures as the Control Officer may specify.

ACPR, Section 41, also requires control of fugitive emissions during construction activities. Fugitive emission prohibitions include the following:

- Visible plume of dust, resulting from contruction activities beyond the nearest property line, whichever is less
- Visible dust emissions on an upward road at a construction site being used by haul trucks
- Visible dust emissions generated by vehicles traveling over mud and directly carried out to a paved road near or adjacent to a construction site
- Handling, transporting, or storing material in such a manner to become airborne

The regulations further indicate that a visible plume of dust resulting from construction activities that extends more than 45.7 meters (m) (150 feet [ft]) from the point of origin, but less than 91.4 m (300 ft) and that has not crossed the property line may be subject to a Notice of Violation, including an

Order to take Corrective Action.

Under Nevada air regulations, NTS, as the owner or operator of a proposed new nonmajor stationary source or a proposed modification to an existing nonmajor stationary source, must file an application and obtain a Class II operating permit before construction is begun (NAC, section 445B.291). A separate operating permit is required for each new and existing stationary source (NAC, section 445B.287). Before an operating permit may be issued for a new stationary source, any source that has the potential to emit greater than 23 t (25 tons) of a regulated air pollutant per year must submit an environmental evaluation to enable the director to make an independent air quality impact assessment and determine that the source will not prevent the attainment and maintenance of the state or national ambient air quality standards, cause a violation of the applicable control strategy contained in the approved state implemented plan, or cause a violation of any applicable requirement (NAC, section 445B.310). Because NIF is not expected to emit in excess of 23 t (25 tons) of any regulated air pollutant per year, no assessment would be necessary.

Construction activities at NTS would require an operating permit for any surface area disturbance (such as clearing, excavating, and leveling the land) involving more than 2 hectares (ha) (5 acres) of land (NAC, section 445.365). No person may engage in construction or use of unpaved or untreated areas without first putting into effect an ongoing program using the best practical methods to prevent particulate matter from becoming airborne (NAC, section 445B.365).

I.5.2.1.3 *Clean Air Act Requirements for New Mexico*

New Mexico Air Quality regulations would apply to air emissions from NIF if it was located at LANL. However, the Albuquerque/Bernalillo County Air Quality Control Board regulations would apply to air emissions from NIF if located at SNL.

Under New Mexico Air Quality regulations (which would apply at LANL), a permit must be obtained before constructing a stationary source or modifying an existing source with a potential emission rate greater than 4.5 kg/hr or 23 t/yr (10 lb/hr or 25 tons/yr) of any regulated air contaminant for which there is a Federal or New Mexico ambient air quality standard (Environmental Improvement Board/ Air Quality Control Regulations [EIB/AQCR] 702, Part 2). If the threshold is exceeded for any one regulated air contaminant, all regulated air contaminants emitted are subject to permit review. A permit is also required for any source or equipment that is subject to the New Source Performance Standards, for any toxic air pollutant emissions or any major source of hazardous air pollutants, any source meeting the applicability requirements of the PSD review, or for permits for nonattainment areas (EIB/AQCR 702). It is not anticipated that the construction or operation of NIF at LANL would emit toxic air pollutants, be a major source of hazardous air pollutants, or be located in a nonattainment area. Therefore, no permit application would be required under this section. One PSD Class I Area, the Bandelier National Monument Wilderness Area, borders LANL to the south; however, to date, LANL has not been subject to PSD requirements (see section I.4.2.1.2.2). New Source Performance Standards (40 CFR 60, Subpart D, as adopted by 20 NMAC 2.77) would have to be met for the operation of steam boilers constructed as or modified to be support facilities for NIF. Under such requirements, any fossil-fueled steam boilers exceeding 73 MW heat input rate (250 million Btu/hr) must meet the standards for PM *10* , nitrogen oxides, sulfur dioxide, and opacity.

Under Albuquerque/Bernalillo County Air Quality Control Board regulations, SNL as the owner or operator of NIF, a commercial or industrial stationary source that emits more than 0.9 t (1 ton) of any air contaminant per year, must obtain a registration certificate for the source (Regulation No. 22). In addition, any persona planning to construct a new stationary source or modify an existing stantionary source of air contaminants over certain thresholds must obtain a permit from Alburquerque/Bernalillo County Air Qulaity Control Board vefore construction.

For construction of NIF in Alburquerque/Bernalillo County, a permit would be neccesary for the disturbance of more than 0.30-ha (.75 acre) surface area (Regulation 8.03). In addition, the permittee must employ means specified in the permit to prevent the escape from the site of airborne particulate matter, if the opacity of which exceeds the opacity of the surrounding airborne background particulate matter by 10 percent.

I.5.2.1.4 Noise Requirements

Section 4 of the *Noise Control Act* of 1972 (42 U.S.C. 4901 et seq.) directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare. EPA has not published regulations concerning noise levels from construction operations. However, the agency has issued guidelines for outdoor noise levels that are consistent with the protection of human health and welfare against hearing loss, annoyance, and activity interference (EPA 1974). Such guidelines state that "undue interference with activity and annoyance will not occur if outdoor levels [of noise] are maintained at an energy equivalent of 55 decibel." These levels are not to be construed as standards, however.

I.5.3 Water Resources Requirements

Regardless of the site selected for the project, NIF would use water for sanitary and domestic purposes, low-conductivity cooling, manufacturing, and processing operations for target and optics maintenance, environmental control of the site and facilities, and emergency and safety systems. It is also anticipated that industrial and sanitary/domestic water would be discharged from the operation of NIF at all sites. For construction activities, stormwater discharges are regulated.

I.5.3.1 *Clean Water Act*

The Federal *Clean Water Act* (CWA) (33 U.S.C. 1251 et seq.) provides that it is illegal to discharge pollutants from a point source into navigable waters of the United States except in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. Through administrative and judicial interpretation, the navigable waters of the United States encompass any body of water for which the use, degradation, or destruction would affect or could affect interstate or foreign commerce, including but not limited to interstate and intrastate lakes, rivers, streams, wetlands, playa lakes, prairie potholes, mudflats, intermittent streams, and wet meadows. This program is administered by the Water Management Division of EPA pursuant to regulations in 40 CFR 122 et seq. Any state may administer its own permit program for discharges into navigable waters within its jurisdiction by submitting the state program to EPA for approval (33 U.S.C. 1342[b]).

Sections 401 and 405 of the *Water Quality Act* of 1987 added section 402(p) to the CWA, which requires EPA to establish regulations for issuing permits for stormwater discharges associated with industrial activity. The language of the *Water Quality Act* of 1987 requiring an NPDES permit for stormwater discharge was codified into EPA regulations at 40 CFR 122.26 (54 FR 246, effective January 4, 1989). Pursuant to revised 40 CFR 122.26(a)(1)(ii), any stormwater discharge associated with industrial activity requires an NPDES permit application. EPA has delegated NPDES permitting authority to the States of California and Nevada. New Mexico, however, has not received such delegation, and NPDES permits in New Mexico are issued by EPA, Region VI. The New Mexico Environment Department certifies that permits meet all state and Federal regulations.

Pursuant to Section 404 of the CWA (33 U.S.C. 1344), there may be no discharges of dredged or fill material into waters of the United States, including rivers, streams, wetlands, and playa lakes (33 CFR 328.8), done than the Corps of Engineers, without a permit issued pursuant to Corps of Engineers rules and regulations (33 CFR 320 through 328). these regulations prescribe special policies, practices, and procedures to be followed by the Corps of Engineers in reviewing apllications for such permits to authorize such discharges (33 CFR, Parts 320, 323, and 325). Pursuant to 33 CFR 320.4., the Corps in issuing such permits must consider the impact that such an activity would have on floodplains and wetlands in accordance with Executive Orders 11988 and 11990.

I.5.3.1.1 *Clean Water Act Requirements in California*

California has NPDES permitting authority, and any permits or permit modifications required by the construction or operation of NIF at LLNL would be issued by the State Water Resources Control Board, Division of Water Quality. Sanitary wastewater from NIF located at LLNL would be discharged to the city of Livermore Water Reclamation Plant. Therefore, no NPDES permit would be necessary for NIF operations. Under current calculations, wastewater treatment capacity at the Reclamation Plant is expected to be sufficient to meet the additional requirements of NIF. However, it might be necessary to report any change in amount or character of discharges to the Livermore Plant under LLNL/city of Livermore pretreatment agreements, since discharge of spent cooling water would be considered an industrial discharge (Steenhoven 1995).

Construction activity associated with NIF would require Notice of Intent to the State Water Resources Control Board to participate in the California General Construction Activity Stormwater Permit. Under the permit, a stormwater pollution prevention plan would have to be developed to mitigate potential water quality impacts from construction activities through the use of best available technology and best conventional pollutant control technology. Once construction was completed, NIF would have to be added to the Livermore Site Industrial Activity Stormwater Pollution Prevention Plan through notification to the State Water Resources Control Board.

I.5.3.1.2 *Clean Water Act Requirements in Nevada*

Nevada is an NPDES-delegated state with general permitting authority. Although NTS holds a sewage treatment permit (GNEV 93001) from the Department of Conservation and National Resources for its current treatment systems, a sanitary wastewater treatment lagoon would have to be constructed to accommodate NIF operations at NTS. The new lagoon would not discharge to any water of the state (Monroe 1995). Under the Nevada Water Pollution Control Law, it is unlawful to discharge pollutants into waters of the state (which includes all streams, lakes, ponds, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation and drainage systems, and all bodies or accumulations of water, surface and underground, natural and artificial) without a written permit for such discharge under such reasonable terms and conditions as required by the Department of Conservation and Natural Resources and Environmental Protection Division (NRS, Title 40, chapter 445.287).

Industrial wastewater and sanitary sewage from NLVF are discharged into the city of North Las Vegas Water Treatment Plant. The North Las Vegas plant holds a current NPDES permit issued by the Nevada Division of Environmental Protection. Under Nevada Water Pollution Control regulations, no permit is required for discharges of pollutants, other than toxic materials, into a publicly owned treatment works, if the owner of such publicly owned treatment works has a valid permit from the state (NAC, section 445.140). Therefore, no permit is necessary for the discharge of NIF wastewater into the North Las Vegas plant. However, under pretreatment agreements and permits with the publicly owned treatment works, NLVF might have to report to the publicly owned treatment works the change in amount and character of its discharge resulting from the construction and operation of NIF. (NAC, section 445.169).

Both NTS and NLVF have requested the Department of Conservation and Natural Resources to issue a determination that stormwater from the sites does not discharge to waters of the state, and, therefore, no stormwater permits, for construction or industrial activity are necessary.

I.5.3.1.3 *Clean Water Act Requirements in New Mexico*

New Mexico has not been delegated NPDES permitting authority; therefore, EPA, Region VI, would issue any new NPDES permits or modify existing permits as necessary. The New Mexico Environment Department reviews and certifies NPDES draft permits issued by EPA to ensure that they meet all state and Federal regulations and standards. Sanitary wastewater from NIF construction and operations would be discharged into LANL's existing sewer system, which has been permitted by the Federal EPA (NPDES Permit NM 0028355). All reporting requirements under the permit regarding changes in the quantity, quality, or character of the discharge resulting from NIF operations must be made to EPA, Region VI (40 CFR 122.41(l), 122.62, 122.63). This requirement would include significant changes in process and quantity or quality of effluent discharged into the existing system and any new discharges. DOE, LANL, and New Mexico Environment Department have entered into a Settlement Agreement to study the stream uses associated with LANL effluent discharges under its NPDES regulations.

In addition to Federal requirements, the New Mexico Water Quality Control Commission regulations require that any person intending to make a new water contaminant discharge, or to alter the character or location of an existing discharge, must file a notice with the Water Pollution Control Bureau of the Environmental Improvement Division (WQCC 821-1-201). If it were necessary to modify the sewer system in a manner that would substantially change the quantity or quality of the discharge from the system, LANL would also have to file plans and specifications of the construction or modification with the Bureau. Otherwise, modifications having a minor effect on the character of the discharge would only have to be reported as of January 1 and June 30 of each year (WQCC 821-1-202).

Sanitary and industrial wastewater from SNL are discharged to the Alburquerque Wastewater Treatment Plant, which holds a Federal NPDES permit. The SNL has pretreatment standards for SNL industrial wastewaters prior to discharge to the plant. Therefore, it would have to notify the plant of any changes in discharges associated with the operation of NIF (40 CFR 403.12).

Since New Mexico has not been delegated NPDES permitting authority, LANL has submitted a Notice of Intent to the federal EPA, Region VI, to participate in the Federal General Permit for Storrwater Discharges Associated with Construction Activities. As a condition of the permit, each facility must have a Stormwater Pollution Prevention Plan. Any construction associated with NIF would have to conform to the conditions of this permit.

I.5.3.2 Safe Drinking Water Act

The primary objective of the *Safe Drinking Water Act* (42 U.S.C. 300(f) et seq). is to protext the qulity of public water supplies, water suplly and distribution systems, and all sources of drinking water. Sections of the Act address public water systems, protection of undergrounds sources of drinking water, emergency powers, genreal provisions, and additional requirements to regulate underground injection wells. The Nation Primary Drinking Water regulations (40 CFR 141 et. seq), administered by EPA, establish standards applicable to publuc water systems. the regulations include maximum contaminant levels, including those for radioactivity, for community and noncommunity water systems. No new public water supply system is anticipated to be constructed at any of the sites.

I.5.3.2.1 *Safe Drinking Water Act Requirements in California*

Water used at the LLNL site is purchased primarily from the city of San Francisco Hetch Hetchy Aqueduct and from the Alameda County Flood and Water Conservation District, Zone 7. Significant alterations to LLNL's drinking water supply requirements due to NIF construction and operation might require that the suppliers be notified of such modification to ensure the new service connection would not cause pressure reduction below state standards (22 *California Code of Regulations* [CCR] 64568).

I.5.3.2.2 *Safe Drinking Water Act Requirements in Nevada*

Nevada has adopted the National Drinking Water regulations (40 CFR 141) for its public water systems regulations (NAC 445.247). NTS will acquire domestic water from its permitted water supply system to serve NIF requirements. Notification of any modification to accommodate NIF operations would be made to the Department of Health Services, including submission of water system modification plans for approval (NAC 445A.657). NLVF would acquire domestic water for NIF from the city of North Las Vegas under an existing agreement. The city would have to be notified of any increase in NLVF water supply usage (Monroe 1995).

I.5.3.2.3 *Safe Drinking Water Act Requirements in New Mexico*

New Mexico has a comprehensive water supply program (NM Regulations [NMR] Title 20, Chapter [uncodified]), under which every public water supply system must site, construct, and maintain its operation in compliance with the requirements of such program. Domestic water to be used at NIF would come from LANL's public water supply system. Under the New Mexico regulations, prior written approval from the New Mexico Environment Department must be obtained before starting any addition to, or modification of, an existing public water supply system that may affect the system reliability or the quantity or quality of the water supplied (NMR 20-7 502). Such approval is not required if the construction or modification is less than 305 m (1,000 ft) of distribution piping appurtenance during any 60-day calendar period, or if such construction or modification takes place at a facility where the water utility staff includes a professional engineer registered in New Mexico who will have responsibility for the project (NMR 20-7-502).

SNL does not own or operate a public water supply system but instead obatins its domestic water suplly from the city od Albuquerque system or the Kirtland Air Force Base system. Official approcal for any additional usage might have to be obtained from these water suplliers, although current water supply capacity is expected to be sufficient to meet the requirements of NIF (section I.4.5.2.3). Any new hookups would have to conform with any requirements of those suppliers.

I.5.3.3 Executive Order 11988 - Flooodplain Management; Executive Order 11990 - Protection of Wetlands

Executive Order 11988 (May 21, 1977) requires federal agencies to establish procedures to ensure that any actions undertaken in a floodplain consider the potential effects of flood hazards and floodplain management and that floodplain impacts be avoided to the extent praticable. Executive Order 11990 (May 24, 1977) requires all federal agencies to consider protection of wetlands in decision making for proposed action.

DOE has established procedures for compliance with these orders entitled "Compliance with Floodplain/Wetlands Environmental Review Requirements" (10 CFR 1022). These regulations require DOE to assess the effects of a proposed action on the survival, quality, and natural or beneficial values of wetlands and to avoid impacts to floodplains to the extent practicable. Pursuant to the regulations and concurrent with DOE's review of a proposed action, DOE shall prepare a floodplain/wetlands assessment that evaluates the positive and negative, direct and indirect, and long- and short-term effects of NIF construction on wetlands and floodplains and alternatives to the proposed action that might avoid adverse effects to floodplains or wetlands, and measures to mitigate the adverse effects of actions in a floodplain or wetlands area (10 CFR 1022.12). None of the sites selected for the construction are located in floodplains or wetlands (sections I.4.1.2.3, I.4.2.2.3, I.4.3.2.3, I.4.4.2.3, I.4.5.2.3, I.4.1.2.4.2, I.4.2.2.4.2, I.4.3.2.4.2, I.4.4.2.4., and I.4.5.2.4.2). However, the option I temporary construction staging area for LLNL would be built in the 500-year floodplain, and the bridge spanning Arroyo Las Positas would be within the 100-year floodplain. The bridge would be designed not to increase the risk of flooding. Also, no highly volatile, toxic, or water reactive materials would be stored in the staging area.

I.5.4 Ecological Resources Requirements

I.5.4.1 *Endangered Species Act*

The *Endangered Species Act* (16 U.S.C.he Interior (all other plant and animal species and their habitats). Section 16 U.S.C. 1536 requires DOE to consult with the Department of the Interior, Fish and Wildlife Service, and/or Department of Commerce, National Marine Fisheries Service, to determine whether endangered and threatened species are known to have critical habitats on or in the vicinity of the sites for the proposed action. The identification of endangered and threatened species and their habitats is provided in 50 CFR 17 and 402. Each site has consulted with the Department of the Interior, Fish and Wildlife Service, concerning impacts on endangered and threatened species, migratory birds, and their critical habitats in the vicinity of the proposed locations for NIF.

I.5.4.2 *Migratory Bird Treaty Act*

The *Migratory Bird Treaty Act*, as amended (16 U.S.C.s 703 et seq.), is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and the former Soviet Union Socialist Republics. It regulates the harvest of migratory birds by specifying the mode of harvest, hunting seasons, and bag limits. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill . . . any migratory bird." Although no permit is required under this Act, DOE would consult with the U.S. Fish and Wildfife Service, as appropriate, regarding impacts to migratory birds and to evaluate ways to avoid or minimize these impacts.

I.5.4.3 *Bald and Golden Eagle Protection Act*

The *Bald and Golden Eagle Protection Act* (16 U.S.C. 668 - 668d) makes it unlawful to take, pursue, molest, or disturb bald (American) and golden eagles, their nests, and eggs anywhere in the United States. No permits or approval procedures are required unless a nest is found to interfere with resource development; in that case, a permit must be obtained from the Department of the Interior to relocate the nest. If a bald (American) or golden eagle nest was found in the vicinity of NIF activities during NIF development and construction, DOE would consult with the Department of the Interior regarding requirements under this Act.

I.5.5 Cultural and Paleontological Resources Requirements

Executive Order 11593, Protection and Enhancement of the Cultural Environment (May 15, 1971), requires Federal agencies to locate, inventory, and nominate qualifying properties under their jurisdiction or control to the National Register of Historic Places (NRHP). This process requires DOE to provide the opportunity for the Advisory Council on Historic Preservation to comment on the possible impacts of the proposed action on any potentially eligible or listed resources.

I.5.5.1 *National Historic Preservation Act*

The *National Historic Preservation Act* (16 U.S.C. 470 et seq.) provides that places with significant national historic value be placed on the NRHP. No permits or certifications are required under this Act. However, pursuant to regulations in 36 CFR 800 et seq., if a proposed action might impact a historic property resource, consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation is required. Such consultation generally results in execution of a Memorandum of Agreement that includes stipulations that must be followed to minimize adverse impacts. No historic places were identified by the appropriate State Historic Preservation Officers at any of the sites.

I.5.5.2 Archaeological and Historic Preservation Act

The *Archaeological and Historic Preservation Act* (16 U.S.C. 469a et seq.) is directed at the preservation of historic and archaeological data that would otherwise be lost as a result of Federal construction. It authorizes the Department of the Interior to undertake recovery, protection, and preservation of archaeological and historic data. If the Federal agency determines that a proposed action might cause irreparable damage to archaeological resources, that agency is required to notify the Department of the Interior in writing. The agency involved may then undertake recovery and preservation or may request that the Department of the Interior undertake preservation measures. No such sites were identified at the proposed NIF locations.

I.5.5.3 *American Indian Religious Freedom Act*

The purpose of the *American Indian Religious Freedom Act* (42 U.S.C. 1996) is to protect and preserve for Native Americans their inherent right of freedom to believe, express, and protect the traditional religions of Native Americans, including, but not limited to, access to religious or traditional sites, use and possession of sacred objects, and freedom to worship through ceremonial and traditional rites. DOE has consulted with all affected Native American groups, and no Native American cultural resources were identified at any proposed NIF location (sections I.4.1.1.5, I.4.2.1.5, I.4.3.1.5, I.4.4.1.5, and I.4.5.1.5).

I.5.6 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629). This Executive Order, with accompanying cover memorandum, calls on Federal agencies to incorporate environmental justice as part of their missions, including decisions made in compliance with NEPA. Specifically, the President's cover memorandum to the Environmental Justice Executive Order mentions NEPA in two contexts:

Each Federal agency shall analyze the environmental effects, including human health, economic and social effects, of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by NEPA. Mitigation measures outlined or analyzed in an environmental assessment, environmental impact statement, or record of decision, whenever feasible, should address significant and adverse environmental effects of proposed Federal actions on minority communities and low-income communities.

Each Federal agency shall provide opportunities for community input in the NEPA process, including identifying potential effects and mitigation measures in consultation with affected communities and improving the accessibility of meetings, crucial documents, and notices.

No formal guidance has been issued by the Federal Working Group on Environmental Justice or DOE concerning this Executive Order. Therefore, the analysis of environmental justice issues presented in the Socioeconomics sections of chapter I.4 may somewhat vary from whatever final guideance may be issued.

I.5.7.1 Atomic Energy Act of 1954

The *Atomic Energy Act* of 1954 (42 U.S.C. 2011 et seq.) authorized DOE to establish standards to protect health or minimize dabgers to life or property for its operations and facilities. In accordance with the *Energy Reorganization Act* of 1974, DOE-realted operations are not subject to licensing by the U.S. Nuclear regulatory Commission (10 CFR 50.11). The transportation, storage, and use of radioactive and hazardous materials is governed by DOE orders. The major DOE orders pertaining to radioactive and hazardous material management at NIF are listed in table I.5.7.1-1.

In addition, DOE has promulgated regulations for the protection of occupational workers from radiation exposure (10 CFR 835). These regulations set occupational exposure limits and require DOE facilities to develope and comply with radiation program, including periodic audits.

Table I.5.7.1-1.--U.S. Department of Energy Orders Applicable to the National Ignition Facility Project

Order	Subject
O 151.1	Comprehensive Emergency Management System
O 232.1	Occurrence Reporting and Processing of Operations Information
O 430.1	Life Cycle Asset Management
O 440.1	Worker Protection Management for DOE Federal and Contractor Employees

O 460.1	Packaging and Transportation Safety
O 460.2	Departmental Materials Transportation and Packaging Management
O 470.1	Safeguards and Security Program
5400.1	General Environmental Protection Program
5400.5	Radiation Protection of the Public and the Environment
5480.4	Environmental Protection, Safety, and Health Protection Standards
5482.1B	Environment, Safety, and Health Appraisal Program
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5630.12A	Safeguards and Security Inspection and Assessment Program
5700.6C	Quality Assurance

In addition, DOE has promulgated regulations for the protection of occupational workers from radiation exposure (10 CFR 835). These regulations set occupational exposure limits and require DOE facilities to develop and comply with a radiation program, including periodic audits.

I.5.7.2 Toxic Substances Control Act

EPA has promulgated regulations governing the use, marking, storage, and disposal of polychlorinated biphenyl (PCB)-contaminated transformers or hydraulic equipment (40 CFR 761) under the *Toxic Substances Control Act* (15 U.S.C. 2601 - 2671). If any such PCB articles are removed during the renovation of existing buildings, they must be stored and disposed of properly. PCB transformers and equipment would be diposed of at licensed incinerators or chemical wast landfills. Shipment offsite of transformers or equipment contaminated with waste PCBs would be manifested, and a proper certificate of Destruction would be obtained.

I.5.7.3 Emergency Planning and Community Right - to - Know Act of 1986

Under the *Emergency Planning and Community Right - to - Know Act of 1986* (EPCRA or SARA, Title III)(42 U.S.C 1101 et seq.), industria facilities are required to provide information, such as inventories of specific chemicals used or stored there, to the appropriate State Emergency Response Commission and Local Emergency Planning Committee (LEPC) to ensure that emergency plans are sufficient to respond to accidental release of hazardous substances. The Act orginally did not appear to apply to Federal Agencies; however, on August 3, 1993, Federal Order 12856 was issued making each Federal agency and its jurisdictional facilities subject to the provisions of the EPCRA and the

Pollution Prevention Act of 1990. Under EPCRA, facilities with more than a threshold quality of an "extremely hazardous substance" (40 CFR 355, appendixes A and B) must provide a representative to the LEPC, promptly inform the LEPC of any "relevant changes" at the facility, and upon request, promptly provide LEPC with "information . . . neccesary for the developing and impplementing the emergency plan." Also, all covered facilities that exceed certain volume thresholds must provide an inventory of the types and quantities of hazardous materials stored or used onsite to LEPC (40 CFR 370). It is not anticipated that NIF operations would require storage of extremely hazardous substances; however, if the site already had submitted information to the LEPC, any relevant changes resulting from NIF operations should be communicated to LEPC.

The transportation of radioactive or hazardous materials is governed by the *Hazardous Materials Transportation Act* (49 U.S.C. 1801 et seq.). The implementing regulations by the Department of Transportation (DOT) (49 CFR 171-179) establish requirements for shipments along public highways, including shipping papers, marking, labeling, placarding, training, emergency response information, and packaging. Therefore, any shipments of radioactive or hazardous materials to or from the NIF location would have to comply with DOT shipping requirements.

I.5.8 Waste Management

I.5.8.1 Solid Waste Disposal Act, as Amended by the Resource Conservation and Recovery Act and the Hazardous Solid Waste Amendments of 1984

The treatment, storage, or disposal of solid, both nonhazardous and hazardous, waste is regulated under the *Solid Waste Disposal Act* , as amended by the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 et seq.) and the *Hazardous Solid Waste Amendments* of 1984 (HSWA). Under Section 3006 of the Act, any state that seeks to administer and enforce a hazardous waste program pursuant to RCRA may apply for EPA authorization of such program. Approved state programs are not static, and as new Federal regulations, limitations, and restrictions are promulgated by EPA, state programs must be revised in response to such changes. Prior to HSWA, changes to Federal requirements were not enforced in authorized states until the state's program was appropriately modified and approved by EPA. Now, EPA enforces Hazardous Solid Waste Amendments requirements in an authorized state until the state receives approval under section 3006 (g).

California, Nevada, and New Mexico have all received authorization to enforce a hazardous waste program under Subpart C of RCRA. Nevada and New Mexico have adopted the Federal requirements for hazardous waste management. California has an authorized hazardous waste program; however, not all the Hazardous Solid Waste Amendments to RCRA have been incorporated, and California operates under a dual state-Federal regulatory system.

Under RCRA, "source, special nuclear, and by-product materials," as defined by the *Atomic Energy Act* of 1954, are excluded from the definition of solid waste and, therefore, cannot be considered hazardous waste. However, by definition, a mixture of hazardous and radioactive wastes (mixed waste) contains constituents that require regulation under RCRA. On July 3, 1986, EPA issued a clarification that the hazardous components of radioactive mixed waste are regulated under RCRA, and the radioactive components are governed by applicable *Atomic Energy Act* regulations. Because of the dual nature of this waste, it was not until 1988 that EPA issued another clarification that states could submit for authorization to regulate mixed waste storage, treatment, and disposal under state programs. When treatment standards for the land disposal restrictions were issued for mixed waste in 1990, problems arose with the long-term storage of mixed waste, since under land disposal restrictions, restricted wastes may not be stored for more than one year (40 CFR 268.50). The storage and treatment capacity problems for mixed wastes created an enforcement problem for those storing mixed wastes, including DOE.

Congress addressed the problems of DOE mixed waste storage in the *Federal Facility Compliance Act* (FFCA) of 1992 (Public Law 102-386, 106 Stat. 1505, October 6, 1992). Although *FFCA* made it clear that sovereign immunity is waived for the enforcement of state RCRA regulations, it granted DOE facilities a 3-year extension period before waiving sovereign immunity concerning the enforcement of land disposal restrictions regulations as applied to mixed waste (October 1995). Section 104 of the Act requires DOE to submit a draft report to EPA and to authorized states that lists national inventories of all mixed waste on a state-by-state basis and analyzes mixed waste treatment capacities and technologies. To extend the application of such sovereign immunity beyond the 3-year period, DOE must also comply with section 105 of the Act, which requires DOE to develop a comprehensive plan to treat mixed wastes for all DOE facilities. Such plans must include a comprehensive requirement for developing schedules for almost all phases of mixed waste disposal. The plans are submitted to EPA, which in turn submits them to the authorized state. DOE announced it would develop such a National Compliance Plan for its mixed waste (57 FR 57710).

Currently California, New Mexico, and Nevada have been authorized to regulate mixed waste under RCRA. Therefore, any necessary permitting of facilities for the treatment, storage, or disposal of mixed waste resulting from NIF operations in California, New Mexico, and Nevada would proceed through their normal RCRA permitting process.

I.5.8.1.1 *California Resource Conservation and Recovery Act Requirements*

LLNL operates treatment, storage, or disposal facilities under Part A interim status pursuant to filings to the California Environmental Protection Agency, Department of Toxic Substances Control (previously the Department of Health Service). Under California regulations, no facility operating under interim status may manage hazardous wastes that are not specified in Partdescribed in Part A of the permit application, or exceed the design capacities specified in Part A of the permit application (22 CCR § 66265.1[c]). LLNL's Part A Permit application does have limitations as to the waste streams that may be stored or treated in the facilities and capacity limitations. However, if all hazardous waste and mixed waste generated at NIF were accumulated onsite and shipped offsite for treatment and disposal within 90 days, such permit requirements would not apply (22 CCR § 66265.1 [d]). If hazardous or mixed wastes were to be stored for more than 90 days in the permitted treatment, storage, or disposal facility, it might be necessary to amend the facility permit to include new waste streams or new capacity requirements resulting from NIF operations (22 CCR § 66270).

I.5.8.1.2 *Nevada Resource Conservation and Recovery Act Requirements*

NTS has a permitted treatment, storage, or disposal facility for storage of hazardous wastes near the Radioactive Waste Management Site in Area 5; however, it is anticipated that hazardous waste, except mixed waste, will be accumulated onsite and shipped offsite for treatment and disposal. Such accumulation does not require a permit if it meets all Federal RCRA generator requirements (40 CFR 262), as adopted by Nevada (NAC 444.8632). NTS has submitted a revised Part B Permit application, which includes a separate storage and disposal unit for solid mixed waste. Such application is pending action by the Nevada Division of Environmental Protection. NTS operates a mixed waste storage facility under PartLevel Land Disposed Restricted Mixed Waste between the State of Nevada and DOE). No mixed waste disposal is currently being conducted at the Part A interim status land disposal unit, pending land disposal restriction treatment determination. Mixed liquid waste may not be disposed of at NTS pursuant to the NTS Waste Acceptance Criteria, NVO-325. However, there are plans to develop this capability, and such a liquid mixed waste treatment facility would have to be permitted by the Nevada Division of Environmental Protection. Otherwise, mixed liquid waste can be stored at the NTS Part A interim status mixed waste storage facility for shipment to an offsite facility for treatment and disposal.

NLVF does not have a permitted treatment, storage, or disposal facility, and hazardous waste at NIF would be accumulated for transportation to offsite treatment, storage, or disposal facilities. Mixed waste would be accumulated for shipment to NTS, once the NTS Part B Permit is issued. Such accumulation would not require a permit if it met all Federal RCRA generator requirements (40 CFR 262), as adopted by Nevada (NAC 444.8632). If hazardous or mixed waste were to be stored for more than 90 days, a treatment, storage, or disposal facility would have to be sited, permitted, and operated under the regulations governing and operators of such facilities (40 CFR 264).

I.5.8.1.3 New Mexico Resource Conservation and Recovery Act Requirements

SNL has a permitted treatment, storage, or disposal facility for the storage of hazardous waste. Hazardous waste generated at NIF would be stored in this facility until it is shipped offsite to an approed disposal facility. SNL is currently storing its liquid mixed waste at the site of generation (Wheeler 1995), SUch accumulation does not require a permit if it meet all Federal RCRA generator requirements (40 CFR 262), as adopted by New Mexico (NM Regulations, Title 20, chapter 4). SNL is currently performing treatability studies at its Radioactive and Mixed Waste Management Facility to obtain a Part B Permit from the state of New Mexico. Once the facility is permitted, mixed waste will be treated there to remove the hazardous component. The residue will be disposed of as radioactive waste. When treatment of hazardous component is not feasible, the mixed waste will be stored onsite until a disposal option becomes available. It may be neccesary to amend the facility permit or the Part A application to include new waste streams or capacity (40CFR 270.42 and 270.72).

LANL has a permitted treatment, storage, or disposal facility; however, it is anticipated that all hazardous waste and mixed waste at NIF would be accumulated onsite and shipped offsite for treatment and disposal. Such accumulation would not require a permit if it mat all Federal RCRA generator requirements (40 CFR 262), as adopted by New Mexico (NM Regulations, Title 20, chapter 4). LANL also has Part A interim status facilities. It might be neccesary to amend the facilty permit to include new waste streams or new capacity.

I.5.8.2 Low-Level Radioactive Waste

It is anticipoated that low-level radioactive waste (LLW) will be generated as a result of the operation of the NIF. As stated above, The *Atomic Energy Act* of 1954 authorized DOE to establish standards to protect human health or minimizethe dangers to life or property. In accordance with the *Energy Reorganization Act* of 1974, DOE-related operations, including the treatment, storage, and disposal of LLW, are not subject to licensing by ythe U.S. Nuclear Regulatory Commission (10 CFR 50.11). Under the *Low-Level Radioactive waste Policy Act* (42 U.S.C 2021b et seq.), the Federal Government is responsible for the disposal of LLW owned or generated by DOE. The disposal of LLW at disposal facilities established or operated exclusively for the disposal of waste generated by the Federal Government is not subject to the other portions of the Act concerning the establishment of state-governed compacts for the disposal of LLW in those states. Therefore, the transportation, treatment, storage, and disposal of LLW generated by DOE is governed by DOE orders. The major DOE orders pertaining to LLW resulting from operation of NIF are listed in table I.5.8.2-1. DOE Order 5820.2A establishes policies and guidelines that are the framework for the LANL LLW management program.

TABLE I.5.8.2-1. - U.S. Department of Energy Orders Concering Low-Level Waste

Order	**Subject**
O 232.1	Occurance reporting and Processing of Operations Information
5400.5	Radiation Protection of the Public and the Environment
5820.2A	Radioactive Waste Management

On March 25, 1993, DOE published a Notice off Proposed Rulemaking to establish standards for the prtection of the public and the environment against radiation from DOE activities (Draft 10 CFR 834). The requirements would be applicable to the control of rediation exposures to the public and the environment from normal operations under the control of DOE and DOE contractor personnel. The regulations include the four basic elements of the radiation protection system:

- **Establish dose limits for exposure of members of the public to radiation and implementation of DOE's as low as reasonably achievable policy.**
- **Manage radioactive materials in liquid waste discharges, in soil columns, and in selected solid-waste-containing radioactive materials, including groundwater protection programs for each DOE site.**
- **Establish requirements for decontamination, survey, and release of buildings, land, equipment, and personal material; and for the management, storage, and disposal of wastes generated by these activities.**
- **Establish an environmental radiation protection program and plan, including an effluent monitoring and environmental surveillance program, to set forth the programs, plans, and other processes to protect the public from exposure to radiation. On August 31, 1995, DOE issued a Notice of Limited Reopening of Comment Period for the draft regulation.**

Once promulgated as a final rule, 10 CFR 834 would govern the management of radiocactive materials and wastes at all the proposed NIF sites.

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1. To determine metric tons/year (t/yr), multiply values by 0.90718.

I.6 List of Preparers

Name	Education/ Expertise	Contribution
Timothy Allison	M.S. Mineral and Energy Resource Economics, M.A. Geography; 11 years experience in regional analysis and economic impact analysis	Socioeconomic Analysis
John Arnish	M.S. Nuclear Engineering, B.S. Physics; 2.D. Chemistry; 5 years experience in radiological pathway analysis, dose calculations, radiological transportation risk analysis	Radiological Transportation Risk Analysis
Christopher Burke	M.S. Technology Management, B.A. Geology; 20 years experience in environmental and energy impact assessment; 5 years experience in site and technology assessment	Purpose and Need, Site Descriptions
Young-Soo Chang	Ph.D. Chemical Engineering; 9 years experience in air quality impact analysis	Air Quality
John D. DePue	M.S. Biology; 20 years experience in technical editing of environmental assessment documents	Technical Editor

Lisa Durham	M.S. Geology; 7 years experience in hydrogeologic analysis; 8 years experience in environmental impact statements	Environmental Impacts Assessment
Rebecca Haffenden	J.D. Law; 15 years experience in legal research and analysis; 5 years experience in environmental impact statements	Environmental, Occupational Safety and Health Permits and Compliance Requirements
John F. Hoffecker	Ph.D. Anthropology; 20 years experience in archaeology; 12 years experience in environmental assessment and cultural resources management	Cultural and Paleontological Resources
Kou-John Hong	P.E., C.H.P., Ph.D. Nuclear Engineering; 16 years experience in radiological engineering and risk assessment.	Radiological Impact Assessment
Sunita Kamboj	Ph.D Health Physics, M. S. Physics; 5 years experience in health physics instrumentation, environmental monitoring; 1 year experience in radiological risk assissment.	Proposed Action
Fred Kirchner	Ph.D Radiation Biology, Diplomate, American Board of Toxicology; 16 years experience in toxicology	Affected Environment

David Kuhaneck	P.E., M.S. Environmental Engineering, B.S. Civil Engineering; 15 years experience in environmental analysis, permitting, and regulations	Air Quality, Acoustics	
Michael A. Lazaro	P.E., M.S. Environmental/ Atmospheric Sciences; M.S. Nuclear Engineering; 19 years experience in atmospheric and environmental science research and assessment; 12 years experience in project management; 6 years experience in hazard/ consequence assessment	Project Manager	
William Metz	Ph.D. Geography; M.I. S. Information Management; 20 years experience in socioeconomic assessment and mitigation; 10Marshall Monarch	M.A. Administration; B.S. Chemical Engineering, P.E.; 25 years experience in technology and regulatory evaluation of industrial air pollution/control systems and energy analysis	Air Quality Impacts
Lee Northcutt	Program Assistance; 20 years of editorial and program management assistance; 5 years experience in environmental impact statement preparation	Glossary, List of Preparers, Abbreviations, Chemical Symbols and Units of Measure, Metric Conversion Chart	

Edwin D. Pentecost	Ph.D. Zoology/ Ecology; 25 years experience in environmental assessment, terrestrial ecosystem analysis, natural resources management and planning	Assistant Project Manager
John M. Pfingston	M.A. History, M.P.A. Environmental Administration; 4 years experience in energy and natural resource research; 5 years experience in environmental assessment and land-use analysis	Land Use
Anthony J. Policastro	Ph.D. Civil Engineering; 20 years experience in air quality analyses; 15 years experience in environmental assessment	Air Quality, Hazardous Chemical Impact Assessment, Acoustics
Markus Puder	Master Law; 3 years experience in environmental and energy legislation, regulation, and policy; 1 year of experience in environmental impact statements	Public Participation, Scoping
Elisabeth Ann Stull	Ph.D. Zoology; 25 years experience in environmental assessment and ecological sciences	Project Description, Purpose and Need

William Vinikour	M.S. Ecological Resources; 20 years experience in environmental research and assessment; 19 years experience in environmental impact statements	PSA Coordinator, Ecological Resources
David Walitschek	M.S. History; 8 years experience in archaeological research; 3 years experience in environmental assessment	References, Distribution List
Dee Wernette	Ph.D. Sociology/ Demographics; 15 years experience in social impacts, demographics, and related social science analyses	Environmental Justice Analysis
Stephen Yin	M.S. Civil Engineering; 10 years experience in environmental impact studies; 15 years experience in hydrologic analysis and water resources planning and design	Water Resources

I.7 Glossary

acoustic: Containing, producing, carrying, arising from, actuated by, related to, or associated with sound.

activation products: The radionuclides formed as a result of a material being activated. For example, cobalt-60 is an activation product resulting from neutron activation of cobalt-59.

acute exposure: The absorption of a relatively large quantity of radiation or intake of radioactive material over a short period of time.

Air Quality Control Region (AQCR): An interstate or intrastate area designated by the Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

air quality maintenance area: An area which, due to current air quality or projected residential and industrial growth, has the potential for exceeding a national ambient air quality standard.

air quality: Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances. Air quality standards are the prescribed level of constituents in the outside air that cannot be exceeded during a specific time in a specified area.

ALARA (as low as reasonably achievable): A philosophy of protection that controls and maintains exposures to individuals and to the work force and general public as low as technically and economically feasible below the established limits.

alluvial fan: Cone-shaped deposits of alluvium made by a stream. Fans generally form where streams emerge from mountains onto the lowland.

alluvial/alluvium: Relating to material deposited by running water, such as clay, silt, sand, and gravel. Sedimentary material transported and deposited by the action of flowing water.

alpha particle: A positively charged particle consisting of two protons and two neutrons that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma). Symbol: a.

ambient air: The surrounding atmosphere as it exists around people, plants, and structures.

ambient noise levels: All encompassing background noise levels associated with a given environment, usually a composite of sounds from many sources, near and far.

ambient sound level (LDN): The 24-hour equivalent continuous sound level with a night-time penalty added, i.e., the time-averaged A-weighted sound level, in decibels, from midnight to midnight, obtained after the addition of 10 dB to sound levels from midnight to 7:00 a.m. and from 10:00 p.m. to midnight.

American Indian Religious Freedom Act of 1978: This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

AP-42: see "emission factors".

aquifer: A saturated geologic unit through which significant quantities of groundwater can migrate under natural hydraulic gradients.

Argus: Laser system at Lawrence Livermore National Laboratory.

arithmetic mean: The average of a set of terms, computed by dividing their sum by the number of terms. See "geometric mean".

arroyo: A gully or channel cut by an intermittent stream.

atmospheric dispersion: The spreading downwind of airborne material due to wind speed and atmospheric turbulence; the greater the spread, the greater the dilution and the smaller the airborne material concentrations.

attainment area: An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the *Clean Air Act* . An area may be an attainment area for one pollutant and a nonattainment area for others (see "nonattainment area").

background radiation: Ionizing radiation present in the environment from cosmic rays and natural sources in the Earth; background radiation varies considerably with location.

basement rocks: The undifferentiated complex of rocks that underlies the rocks of interest in an area. The crust of the earth below sedimentary deposits, extending downward to the Mohorovicic discontinuity. In many places the rocks of the complex are igneous and metamorphic and of Precambrian age.

beamlets: Independent laser beams.

Best Available Control Technology (BACT): A term used in the *Federal Clean Air Act* that means the most stringent level of air pollutant control considering economics for a specific type of source based on demonstrated technology.

Best Management Practices: Activities, procedures, or physical structures for reducing the amount of pollution entering the surface water and groundwater.

beta particle: An elementary particle emitted from a nucleus during radioactive decay; it is negatively or positively charged, identical in mass to an electron, and in most cases easily stopped, as by a thin sheet of metal. Symbol: b.

Biological Resources Evaluations Team (BRET) : The team within the Environmental Protection Group of Los Alamos National Laboratory responsible for biological assessments.

biota: The plant and animal life of a region.

bounding: In the context of accident analysis, bounding is a condition, consequence, or risk that provides an upper bound that is not exceeded by other conditions, consequences, or risks. The term is also used to identify conservative assumptions that will likely overestimate actual risks or consequences.

British thermal unit (Btu): A unit of heat; the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit. One British thermal unit equals 1,055 joules (or 252 calories).

cancer: A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation or to certain chemicals at sufficient concentrations and exposure durations.

candidate sites: Candidate sites for the National Ignition Facility are Lawrence Livermore National Laboratory (LLNL) as the preferred site, and Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), and the Nevada Test Site (NTS) (Area 22 main site location and North Las Vegas Facility [NLVF] location near NTS) as alternative sites.

carbon monoxide (CO): A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

change-out: A procedure by which components affected by induced radioactivity are periodically rotated between in-service and out-of-service status to allow the induced radioactivity to decay below predetermined limits and thus maintain a lower total level of radioactivity or a longer useful life. In some cases, decontamination cleaning may also be done during the out-of-service period.

chronic exposure: The absorption of radiation or intake of radioactive and/or chemical materials over a long period of time.

Class I area: Pristine areas in the United States whose air quality requires special protection from pollution from new sources.

Class II area: Areas in the United States with acceptable air quality levels where moderate increases in air pollutant concentrations from new sources are allowed.

Class III area: Areas in the United States with acceptable air quality levels where larger increases in air pollutant concentrations from new sources are allowed than in Class II areas.

Clean Air Act Amendments of 1990: Expands the Environmental Protection Agency's enforcement powers and adds restrictions on air toxins, ozone-depleting chemicals, stationary and mobile emissions sources, and emissions implicated in acid rain and global warming.

Clean Air Act: Federal Act that mandates the promulgation and enforcement of air pollution control standards for stationary sources and motor vehicles.

Clean Water Act of 1972, 1987: Federal Act regulating the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit as well as regulating discharges to or dredging of wetlands.

climatology: The science that deals with climates and investigates their phenomena and causes.

Code of Federal Regulations (CFR): All Federal regulations in force are published in codified form in the Code of Federal Regulations.

collective committed effective dose equivalent: The committed effective dose equivalent of radiation for a population.

colluvium: A general term applied to any loose, heterogeneous, and incoherent mass of soil material and/or rock fragments deposited by rainwash, sheetwash, or slow continuous downslope creep, usually collecting at the base of gentle slopes or hillsides. Deposition by a combination of gravity and water.

committed dose equivalent: The predicted total dose equivalent to a tissue or organ over a 50-year period after an intake of radionuclides into the body. It does not include external dose contributions. Committed dose equivalent is expressed in units of rem or Sievert. The committed effective dose equivalent is the sum of the committed dose equivalents to various tissues of the body, each multiplied by the appropriate weighting factor.

Composite Noise Rating: see "Modified Composite Noise Rating" (CNR).

Conceptual Design Option: This option would use an ICF approach called indirect drive. In indirect drive, laser beams would illuminate and heat the interior surfaces of a metal case (hohlraum) containing a deuterium-tritium-filled capsule. The beams would cause the case to emit x rays that would strike the fusion target capsule and drive the fusion reaction.

criteria pollutants: Six air pollutants for which national ambient air quality standards are established by the Environmental Protection Agency under Title I of the *Federal Clean Air Act* . The six pollutants are sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter smaller than 10 microns in diameter (PM10), and lead.

critical habitat: Air, land, or water area and constituent elements, the loss of which would appreciably decrease the likelihood of survival and recovery of a listed species or a distinct segment of its population.

cryogenic target positioner: The system that is composed of a telescoping arm that is used to insert and withdraw the complete target cryogenic system and target, and allows aiming, alignment, and engagement by the NIF laser.

cultural resources: Archaeological sites, architectural features, traditional use areas, and Native American sacred sites or special use areas.

curie (Ci): A unit of radioactivity equal to 37 billion disintegrations per second; also, activity of that quantity of material in which 3.7 x 10 *10* atoms are transformed per second.

dBA (Decibel, A-weighted): A unit of weighted sound pressure level that correlates overall sound pressure levels with the frequency response of the human ear; measured by the use of a metering characteristic and the "A" weighting specified by the American National Standard Institute S1.4-1971 (R176).

decommissioning: The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

decontamination: The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment--such as radioactive contamination from facilities, soil, or equipment--by washing, chemical action, mechanical cleaning, or other techniques.

deuterium: The hydrogen isotope that is twice the mass of ordinary hydrogen and that occurs in water; also called heavy hydrogen.

diatomaceous : Composed of or containing numerous diatoms or their siliceous remains.

DOE Orders: Requirements internal to the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

dose: The amount of energy deposited in body tissue due to radiation exposure. Various technical terms--such as dose equivalent, effective dose equivalent, and collective dose--are used to evaluate the amount of radiation an exposed individual or population receives.

driver: A device for supplying the primary source of energy to an inertial fusion energy target; drivers can be lasers, ion beams, or intense gamma ray sources.

effective dose equivalent (EDE): The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated. The EDE includes the dose from radiation sources internal and/or external to the body and is expressed in units of rem. The International Commission on Radiological Protection defines this as the effective dose.

emission factors: An average value that relates to the quantity of an air pollutant released to the atmosphere with the activity associated with the release of the pollutant and usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity that emits the pollutant. Emission factors are widely used for estimating air pollutant emissions and are often acceptable by regulatory authorities as an appropriate estimation of air pollution emissions to determine compliance with regulations.

emission offsets: Areas that allow no net increase in air pollution emissions require that a new source offset emission increases by decreasing an equivalent amount of emissions from an existing source. In some cases emission offsets or credits can be obtained from a depository that collects emission credits from retired sources.

endangered species: Any species that is in danger of extinction throughout all or a significant portion of its geographic range.

Enhanced Option: The Enhanced Option would include the indirect drive operations of the Conceptual Design Option and a second approach called direct drive. The Enhanced Option would also include the capability to perform an increased number of yield experiments to accommodate greater user needs. No hohlraum would be used in the direct drive approach. Instead, a large number of laser beams would be employed to ensure good uniformity of the driving force (laser light) over the face of the target. The laser beams would impinge directly on the deuterium-tritium-filled capsule to drive the fusion reaction.

Environmental Assessment (EA): A concise public document that provides sufficient evidence and analysis for determining whether to prepare an environmental impact statement (EIS) or a finding of no significant impact for a proposed action. An EA includes brief discussions of the need for the proposed action, the features of alternatives, the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.

Environmental Impact Statement (EIS): A document required of Federal agencies by the *National Environmental Policy Act* for major proposals or legislation significantly affecting the environment. A tool for decisionmaking, it describes the positive and negative effects of the undertaking and alternative actions.

environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or environmental hazards due to a lack of political or economic strength.

ERPG-2 (Emergency Response Planning Guidelines-2): Concentration level for a 1-hour inhalation exposure that would allow a person to take protective action and avoid irreversible health effects.

exposure pathways: The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air is also included.

exposure: The condition of being made subject to the action of radiation. Sometimes also used as a generic term to refer to the dose of radiation absorbed by an individual or population.

fault: A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

federally listed species: see "threatened, endangered, candidate, or rare species".

fission: The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

flood, 100-year: A flood event of such magnitude it occurs, on average, every 100 years (equates to a 1-percent probability of occurring in any given year).

flood, 500-year: A flood event of such magnitude it occurs, on average, every 500 years (equates to a 0.2-percent probability of occurring in any given year).

floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas including, at a minimum, that area inundated by a 1-percent or greater chance flood in any given year. The base floodplain is defined as the 100-year (1.0 percent) floodplain. The critical action floodplain as defined as the 500-year (0.2 percent) floodplain.

footprint: The layout of a facility on the ground; also refers to an area affected by release of radioactive materials.

fugitive dust: The dust released from activities associated with an alternative such as construction, manufacturing, or transportation.

fugitive emissions: Uncontrolled emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

fusion: Nuclear reaction in which light nuclei are fused together to form a heavier nucleus, accompanied by the release of immense amounts of energy and fast neutrons.

fusion fuel: Mixture of deuterium and tritium contained in a small capsule called the target.

fusion reaction: When two nuclei of lighter elements are brought into close enough proximity, they can undergo thermonuclear fusion forming a single nucleus and releasing energy at the slight expense in mass of the original constituents. Typically, a deuterium and tritium nucleus are fused in such a reaction to produce a helium nucleus plus one free neutron. The released energy of 17.6 MeV (million electron volts) is carried mostly as kinetic energy by the neutron (14 MeV).

gamma: High-energy, short-wavelength electromagnetic radiation (a packet of energy) emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials such as lead or uranium. Gamma rays are similar to x rays, but are usually more energetic. Symbol: g.

geometric mean: For a set of *n* terms, the *n* th root of their product. For a set of positive numbers, the geometric mean is always less than or equal to the arithmetic mean (see "arithmetic mean").

habitat: Area where a plant or animal lives.

hazardous chemical: Any chemical that is a physical hazard or a health hazard as defined by the Occupational Safety and Health Administration (29 CFR 1910.1201). For *Superfund Amendments and Reauthorization Act* (SARA) Title III, Section 311, the term is defined the same with certain named exceptions.

hazardous waste: Under the *Resource Conservation and Recovery Act* , a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and byproduct material, as defined by the *Atomic Energy Act* , are specifically excluded from the definition of solid waste.

hohlraum: The metal case surrounding the target on indirect-drive inertial confinement fusion.

igneous: Refers to a rock or mineral that solidified from molten or partly molten material, i.e., from a magma; also, applied to processes leading to, related to, or resulting from the formation of such rocks. Igneous rocks constitute one of the three main classes into which rocks are divided, the others being metamorphic and sedimentary.

ignition: Ignition (fusion) is defined as the conditions leading to the self-heating of the fusion fuel by the fusion driver (such as laser beams). That condition occurs during the final part of the laser pulse when the fuel core is compressed to 20 times the density of lead (226 g/cm^3) and simultaneously heated to 100 million °C. The self heating of the fuel capsule is caused by alpha particle (fusion reaction byproduct) deposition. Ignition occurs when the reaction product deposition becomes faster than the heating caused by compression.

ignitron switch: A high current switch used to discharge energy storage capacitors, which are used to fire laser flashlamps.

inertial confinement fusion (ICF): An energetic driver beam (laser, x ray, or charged particle) initiated nuclear fusion using the inertial properties of the reactants as a confinement mechanism.

inertial fusion energy (IFE): The use of high-repetition-rate lasers or ion drivers (about 10 pulses per second) to accomplish laboratory and commercial thermonuclear fusion.

ingestion dose: An internal dose that results from the oral intake of food, water, soil, or other media contaminated with radioactive material.

input parameters: Values of variables needed to run a computer model.

interim (permit) status: Period during which treatment, storage, and disposal facilities coming under the *Resource Conservation and Recovery Act* of 1980 are temporarily permitted to operate while awaiting denial or issuance of a permanent permit.

isotope: An atom of a chemical element with a specific atomic number and atomic mass. Isotopes of the same element have the same number of protons but different numbers of neutrons and different atomic masses.

Joule: A metric unit of energy, work, or heat, equivalent to 1 watt-second, 0.737 foot-pound, or 0.239 calorie.

Key Decisions (KDs): The Department of Energy's procedure for approving large projects such as NIF is based on "Critical Decisions" (formerly known as Key Decisions) made by the Secretary of Energy. In January 1993, the Secretary approved "Key Decisions" 0, which affirmed the need for NIF and authorized a collaborative effort by the three DOE defense laboratories and the University of Rochester Laboratory for Laser Energetics to produce a conceptual design report. This report was completed in April 1994. "Key Decisions" 1 was signed by the Secretary in October 1994. This decision initiated preliminary design, safety analysis, cost and schedule validation and a two-year EIS, which will include public involvement. Critical Decision 3 (formerly known as Key Decision 3), scheduled for late 1997, will authorize construction and major procurements.

laser optics: Many large optical components are required for NIF and are located throughout the laser system. These include laser slabs housed within the amplifier columns, lenses used in the spatial filters for image relaying and on the target chamber for final focusing of the beams on the target, mirrors to reflect the beams within the laser cavity, and to direct the beam on the target chamber, polarizers and potassium dihydrogen phosphate crystal for switching and frequency conversion, and phase plates to smooth the beams and protect the final focus lenses from debris. Many other optical elements are used in laser diagnostics, in beam control systems, and for pulse injection into the main amplifiers.

laser pulse: The duration of time from the beginning of laser deposition on a surface to the end of the laser deposition.

laser: A device that produces a beam of monochromatic (single-color) "light" in which the waves of light are all in phase. This condition creates a beam that has relatively little scattering and has a high concentration of energy per unit area of the beam.

latent cancer fatality: Term used to indicate the estimated number of cancer fatalities which may result from exposure to a cancer-causing element. Latent cancer fatalities are similar to naturally occurring cancers and may occur at any time after the initial exposure.

LDN: see "ambient sound level".

leaching test: A test conducted to determine the leach rate of a waste form. The test results may be used for judging and comparing different types of waste forms, or may serve as input data for a long-term safety assessment of a repository.

level of concern: The concentration of an extremely hazardous substance (EHS) in the air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

level of service (LOS): The extent of community, health care and educational services provided by local jurisdictions in the vicinity of the proposed NIF sites. LOS is measured in terms of per capita expenditures on services in each of these categories. In traffic studies, LOS means the different operating conditions that occur in a lane or roadway when accommodating various traffic volumes. A qualitative measure of the effect of traffic flow factors such as special travel time, interruptions, freedom to maneuver, driver comfort, convenience, and (indirectly) safety and operating cost. Levels of service are described by a letter rating system of A through F, with LOS A indicating stable traffic flow with little or no delays and LOS F indicating excessive delays and jammed traffic conditions.

location: In this EIS, location refers to the proposed location of the National Ignition Facility within or near the larger DOE-controlled Federal site.

LOS : see "level of service."

low-income status: Based on Census data definitions of individuals below the poverty line. For the 1990 Census, for example, low-income status included individuals in 4-person families with 1989 incomes at or below $12,674. Other poverty thresholds are provided by the Census Bureau for larger and smaller family sizes.

low-level waste (LLW): Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or "11e(2) by-product material" as defined by DOE Order 5820.2A, *Radioactive Waste Management.* Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

maintenance pollutants: Criteria air pollutants in an Air Quality Maintenance Area that may exceed the ambient air quality standard over time.

master-oscillator power-amplifier (MOPA) chain: Solid-state laser design that provides the required laser beam energy and power amplification using a single-pass MOPA chain. The MOPA chain starts with a small oscillator (the master oscillator) that produces a laser pulse, which enters a preamplifier before making a single pass through a chain of amplifiers of gradually increasing size.

Master Oscillator Room (MOR): A self-contained special-purpose room that would house the NIF Master Oscillators and their supporting equipment. The purpose of this facility is to supply the 192 individually shaped and timed low-level laser pulses to the Preamplifier Modules located beneath the Spatial Filters in the main laser hall.

maximally exposed individual (MEI): A hypothetical individual who could potentially receive the maximum possible dose of radiation (or hazardous chemical).

maximum contaminant levels: Maximum permissible concentration of a contaminant in water which is delivered to any user of a public water system.

maximum design yield: The NIF Target Area has been designed to safely confine and withstand the effects of the yield of its targets up to this yield on some routine basis (e.g., weekly).

maximum yield experiment: A fusion ignition experiment that generates maximally expected fusion energy.

meteorology: The science dealing with the atmosphere and its phenomena, especially as it relates to weather.

millirem (mrem): One-one-thousandth of a rem (see "rem").

minority populations: Includes individuals who report themselves as belonging to any of the following racial groups: Black (reported their race as "Black or Negro," or reported entries such as "African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian"); American Indian, Eskimo, or Aleut; Asian or Pacific Islander, or "Other Race." In addition, individuals identifying themselves as Hispanic origin are also included in the minority category. Hispanics can be of any race, however. To avoid double-counting minority Hispanic individuals, only white Hispanics were included in the number of racially based minorities in a tabulation, since nonwhite Hispanics had already been counted under their minority racial classification.

Miocene: A geologic epoch in the Cenozoic Era dating from 26 to 7 million years ago.

mixed waste: Radioactive waste that contains nonradioactive toxic or hazardous materials that could cause undesirable effects in the environment. Such waste has to be handled, processed and disposed of in such a manner that considers the chemical as well as its radioactive components.

model: A conceptual, mathematical, or physical system obeying certain specified conditions, whose behavior is used to understand the physical system to which it is analogous.

Modified Composite Noise Rating (CNR): Noise rating system that determines impacts from a fixed noise source using objective and subjective factors. Noise ranked A through D is generally considered to be acceptable with "A" representing essentially no impacts. Rankings above "D" are usually addressed with mitigative measures unless the source is temporary.

molecular sieve: A material with a rigid, uniform pore structure that completely excludes molecules larger than the structure pore openings and that can absorb certain classes of small molecules from a fluid in contact with the material.

MOR: see "Master Oscillator Room".

mrem: One one-thousandth of a rem (see "rem").

NAAQS: see "National Ambient Air Quality Standards".

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act* , as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Environmental Policy Act (NEPA) of 1969: The Act that established the national policy to protect humans and the environment, requiring environmental reviews of Federal actions that have the potential for significant impact on the environment, and established the Council on Environmental Quality.

National Historic Preservation Act of 1966, as amended: This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal code, if a proposed action might impact an historic property resource, it mandates consultation with the proper agencies.

National Ignition Facility (NIF): The proposed international research center comprising the world's most powerful laser, NIF would achieve ignition of fusion fuel and energy gain for the first time in a laboratory.

National Pollutant Discharge Elimination System (NPDES): Federal permitting system required for hazardous effluents regulated through the *Clean Water Act* , as amended.

National Register of Historic Places: A list maintained by the National Park Service of architectural, historic, archaeological, and cultural sites of local, state, or national significance.

neodymium: A rare-earth metal listed in the periodic table of elements with an atomic number of 60 and an atomic weight of 144.24. The metal has a bright silvery metallic luster. Neodymium is one of the more reactive rare-earth metals and quickly tarnishes in air, forming an oxide that spalls off and exposes the metal to oxidation. Besides its use in producing coherent light in glass lasers, this metal has been used in astronomical work to produce sharp bands by which spectral lines may be calibrated. Neodymium salts are also used as a colorant for enamels, and in its separated form it is used to color glass in delicate shades ranging from pure violet to wine-red and warm gray.

neodymium glass laser: A type of solid-state laser that uses neodymium-doped optical fibers, rods, or glass slabs, with small amounts neodymium added, in which laser generation and amplification equipment are made. This equipment includes a master oscillator, preamplifier, and a series of amplifiers needed to generate and propagate laser beamlines that are highly stable and with the desired peak power level and frequency.

NEPA: see *National Environmental Policy Act.*

neutron: An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

nitrogen oxides (NOx): Refers to the oxides of nitrogen, primarily NO (nitrogen oxide) and NO_2 (nitrogen dioxide). These are produced in the combustion of fossil fuels and can constitute an air pollution problem. When nitrogen dioxide combines with volatile organic compounds, in sunlight, ozone is produced.

No Action alternative: Under this alternative, DOE would not construct and operate NIF and its support facilities. In the absence of NIF, the Nova Facility at LLNL would continue to operate beyond the year 2000.

Noise Control Act of 1972: This Act directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

nonattainment area: An air quality control region (or portion thereof) in which the Environmental Protection Agency has determined that ambient air concentrations exceed national ambient air quality standards for one or more criteria pollutants.

nonhazardous wastes: Routinely generated, nonhazardous wastes include general facility refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, dirt, and rubble. These wastes are segregated and recycled whenever possible.

normal operations: All normal conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency of more than 0.1 event per year.

Nova: A 10-beam, neodymium glass fusion laser facility at Lawrence Livermore National Laboratory capable of operating at 50 terawatts at 1/3 micrometers that was completed in 1984 and used for inertial confinement fusion target irradiation experiments.

NPDES: see "National Pollutant Discharge Elimination System" .

nuclear weapon: The general name given to any weapon in which the explosion results from the energy released by reactions involving atomic nuclei, either fission, fusion, or both.

Occupational Safety and Health Administration (OSHA): Oversees and regulates workplace health and safety, created by the *Occupational Safety and Health Act* of 1970.

opacity restrictions: Visible-emission regulations that are based on the light-scattering properties of suspended matter in the ambient atmosphere and apply to near-field emissions of fixed sources.

ozone (O3): The triatomic form of oxygen. In the stratosphere, ozone protects the Earth from the sun's ultraviolet rays; in lower levels of the atmosphere, ozone is considered an air pollutant.

paleontology: The study of fossils.

particulate (airborne): Small particles that are emitted from fixed or mobile sources and dispersed in the atmosphere.

Pasquill stability categories: Classification scheme that describes the degree of atmospheric turbulence. Categories range from extremely unstable (A) to extremely stable (F). Unstable conditions promote the rapid dispersion of atmospheric contaminants and result in lower air concentrations as compared with stable conditions.

perennial stream: A watercourse that flows year-round.

Permissible Exposure Limit (PEL): Occupational exposure limits endorsed by OSHA. May be for short-term or 8-hour duration exposure.

person-rem: The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a population group.

pH (potential of hydrogen): A measure of the hydrogen ion concentration in aqueous solution. Pure water has a pH of 7, acidic solutions have a pH less than 7, and basic solutions have a pH greater than 7.

photochemical oxidant: A class of compounds typified by ozone that represents oxidizing compounds created in the atmosphere with sunlight as a catalyst under low wind conditions.

piedmont: An area, plain, slope glacier, or other feature at the base of a mountain.

playa: Level area at the bottom of a desert basin that at times is temporarily covered with water; a dry lake bed.

Pleistocene: The geologic epoch that began approximately 1.8 million to 10,000 years ago (is generally equated with the "Ice Age").

Pliocene: Geologic epoch between the Miocene and the Pleistocene epochs approximately 5.5 to 1.8 million years ago.

plume: The spatial distribution of a release of airborne or waterborne material as it disperses in the environment.

PM10: Particulate matter of aerodynamic diameter less than 10 micrometers.

population dose (population exposure): Summation of individual radiation doses received by all those exposed to the source or event being considered. The collective radiation dose received by a population group, usually measured in units of person-rem.

Precambrian: Dating from before the Cambrian geologic period more than 570 million years ago.

precursor pollutants: Pollutants that must be present in the atmosphere before chemical reactions take place and form the pollutant of interest. For example, nitrogen oxides, volatile organic compounds, and carbon monoxide are precursor pollutants to the formation of ozone.

preferred alternative: The preferred alternative for NIF is the Enhanced Option (indirect and direct drive) constructed at LLNL, the preferred site.

Prevention of Significant Deterioration (PSD): Regulations established by the 1977 *Clean Air Act* Amendments to limit increases in criteria air pollutant concentrations above baseline.

Project-Specific Analysis (PSA): This document provides an environmental evaluation of the impacts of construction and operation of the NIF as a basis for DOE's decision on whether to construct and operate such a facility at any of five locations at four candidate sites.

Proposed Action alternative: To site, construct, and operate the National Ignition Facility, which would be capable of achieving fusion ignition by the inertial confinement fusion process.

PSD: see "Prevention of Significant Deterioration".

public: Anyone outside the boundary of a DOE site at the time of an accident or during normal operations.

Quaternary: The period of geologic time since the end of the Pliocene, comprising the Pleistocene and Holocene, from about 1.6 million years ago to the present.

radiation: The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced radiation.

radioactive decay time: Associated with the spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide; the process results in a decrease, with time, in the number of original radioactive atoms in the sample. The half-life decay "time" is generally defined in terms of the time required for one-half of the original species to decay.

radioactive decay: The decrease in the quantity of a radioactive material with the passage of time.

radioactive waste: Materials from nuclear operations that are radioactive or are contaminated with radioactive materials and for which use, reuse, or recovery are impractical.

radioactivity: The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

radiological risk: The product of the accident consequence (dose) and the probability of the accident occurring; calculated by considering a wide range of accidents, from high-probability low-consequence events to low-probability high-consequence events.

radionuclide: An atom that exhibits radioactive properties. Standard practice for naming a radionuclide is to use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60 or Co-60, a radionuclide of cobalt).

rare species: Populations and/or individuals occurring in very low numbers relative to other similar taxa in the state, although common or regularly occurring throughout much of their range. They may be found in a restricted geographic region or occur sparsely over a wider area. Although rare, populations are apparently stable.

region of influence (ROI): The area surrounding each proposed NIF site in which at least 90 percent of the current DOE workforce lives, and counties in which at least 5 percent of the DOE workforce lives.

rem: The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of x ray or gamma-ray exposure.

Resource Conservation and Recovery Act (RCRA), as amended: The Act that provides a "cradle to grave" regulatory program for hazardous waste and that established, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

resuspended inhalation: Exposure route in which radioactive materials enter the body through inhalation of air contaminated with radioactive particulates that were previously deposited on the ground following an accidental release.

riparian: Of, on, or pertaining to the bank of a river, stream, or lake.

risk factor: Numerical estimate of the severity of harm associated with exposure to a particular risk agent.

roentgen: a unit of exposure to ionizing x- or gamma radiation equal to or producing 1 electrostatic unit per cubic centimeter of air. It is approximately equal to 1 rad.

Safe Drinking Water Act, as amended: This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

SARA: see *Superfund Amendments and Reauthorization Act.*

sedimentary rock: A rock resulting from the consolidation of loose sediment that has accumulated in layers, consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice.

seismic zone: An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: (1) Zone 0 - no damage; (2) Zone 1 - minor damage; corresponds to intensities V and VI of the modified Mercalli intensity scale; (3) Zone 2A - moderate damage; corresponds to intensity VII of the modified Mercalli intensity scale (eastern United States); (4) Zone 2B - slightly more damage than 2A (western United States); (5) Zone 3 - major damage; corresponds to intensity VII and higher of the modified Mercalli intensity scale; (6) Zone 4 - areas within Zone 3 determined by proximity to certain major fault systems.

seismicity: The tendency for the occurrence of earthquakes.

severity: Function of the magnitudes of the mechanical forces (impact) and thermal forces (fire) to which a package may be subjected during an accident; any sequence of events that results in an accident in which a transport package is subjected to forces within a certain range of values is assigned to the accident severity category associated with that range.

shielding: Any material or obstruction (bulkheads, walls, or other constructions) that absorbs radiation in order to protect personnel or equipment.

shot: Refers to all (192) laser beams hitting the target simultaneously.

site: In this PSA, the term "site" refers to a DOE-controlled Federal site, such as Los Alamos National Laboratory or the Nevada Test Site.

socioeconomics (analyses): Analyses of those parts of the human environment in a particular location that are related to existing and potential future economic and social conditions. The welfare of human beings as related to the production, distribution, and consumption of goods and services.

Solid Waste Management Unit (SWMU): Any discernible unit at which solid wastes have been placed at any time regardless of whether the unit was intended for solid or hazardous waste management.

source: Any physical entity that may cause radiation exposure, for example by emitting ionizing radiation or releasing radioactive material.

stability class: see "Pasquill stability categories".

Stockpile Stewardship and Management Program: A single, highly integrated technical program for maintaining the safety and reliability of the U.S. nuclear stockpile in an era without nuclear testing and without new weapons development and production.

Stormwater Pollution Prevention Plan: A plan required by an NPDES permit for controlling stormwater pollution resulting from construction or industrial activities.

sulfur oxides (SOx): A general term used to describe the oxides of sulfur; pungent, colorless gases formed primarily by the combustion of fossil fuels. Sulfur oxides, which are considered major air pollutants, may damage the respiratory tract as well as vegetation.

Superfund Amendments and Reauthorization Act (SARA): Public Law 99-499 passed in 1986 which amends the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) of 1980. SARA more stringently defines hazardous waste cleanup standards and emphasizes remedies that permanently and significantly reduce the mobility, toxicity, or volume of wastes. Title III of SARA, the *Emergency Planning and Community Right-to-Know Act* , mandates establishment of community emergency planning programs, emergency notification, reporting of chemicals, and emission inventories.

targets: Refers to a microstructure containing a tiny fuel capsule at which the lasers are directed.

tectonic: Pertaining to the processes causing, and the rock structures resulting from, deformation of the earth's crusts.

terawatt (TW): The equivalent of one trillion watts (1012).

terrestrial: Pertaining to plants or animals living on land rather than in water.

thermoluminescent dosimeter: A radiation detection device that accumulates a dose or exposure over a period of time.

threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

threshold limit value (TLV): The recommended concentration of a contaminant that a worker may be exposed to according to the American Council of Governmental Industrial Hygienists.

time-weighted average (TWA): Time-weighted average representing 8 hours per day for 40 weeks for 40 years of exposure.

total suspended particulates (TSP): Particulate matter present in the atmosphere.

Toxic Substances Control Act of 1976 (TSCA): Act authorizing the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the Environmental Protection Agency before they are manufactured for commercial purposes.

transuranic (TRU) waste: Waste contaminated with alpha-emitting radionuclides of atomic numbers greater than 92 with half-lives greater than 20 years and concentrations greater than 100 nanocuries/ gram at time of assay. It is not a mixed waste.

tritium: A radioactive isotope of the element hydrogen with two neutrons and one proton. Common symbols for this isotope are H-3 and T.

tuff: A rock formed of compacted volcanic fragments, generally smaller than 4 millimeters in diameter.

Type A packaging: Packaging designed to retain the integrity of containment and shielding required by regulation under normal conditions of transport as demonstrated by the required test. Type A packaging (e.g., 55-gallon drums) is typically used to transport materials such as low-level radioactive waste.

volatile organic compounds (VOCs) : A broad range of organic compounds (such as benzene, chloroform, and methyl alcohol), often halogenated, that vaporize at ambient or relatively low temperatures.

waste management: The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transport, and disposal of waste, as well as associated surveillance and maintenance activities.

waste minimization: Actions that economically avoid or reduce the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. These actions will be consistent with the general goal of minimizing current and future threats to human health, safety, and the environment.

weapons effects: Deals with outputs of nuclear weapons and the associated effects on materials and the environment.

wetland: Land or area containing hydric soils, saturated or inundated soil during some portion of the plant growing season, and containing plant species tolerant of such conditions (includes swamps, marshes, and bogs).

wind rose: A depiction of wind speed and direction frequency for a given period of time.

x rays: Penetrating electromagnetic radiations with wavelengths shorter than those of visible light, usually produced by irradiating a metallic target with large numbers of high-energy electrons. In nuclear reactions, it is customary to refer to photons originating outside the nucleus as x rays and those originating in the nucleus as gamma rays, even though they are the same.

yield experiments: A measure of fusion energy/neutron production in experiments that use a mixture of deuterium and tritium isotopes as fuel.

I.8 References

ABAG 1993, *Projections 94,* Oakland, CA, Dec.

ABCAQCB 1973, *Ambient Air Quality Standards,* Albuquerque, NM, May 21.

ABCAQCB 1995, *Ambient Air Quality Standards and Air Quality Control Regulations,* Albuquerque, NM, June compilation.

Alameda County, 1994, *Comprehensive Annual Financial Report for Year Ending June 30, 1994,* Oakland, CA.

Alameda County Fire Department, 1995, unpublished information, Oakland, CA, Oct. 19.

Albuquerque-Bernalillo County Air Quality Control Board--See ABCAQCB.

American Medical Association, 1994, *Physician Characteristics and Distribution in the United States,* Chicago, IL.

Andrews, T., and M. Tobin, 1995, letter from Andrews and Tobin (Lawrence Livermore National Laboratory, Livermore, CA) to Jon Yatabe (Lawrence Livermore National Laboratory, Livermore, CA) July 17.

Architectural Research Consultants, Inc., 1994, *Site Selection Study, Jupiter Accelerator Facility,* Sandia National Laboratories, Albuquerque, NM, Feb. 28.

Association of Bay Area Governments--See ABAG.

Atencio, I., 1995, "SNL Chemical Inventory Data Required for the NIF EIS," memorandum from Atencio (Sandia National Laboratories, Albuquerque, NM) to T. Wheeler (Sandia National Laboratories, Albuquerque, NM), Aug. 8.

BAAQMD 1995, *District Rules and Regulations,* San Francisco, CA, July.

BEA 1990, *Bureau of Economic Analysis Regional Projections to 2040, Vol. II, Metropolitan Statistical Areas,* U.S. Department of Commerce, Washington, DC, Oct.

Bay Area Air Quality Management District--See BAAQMD.

Bennett, J.M., 1994, *Cultural Resources Investigation Results for the Proposed NIF Project,* memorandum from Bennett (ORAD Archaeologist) to J. Yatabe (Lawrence Livermore National Laboratory, Livermore, CA), Aug. 8.

Bernalillo County, 1994, *Comprehensive Annual Financial Report for the Year Ended June 30,* 1994, Albuquerque, NM

BLM 1990, "Surface Management Status 1:100,000 Metric Topographic Map of Los Alamos, New Mexico," U.S. Department of the Interior, 1990.

Bowen, B.M., 1989, *Los Alamos Climatology,* LA-11735-MS., Los Alamos National Laboratory, Los Alamos, NM.

Bowen, B.M., 1992, *Los Alamos Climatology Summary, Including Latest Normals From 1961-1990,* Los Alamos National Laboratory, Los Alamos, NM.

Bowers, J., and D. Crawford, 1995, *Waste Handling Capabilities at LLNL with Respect to Proposed National Ignition Facility,* Waste Management Division, Lawrence Livermore National Laboratory, Livermore, CA.

Bowers, J., 1995, transmittal from Bowers (Lawrence Livermore National Laboratory, Livermore, CA) to G. Miley (University of Illinois, Urbana-Champaign, IL), Aug. 25.

Boyes, J.D., 1995, letter from Boyes (Sandia National Laboratories, Albuquerque, NM) to S./P>

Bureau of Land Management--See BLM.

Burns, M.J., 1995, *White Rock Noise Measurements During PHERMEX Tests, 11 March 1995,* LANL Memorandum No. DX-DO:DARHT-95-31, Los Alamos, NM, March 13.

Bury, R.B., et al., 1994, "Distribution, Habitat Use, and Protection of the Desert Tortoise in the Eastern Mojave Desert," in *Biology of the North American Tortoise,* R.B. Bury and D.J. Germano (eds.), Fish and Wildlife Research 13, U.S. Department of the Interior, National Biological Survey, Washington, DC.

California Department of Transportation, 1995, letter from C. Jones (Public Information Officer, California Department of Transportation, Oakland, CA) to S. Varner, Halliburton-NUS, Gaithersburg, MD), July 11.

California Environmental Protection Agency Air Resources Board--See CARB.

CARB 1993, *California Air Quality Data Summary of 1993 Air Quality Data, Gaseous and Particulate Pollutants,* Vol. XXV, Sacramento, CA.

CARB 1994, *Amendments to the Area Designations for State Ambient Air Quality Standards with Maps of Area Designations for the State and National Ambient Air Quality Standards,* Sacramento, CA.

Carpenter, K., 1995, unpublished information, Nevada Department of Transportation.

City of Albuquerque, 1994, *Comprehensive Annual Financial Report for the Year Ended June 30, 1994,* Albuquerque, NM.

City of Espanola, 1995, unpublished information, Espanola, NM, Oct. 12.

City of Espanola Police Department, 1995, unpublished information, Espanola, NM, Oct. 19.

City of Henderson, 1995, *Final Budget for Fiscal Years 1995-1996,* Henderson, NV.

City of Henderson Fire Department, 1995, unpublished information, Henderson, NV, Sept. 11.

City of Henderson Personnel Department, 1995, unpublished information, Henderson, NV, Sept. ASS="BodyText"> City of Santa Fe, 1995, unpublished information, Santa Fe, NM, Oct. 12.

City of Santa Fe Police Department, 1995, unpublished information, Santa Fe, NM, Oct. 20.

City of Tonopah Fire Department, 1995, unpublished information, Tonopah, NV, Oct. 19.

City of Tracy, 1994, *Comprehensive Annual Financial Report for Year Ending June 30, 1994,* Tracy, CA.

Clark County, 1994, *Comprehensive Annual Financial Report Year Ended June 30, 1994,* Las Vegas, NV.

Clark County Personnel Department, 1995, unpublished information, Las Vegas, NV, Oct. 19.

Clark County School District, 1994, *Comprehensive Annual Financial Report Year Ended June 30, 1994,* Las Vegas, NV.

Contra Costa County, 1994, *Comprehensive Annual Financial Report for Year Ending June 30, 1994,* Martinez, CA.

Contra Costa County School Districts, 1994, 1993-94 Annual Financial Report, Martinez, CA.

Contra Costa Fire Protection District, 1995, unpublished information, Martinez, CA, Sept. 11.

Corn, P.S., 1994, "Recent Trends of Desert Tortoise Populations in the Mojave Desert," in *Biology of the North American Tortoise,* R.B. Bury and D.J. Germano (eds.) Fish and Wildlife Research 13, U.S.

Department of the Interior, National Biological Survey, Washington, DC.

DBHCC 1993, *Air Pollution Control Regulations, Section 11--Ambient Air Quality Standards,* Clark County, Las Vegas, NV, May 27.

DBHCC 1995, *Air Pollution Control Regulations,* revised, Las Vegas, NV, June 22.

DeBoisblance, W., 1995, personal communication from DeBoisblance (Bay Area Quality Management District, Air Quality Engineer, CA) to R. Haffenden (Argonne National Laboratory, Argonne, I11.), Aug. 2.

DeBoisblance, W., 1995, personal communication from DeBoisblance (Bay Area Air Quality Management District, San Francisco, CA) to R. Haffenden and M. Monarch (Argonne National Laboratory, Argonne, IL), Aug. 15.

District Board of Health of Clark County--See DBHCC.

DOC 1994, *U.S.A. Counties 1994: Statistical Abstract Supplement,* U.S. Department of Commerce, Washington, DC.

DOE 1986, *Environmental Assessment Yucca Mountain Site, Nevada Research and Development Area, Nevada,* Vol. 1, DOE/RW-0073, Office of Civilian Radioactive Waste Management, Washington, DC, May.

DOE 1988, *Environmental Survey Preliminary Report*, DOE/EH/OEV-18-P, Environment, Safety and Health, Office of Environmental Audit, Sandia National Laboratories, Albuquerque, NM.

DOE 1990, *Fusion Policy Advisory Committee (FPAC) Final Report*, DOE/S-0081, Technical Panel on Magnetic Fusion of the Energy Research Advisory Board, Washington,dioactive and Mixed Waste Management Facility, Sandia National Laboratories, Albuquerque, New Mexico, Albuquerque Field Office, Albuquerque, NM, June.

DOE 1993c, Black, S.C., A.R. Latham, and Y.E. Townsend (Editors), *Annual Site Environmental Report - 1992* , DOE/NV/10630-66 UC-600, Volume 1, Reynolds Electrical & Engineering Co., Inc., Las Vegas, NV, Sept.

DOE, 1993d, *Technical Information Package Proposal for Reconfiguration of Nuclear Weapons Complex at the Nevada Test Site--Environment, Safety & Health*, Volume 4, submitted by the Nevada Operations Office, to the U.S. Department of Energy, Deputy Assistant Secretary, Office of Weapons Complex Reconfiguration, Washington, DC, Sept. 15.

DOE 1994a, *DOE Nevada Operations Office Annual Site Environmental Report--1993* , DOE/NV/113432-123, prepared by Reynolds Electrical & Engineering Co., Inc., Las Vegas, NV.

DOE 1994b, *Nevada Site Development Plan, Part 2, North Las Vegas and Remote Sensing Laboratory Sites,* Nevada Operations Office, Las Vegas, NV.

DOE 1995a, *The National Ignition Facility (NIF) and the Issues of Nonproliferation* , Draft Study, Office of Arms Control and Nonproliferation, Washington, DC, Aug. 23.

DOE 1995b, *The Stockpile Stewardship and Management Program; Maintaining Confidence in the Safety and Reliability of the Enduring U.S. Nuclear Weapon Stockpile,* Office of Defense Programs, Washington, DC, May.

DOE 1995c, *Dual Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement,* DOE/EIS-0228, Los Alamos Area Office, Los Alamos, NM, August.

DOE 1995d, *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling,* Vols. I and II, DOE/EIS-0161, Office of Reconfiguration, Washington, DC, Oct.

DOE 1995e, *Environmental Assessment for Nevada Support Facility,* Nevada Field Office, Las Vegas, NV, Jan.

DOE 1995f, *DOE Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*, Vol. 1, Appendix F, DOE/EIS-0203-D.

DOE 1995g, *Environmental Assessment for Solid Waste Disposal, Nevada Test Site, Nye County, Nevada*, preapproval draft, DOE/EA-1097.

DOE 1995h, *Environmental Assessment for Construction of the Proposed Nevada Support Facility at the DOE North Las Vegas Facility,* DOE/EA-0955, Washington, DC/Las Vegas, NV, Jan.

DOE and University of California, 1992, *Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories,* Livermore, CA, DOE/EIS-0157, U.S.ogram, Operable Unit 1086, TA-15, Los Alamos National Laboratory, Los Alamos, NM.

EG&G Energy Measurements, 1991, *The Distribution and Abundance of Desert Tortoises on the Nevada Test Site,* EGG 10617-2081, Santa Barbara Operations, Goleta, CA, Jan.

EPA 1974, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety,* 550/9-74-004. Office of Noise Abatement and Control, Arlington, VA, March.

EPA 1989, Air/Superfund National Technical Guidance Study Series, Volume III -- Estimation of Air

Emissions from Clean-up Activities at Superfund Sites, EPA-450/2-89-003, Interim Final, Office of Air Quality Planning and Standards, Research Triangle Park, NC, Jan.

EPA 1992a, *Users Guide for the Industrial Source Complex (ISC2) Dispersion Models, Volume I--User Instructions*, EPA-450/4-92-008a, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March.

EPA 1992b, *Users Guide for the Industrial Source Complex (ISC2) Dispersion Models, Volume II--Description of Model Algorithms,* EPA-450/4-92-008a, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March.

EPA 1993, *EPA Supplement F to Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources,* Office of Air Quality Planning and Standards, Research Triangle Park, NC, July.

EPA 1995a, *Supplement C to the Guideline on Air Quality Models (Revised),* Appendix W of 40 CFR Part 51, EPA-45-/2-78-027R-C. Aug.

EPA 1995b, *Support Center for Regulatory Air Models, Bulletin Board System (SCRAM BBS), Surface Meteorological Data Files (CD144 format) and Twice Daily Mixing Height Data (TD9689 format),* Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC (June, date listed on fields electronically accessed).

EPA 1995c, U.S. Environmental Protection Agency, 1995c, *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, Fifth Edition*, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January.

FBI 1993, *Uniform Crime Report: Crime in the United States,* U.S. Department of Justice, Washington, DC.

Federal Bureau of Investigation--See FBI.

Fegan, F., 1995, personal communication from Fegan (New Mexico Highway and Transportation Department, Santa Fe, NM) to S. Varner (Halliburton-NUS, Gaithersburg, MD), May 16.

Federal Emergency Management Agency--See FEMA.

FEMA 1983, *Flood Insurance Rate Map, City of North Las Vegas, Nevada,* Washington, DC.

Foley, R., 1996, letter from R. Foley to J. Yatabe, Lawrence Livermore National Laboratory, on construction and operations resources for NIF sites under construction, Jan. 4.

Gale Research, 1992, *Weather of U.S. Cities,* 4th ed., Gale Research Inc., Detroit, MI.

Gawronski, T., 1995, facsimile from Gawronski (Laser Program Facilities Operations Group, Lawrence Livermore National Laboratory, Livermore, CA) to J. Pfingston (Argonne National Laboratory, Argonne, IL), Aug. 3.

Halliburton-NUS, 1995, unpublished data prepared for Argonne National Laboratory, Argonne, IL., Halliburton-NUS, Gaithersburg, MD, Aug.

Hattori, E.M., 1995, letter from Hattori (Department of Museums, Library, and Arts, State Historic Preservation Office, State of Nevada, Carson City, NV) to D.R. Elle (U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV), Oct. 11.

Hoagland, S.R., 1990, *A Cultural Resources Survey and Review for Sandia National Laboratories, Area I, South of O Street, Kirtland Air Force Base, New Mexico,* CGI Report No. 8067AB, prepared by the Chambers Group, Inc., Albuquerque, NM, for Sandia National Laboratories, Albuquerque, NM, Sept. 17.

Holzworth. G.C., 1972, *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States,* Office of Air Programs Publication No. AP-101, U.S. Environmental Protection Agency, Research Triangle Park, NC, Jan.

IAEA 1995, *Energy from Inertial Fusion,* STI/PUB/944, Vienna, Austria, March.

ICF Kaiser Engineers, Inc., and the Los Alamos National Laboratory (LANL), 1994, *Preliminary Estimate for Siting of the National Ignition Facility at Los Alamos National Laboratory,* Los Alamos, NM, Sept.

ICRP 1991, "1990 Recommendations of the International Commission on Radiological Protection." ICRP Publication 60, Annals of the ICRP, 21 (1-3), Pergamon Press, New York, NY.

International Atomic Energy Agency--See IAEA.

International Commission on Radiological Protection--See ICRP.

International Technology (IT) Corporation and Consensus Planning, Inc./Zephyr Design, 1992, *Sandia National Laboratories, Albuquerque - Environmental Baseline Update,* Albuquerque, NM, May.

Johnson, K., et al., 1995, *Stockpile Surveillance: Past and Future*, in press, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories/New Mexico, Sept.

Jones, R.C., 1995, *A Class III Cultural Resources Reconnaissance of the Proposed National Ignition*

Facility, Nevada Test Site Area 23 and EG&G North Las Vegas Facility, Nye and Clark Counties, Nevada, Cultural Resources Reconnaissance Short Report SR082395-1, report prepared by the Desert Research Institute for the U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV, Sept.

Kirk, A.S.,1995, letter from Kirk to G. Van Tiem (Police Department, Los Alamos National, Los Alamos, NM), as cited in U.S. Department of Energy, 1995, *Dual Axis Radiographic Hydrodynamic Test Facility Draft Environmental Impact Statement,* DOE/EIS-0228D, Los Alamos Area Office, Los Alamos, NM, May.

Klem, D., Jr., 1990, "Collisions between Birds and Windows: Mortality and Prevention," *Journal of Field Ornitholog* y 61(1):120-128.

Knowles, C.J., and P.M. Gulash, 1989, *Phase I Tortoise Evaluation Undeveloped Site West of Commerce Street between Rossmoyne Ave. and EG&G Fence North Las Vegas, Nevada,* prepared by Western Technologies Inc., Las Vegas, NV, for EG&G, Las Vegas, NV, Oct. 13.

Kreiner, S., 1995, unpublished meteorological data summary for 1990-1994. Transmittal from Kreiner (Los Alamos National Laboratory, Los Alamos, NM) to M. Nimmagadda (Argonne National Laboratory, Argonne, IL).

LANL 1990a, *1990 LANL Site Development Plan -- Technical Information,* LA-CP-90-405, Facilities Engineering Division, Los Alamos, NM, Sept.

LANL 1990b, *Environmental Surveillance at Los Alamos During 1989,* LA-12000-ENV, Los Alamos, NM, Dec.

LANL 1993, *RFI Work Plan for Operable Unit 1111, Final Draft,* Environmental Restoration Program, Los Alamos, NM.

LANL 1994, *Environmental Surveillance at Los Alamos During 1992*, LA-12764-ENV, Environmental Protection Group, Los Alamos, NM, July.

LANL 1995a, unpublished meteorological data for 1994, transmittal from G. Stone (Los Alamos National Laboratory, Los Alamos, NM) to Y.S. Chang (Argonne National Laboratory, Argonne, IL), July.

LANL 1995b, *Water Supply at Los Alamos During 1993,* LA-12951-RD, Livermore, CA, Oct.

Lawrence Livermore National Laboratory--See LLNL.

Lazaro, M., et al., 1996, Technical Documentation in Support of the Draft Project-Specific Analysis for Construction and Operation of the National Ignition Facility-Public Comment Draft, Environmental Assessment Division, Argonne National Laboratory, Argonne, IL.

Lazaroff, G., 1995a, "National Ignition Facility Siting Proposal," transmittal from Lazaroff (EG&G, North Las Vegas Facility, Las Vegas, NV) to C. Burke (Argonne National Laboratory, Argonne, IL), June 22.

Lazaroff, G., 1995b, "Nonradioactive Hazardous Chemical Inventory for Specific Chemicals," memorandum from Lazaroff (EG&G North Las Vegas Facility, Las Vegas, NV) to K. Wolf (EG&G North Las Vegas Facility, Las Vegas, NV), July 24.

Lazaroff, G., 1995c, facsimile from Lazaroff (EG&G, North Las Vegas Facility, Las Vegas, NV) to J. Pfingston (Argonne National Laboratory, Argonne, IL), July 31.

Lazaroff, G., 1995d, personal communication between Lazaroff (EG&G, North Las Vegas Facility, Las Vegas, NV) and J. Pfingston (Argonne National Laboratory, Argonne, IL), Aug. 4.

LLNL 1986, *100 Year Flood and Zone Plan*, FEMA National Flood Insurance Program.

LLNL 1992, *Environmental Report for 1991*, Livermore, CA.

LLNL 1994a, *Energy and Technology Review, the National Ignition Facility*, UCRL-5200-94-12, Livermore, CA, Dec.

LLNL 1994b, *National Ignition Facility Conceptual Design Report*, UCRL-PROP-117093, NIF-LLNL-94-113, L-16973-1, Livermore, CA, May.

LLNL 1994c, *National Ignition Facility Siting Proposal*, UCRL-PROP-119353, L-18862-1, Livermore, CA, Dec.

LLNL 1994d, *Environmental Report for 1993*, UCRL-50027-93, Livermore, CA, Sept.

LLNL 1995a, *FY95 Technical Site Information* AR-118365-94, Livermore, CA.

LLNL 1995b, *National Ignition Facility Site Requirements*, NIF-LLNL- 93-089, L-16083-1, Livermore, CA, July.

LLNL 1995c, *1995 Site Development Plan*, UCRL-LR-110253-95, Livermore, CA.

LLNL 1995d, unpublished meteorological data for 1994, transmittal from F. Govenia (Lawrence Livermore National Laboratory, Livermore, CA) to A. Policastro (Argonne National Laboratory, Argonne, IL), July.

Los Alamos County, 1995, *Comprehensive Annual Financial Report for Year Ending June 30, 1995,* Los Alamos, NM.

Los Alamos County Police and Sheriff's Department, 1995, unpublished information, Los Alamos, NM, Oct. 12.

Los Alamos National Laboratory--See LANL.

Meier, W.R., 1994, "Osiris and SOMBRERO Inertial Fusion Power Plant Design -- Summary, Conclusions, and Recommendations," *Fusion Engineering Design 25* :145-157 (1994).

Middle Rio Grande Council of Governments, 1995, *1995 Transportation Program for the Albuquerque Metropolitan Planning Area.*

Moir, R.W., 1994, "Improvements to the HYLIFE-II Inertial Fusion Energy Power Plant Design," *Fusion Technology* 26:1169-1177.

Monroe, L., 1995, personal communication from Monroe (Nevada Test Site, Nevada) to R. Haffenden (Argonne National Laboratory, IL), Aug. 15.

Montoya, K., 1995, personal communication from Montoya (U.S. Department of Energy, Los Alamos National Laboratory, Los Alamos, NM) to S. Varner (Halliburton-NUS, Gaithersburg, MD), Aug. 2.

Nalco Chemical Company, 1987, *Questions and Answers, Road Dust Control*, Naperville, IL.

NAS 1990, *Second Review of the Department of Energy's Inertial Confinement Fusion Program, Final Report*, Washington, DC, Sept.

National Academy of Sciences--See NAS.

National Oceanic and Atmospheric Administration--See NOAA.

National Park Service--See NPS.

NBAQ, *1988-1992 Trend Report,* Division of Environmental Protection, Carson City, NV.

NOAA 1990, *Local Climatological Data, Annual Summary with Comparative Data, 1961-1990, Albuquerque*, *NM* , National Climatic Data Center, Asheville, NC.

NPS 1983, "Great Basin Timber Mountain Caldera, Nye County, Nevada," *Natural Landmark Brief,* compiled by the Wildlife and Vegetation Division, U.S. Department of the Interior, Sept.

Nevada Bureau of Air Quality--See NBAQ.

Nevada Department of Transportation, 1993, 1 *993 Annual Traffic Report,* Planning and Program Development Traffic Section.

Nevada State Environmental Commission--See NSEC.

Nevada Test Site--See NTS.

New Mexico Air Quality Bureau--See NMAQB.

New Mexico Environment Improvement Board--See NMEIB.

New Mexico Public Schools, 1994, *Financial Statistics Fiscal Years 1993-94 actual and 1994-95 estimated,* Santa Fe, NM.

NMAQB 1994, *New Mexico Air Quality, 1991-1993,* NMED/AQB-94/1.

NMEIB 1981, *Air Quality Control Regulation 201-Ambient Air Quality Standards*, June 15.

NMEIB 1994, *Ambient Air Quality Standards and Air Quality Regulations* revised, Santa Fe, NM, Nov. 17.

NMEIB 1995, "Title 20: Environmental Protection, Chapter 2: Air Quality (Statewide), Part 72: Construction Permits," *New Mexico Air Quality Control Regulations,* Santa Fe, NM, Nov. 30.

NMEIB 1996, "Title 20: Environmental Protection, Chapter 2: Air Quality (Statewide), Part 3: Ambient Air Quality Standards," *New Mexico Air Quality Control Regulations,* Santa Fe, NM, Jan. 10.

NSEC 1995, "Air Pollution Standards" *Nevada Administrative Code,* Chapter 445B, Carson City, NV.

NTS 1996, Nevada Test Site comments on the *Stockpile Stewardship and Management Draft Programmatic Environmental Impact Statement*, Feb. 1996.

Nye County, 1994, *Comprehensive Annual Financial Report for Fiscal Year Ended June 30, 1994,* Tonopah, NV.

Nye County Personnel Department, 1995, unpublished information, Tonopah, NV, Oct. 19.

Nye County School District, 1995, unpublished information, Tonopah, NV, Sept. 12.

Nye County Sheriff's Department, 1995, Unpublished Information, Tonopah, NV, Oct. 19.

Omernik, J.M., 1986, "Ecoregions of the United States," supplement (map and table) to the *Annals of the Association of American Geographers* 77(1).

Omni-Means, 1990, *Traffic Impact Analysis for the Proposed EG&G Facility Expansion City of North Las Vegas, Nevada,* Omni-Means, Ltd., Roseville, CA, Aug.

Ortego, K., 1995a, transmittal from Ortego (Raytheon Services Nevada, Las Vegas, NV) to G. Miley and M. Petra (University of Illinois, Urbana-Champaign, IL), Aug. 25.

Ortego, K., and J. Johnston, 1995b, Transmittal from Ortego and Johnston (Raytheon Services Nevada, Las Vegas, NV) to G. Miley and M. Petra (University of Illinois, Urbana-Champaign, IL), Sept.evada, 1995, *Nevada Test Site - Area 22, NIF Site Requirement's Site Proposal,* SK-022-99-667, Las Vegas, NV, July.

Reynolds Electrical & Engineering Co., Inc., 1994, *U.S. Department of Energy Nevada Operations Office Annual Site Environment Report--1993, Volume I,* DOE/NV/11432-123, Las Vegas, NV, Sept.

Richardson, C., 1995a, transmittal from Richardson (Los Alamos National Laboratory, Los Alamos, NM) to F. Kirchner (Argonne National Laboratory, Argonne, IL), Aug. 2.

Richardson, C., 1995b, personal communication from Richardson (Los Alamos National Laboratory, Los Alamos, NM) to J. Pfingston (Argonne National Laboratory, Argonne, IL), July 28.

San Joaquin County, 1994, Comprehensive Annual Financial Report for Year Ending June 30, 1994, Stockton, CA.

San Joaquin County Schools, 1995a, unpublished information, Stockton, CA, Aug. 23.

San Joaquin County Schools, 1995b, unpublished information, Stockton, CA, Sept. 11.

Santa Fe County, 1995, unpublished information, Santa Fe, NM, Oct.

Santa Fe County Sheriff's Department, 1995, unpublished information, Santa Fe, NM, Oct. 20.

Seylar, R.E., 1994, *Safety Assessment: Radioactive and Mixed Waste Management Facility,* Sandia National Laboratories, New Mexico, July 22.

Sandia National Laboratories--See SNL.

SNL 1991, Hwang, S.G., et al, *1990 Environmental Monitoring Report,* SAND91-0592 UC-630, Sandia National Laboratories, Albuquerque, NM.

SNL 1994, *1993 Environmental Report,* SAND94-1293 UC-630, Sandia National Laboratories, Albuquerque, NM.

SNL 1995a, *Sandia National Laboratory Site Development Plan FY 1995,* Sites Planning Department, Albuquerque, NM.

SNL 1995b, *Sandia National Laboratories, New Mexico, Environmental Restoration Geographic Information System: 100 and 500 Year Flood Plains,* KAFB/SNL, Map ID, 1995.

Steenhoven, J., 1995, personal communication from Steenhoven (Lawrence Livermore National Laboratory, Livermore, CA) to R. Haffenden (Argonne National Laboratory, Argonne, IL), Aug. 11.

Taipale, C., 1995, unpublished 1994 air monitoring data summaries, transmittal from Taipale (Clark County Health District, Las Vegas, NV) to M. Monarch (Argonne National Laboratory, Argonne, IL), July 18.

Tobin, M., 1995, transmittal from Tobin (Lawrence Livermore National Laboratory, Livermore, CA) to M. Petra (University of Illinois, Urbana-Champaign, IL), Aug. 10.

Tobin, M., and J.F. Latkowski, 1995, letter from Tobin and Latkowski (Lawrence Livermore National Laboratory, Livermore, CA) to J.M. Yatabe (Lawrence Livermore National Laboratory, Livermore, CA), July 12.

Travis, J.R., 1992, *Atlas of the Breeding Birds of Los Alamos County, New Mexico,* LA-12206, Los of Civil Engineering, DSC-PR-Washington, DC, October 30.

USAF 1993, *Final Environmental Impact Statement Space Nuclear Thermal Propulsion Program Particle Bed Reactor Propulsion Technology Development and Validation*, May.

USDA 1987, *Environmental Impact Statement, Santa Fe National Forest Land Management Plan, Mora, San Miguel, Santa Fe, Sandoval, Los Alamos and Rio Arriba Counties, New Mexico,* Forest Service, Southwestern Region, Santa Fe National Forest, Santa Fe, NM.

USDA 1990, *Map of Santa Fe National Forest, New Mexico,* Forest Service, South Western Region.

USGS 1972, *National Atlas, 1:2,000,000, Department of the Interior, revised 1972.*

USGS 1978, *Albuquerque, New Mexico,* 30x60 minute series, U.S. Department of the Interior, Denver, CO.

USGS 1979, *Belen, New Mexico*, 30x60 minute series, U.S. Department of the Interior, Denver, CO.

Vigil, E.A., 1995, *Noise Measurement at State Road 4 and Bandelier Turn Off at State Road 4 during*

PHERMEX Test on March 11, 1995, LANL Memorandum No. ESH-5:95-11825, Los Alamos National Laboratory, Los Alamos, NM, March 17.

Wheeler, T., 1995a, letter from Wheeler (Sandia National Laboratories, Albuquerque, NM) to J.F.ly 13.

Wheeler, T., 1995d, personal communication from Wheeler (Sandia National Laboratories, Albuquerque, NM) to R. Haffenden (Argonne National Laboratory, Argonne, IL), Aug. 17.

White, R., 1995a, "NTS Part B RCRA Permit Application--Climate," transmittal from White (Raytheon Services Nevada, Las Vegas, NV) to C. Burke (Argonne National Laboratory, Argonne,

APPENDIX J: CONTAINED FIRING FIRING FACILITY PROJECT-SPECIFIC ANALYSIS

J.1 Introduction

The Department of Energy (DOE) proposes to construct and operate a facility to provide containment of explosives test experiments at Lawrence Livermore National Laboratory (LLNL). These tests are currently conducted outdoors on a firing pad (also called a firing table) at the existing operational Building 801 (B801) facility, located at LLNL's Experimental Test Site (Site 300). Detonation experiments using explosives have been conducted outdoors at Site 300 since the early 1950s. The proposed Contained Firing Facility (CFF) would be a modification to the existing B801 Flash X-Ray (FXR) Facility and would consist of an enclosed Firing Chamber, a Support Facility, and a Diagnostic Equipment Facility. An Office Module, to be constructed approximately 46 meters (m) (150 feet [ft]) from the proposed Firing Chamber, is also proposed.

Two alternatives to the proposed action are addressed in this environmental assessment:

- No action (continue operation of the current B801 facility and its outdoor firing activities at planned levels).
- Build the CFF at an alternative Site 300 location (vicinity of B851).

The Record of Decision (ROD) issued January 27, 1993, for the August 1992 Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, DOE/Environmental Impact Statement (EIS) 0157, (1992 EIS/Environmental Impact Report [EIR]) (DOE/University of California [UC] 1992), published the Secretary of Energy's decision to continue to operate LLNL, including near-term proposed projects (those within 5 to 10 years). The proposed B801 CFF is described as one of the projected, budgeted new facilities under the proposed action, (table 3-3) in the 1992 EIS/EIR, and is further discussed in section J.2.5.3 (Proposed Construction Projects, LLNL, Site 300) and table 4.15-2 (LLNL Site 300, Overview) of the 1992 EIS/EIR. The potential impacts of construction and operation of the proposed CFF are expected to be within the scope of the impacts of normal Site 300 operations and potential Site 300 accidents as outlined in the 1992 EIS/EIR. This environmental impact analysis is tiered from the 1992 EIS/EIR and provides additional detailed information on CFF operations and its potential impacts.

This environmental impact analysis was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, (42 *United States Code* section 4321 et seq.) and adheres to policies and procedures for DOE compliance with the NEPA as set forth in 10 *Code of Federal Regulations* , Part 1021 (57 *Federal Register* [FR] 15122, April 24, 1992).

J.2 Purpose and Need for Action

To meet its present and future strategic stockpile stewardship responsibilities DOE needs to insure its long-term ability to continue conducting hydrodynamic testing of certain explosive and metal containing materials at its existing FXR Facility (Building 801) at LLNL's Site 300. As the most up-to-date U.S. hydrodynamic test facility, the current Building 801 FXR Facility serves a key role in providing essential hydrodynamic test data needed by DOE to assess key elements of stockpile safety and reliability in the absence of nuclear testing by the United States.

In order to assure its continued future ability to provide this needed test data at its Site 300 facility and consistent with its policy of improving environmental, safety, and health posture of its operations, DOE proposes to further reduce the environmental, safety, and health impacts of its current Site 300 explosives tests by conducting certain experiments (such as those involving depleted uranium, tritium, and beryllium) in an enclosed Firing Chamber.

The purpose of the CFF enclosure would be to reduce gaseous and particulate air emissions from explosives testing, reduce the generation of solid low-level radioactive waste (LLW) (resulting from present Site 300 outdoor firing table activities), reduce testing noise, improve the safety of testing by controlling fragment dispersion, and improve the quality of diagnostics data derived from testing by better controlling experimental conditions.

Without the CFF's enclosed Firing Chamber and supporting project elements, hydrodynamic testing would have to continue to be done in the outdoor environment, thus reducing test scheduling flexibility, and continuing the currently projected outdoor firing, environmental, and safety postures.

Siting such a facility at LLNL's Experimental Test Site, Site 300, was included as a projected facility under the proposed action of DOE's 1992 EIS/EIR to continue operation of LLNL (section 3.1.2 and table 3-3, 1992 EIS/EIR); the Secretary of Energy issued the ROD on this EIS January 27, 1993 (58 FR 6268).

J.3 Description of the Proposed Action and Alternatives

J.3.1 Proposed Action

The proposed action is to design, construct, operate, and ultimately decontaminate and decommission (D&D) a CFF in the area of B801 at LLNL's Site 300 (figures J.3.1-1 and J.3.1-2) and to modify the existing FXR Facility in B801 so as to preclude damage to FXR equipment when detonations occur in the adjacent, proposed CFF Firing Chamber (figure J.3.1-3) (LLNL 1995).

J.3.1.1 Design

J.3.1.1.1 Current B801 Complex

The core elements of the current 1,628 square meters (m^2) (17,522 square feet [ft^2]) B801 complex are the bunker, housing the firing control room, and the linear induction accelerator/FXR Facility and other diagnostic equipment, as well as an outdoor gravel pad firing table. Detonations of explosives assemblies (which may contain depleted uranium, beryllium, and/or tritium-containing components) are done on the gravel firing table, and the dynamics of the detonation process are recorded by the FXR system and associated diagnostics equipment through ports in the B801 FXR Facility. Other infrastructure at the present B801 complex includes support buildings, loading docks, underground control and gas storage bunkers, an underground camera (optics) room, and utilities.

J.3.1.1.2 Proposed Contained Firing Facility Design Concept

The proposed CFF would augment and be collocated with (adjacent to) the current B801 (see figure J.3.1-3). The four main elements of CFF would be the Firing Chamber, Support Facility, Diagnostic Equipment Facility, and an Office Module, totaling approximately 2,685 m^2 (28,900 ft^2) of additional developed space within the present B801 complex area. The present B801 gravel firing table would be partially paved after it was ensured that any gravel and debris contaminated above regulatory limits were removed. The new proposed facility elements would be designed and placed to provide an efficient, safe, fully integrated test and diagnostics complex that would operate for a projected 30-year lifetime. The facility would be designed and operated in full compliance with applicable DOE orders as well as applicable Federal and state laws and regulations.

J.3.1.1.3 Firing Chamber

The Firing Chamber would be designed to contain the blast overpressure and fragment effects from detonations of explosives assemblies (figure J.3.1.1.3-1). It would retain solid debris, gases, and particulate and aerosol products generated from the detonation, allowing for their selective removal, or, in the case of certain gases, their controlled release to the atmosphere through use of scrubbers, absorbents, high-efficiency particulate air (HEPA) filters, and other similar equipment. The explosives quantities would vary with a maximum of 60 kilograms (kg) (132 pounds [lb]) of plastic-bonded explosive 9404, or an equivalent trinitrotoluene design weight of 94 kg (207 lb). The inside walls of the chamber would be protected from high-velocity detonation fragments by replaceable shielding.

The Firing Chamber would be a cast-in-place, steel-reinforced concrete structure with diagnostic and optical line-of-sight ports for data collection. Walls would be 1.2-m (4-ft) thick and would support a 1.4-m- (4.5-ft)-thick ceiling slab and be supported on a 1.8-m- (6-ft)-thick floor slab. On the south side, an existing camera room would be integrated into and be used as part of the chamber. The 0.9-m (3-ft)-thick existing roof of the camera room would be covered by a 0.6-m- (2-ft)-thick concrete overlay to increase its structural capacity.

All interior surfaces of the chamber would be lined with 1.3 centimeters (cm) (0.5 inches [in]) steel plate. Replaceable 2.5 cm (1 in) thick steel tiles would be attached to the steel-lined walls and ceiling. Floors would also be covered with replaceable steel tiles whose thickness would vary with the experiment. Equipment would be brought into the Firing Chamber through a 3.7 m (12 ft) by 4.3 m (14 ft) blast door. Two personnel safety exit doors would be situated to provide egress during test setup. Blast doors would also be protected from detonation fragments. The chamber would have conditioned air, lighting, a water washdown system, a separate tritiated-gas stripping system, a drain leading to a holding tank, and water recycling and evaporation systems. The air supply and exhaust openings would also be protected from blast damage by shielding dampers and blast valves.

The air management system supporting the chamber would consist of a normal operation exhaust system with a post-firing air purge system, and a gas-stripping system for use after experiments involving tritium. During normal operation, the exhaust system (figure J.3.1.1.3-2) would maintain a negative pressure in the Firing Chamber relative to the Support Facility.

Following a test firing, an air purge system would exhaust air, suspended particulates, and gases from the chamber through filter and scrubber systems before the discharge of air and remaining gases to the atmosphere through a roof-mounted stack approximately 15.2 m (50 ft) above ground level. Air would be taken in through openings in the chamber wall. Ductwork would be protected from dynamic and static blast overpressure. The filtration system for use after detonations would consist of a centrifugal precipitator; a 95-percent efficient pulse-jet dust collector with fusible sprinkler head; 30-percent efficient prefilters; 99.97-percent efficient, nuclear-grade HEPA filters; a scrubber system to remove gases and vapors; and a fan. The filter housing would be a bag-out type, and would include ports for testing HEPA filter-bank efficiency and monitoring pressure drop across the filters. Any waste storage and treatment areas that may be required for processing liquid from the gas absorption wet scrubber would be designed and operated in conformance with applicable waste management procedures and DOE orders.

After tests involving tritium-containing materials, a tritium scrubber system would be activated. In addition to filtering particulate, this system would also remove at least 95 percent of any tritium. The tritium scrubbing system would consist of a standard hot catalyst/desiccant system designed to ensure oxidation and removal of airborne tritium as primarily tritiated water (HTO).

The chamber also would be designed with water washdown systems for post-test cleaning and fire protection (figure J.3.1.1.3-3). The washdown system installed in the ceiling of the chamber, consisting of an articulating nozzle, would direct water to all interior surfaces. The high-velocity spray nozzle could operate automatically or manually via remote controls with the use of video monitoring. When operated manually, personnel would use hoses from reels located outside the chamber. Residual water retained by pitted floor tiles would be removed by manual or mechanical methods. A floor drain (protected by a blast-resistant valve) would collect contaminated water and direct it to a holding tank for analysis followed by filtration and evaporation or transfer to an appropriate treatment facility.

J.3.1.1.4 Support Facility

The Support Facility would provide a staging area for preparation of the nonexplosive components of an experiment; storage of equipment and materials; and personnel locker rooms, rest rooms, and decontamination showers. A mezzanine above the personnel area would house mechanical equipment. A mechanical equipment area would be located adjacent to the staging area. The size of the Support Facility would be approximately 1,542 m^2 (16,600 ft^2).

The Support Facility would be separated into gray and clean areas. The gray areas would be areas in which contamination could occur. Egress from the gray areas would require passage through decontamination and change areas prior to entering the clean areas. The Support Facility rooms would have a negative air pressure relative to the clean areas to control the potential for migration of contamination to clean areas.

J.3.1.1.5 Diagnostic Equipment Facility

The Diagnostic Equipment Facility would house various diagnostic equipment used to evaluate the results of explosives tests. The Diagnostic Equipment Facility would be similar in construction to the Support Facility but would be designed to protect personnel who occupy this area during the tests. The facility would be approximately 576 m^2 (6,200 ft^2) . The Diagnostic Equipment Facility would be controlled as, and be considered to be, a clean area. An additional 0.6 m (2 ft) thickness of reinforced concrete wall would be placed 1.2 m (4 ft) from the Firing Chamber wall to create a utility corridor for diagnostic devices, as well as to provide an additional safety buffer wall for personnel. Pressure-rated personnel doors would be installed at either end of the corridor for access. The Diagnostic Equipment Facility would be the main personnel entrance into the new CFF complex.

J.3.1.1.6 Office Module

A premanufactured Office Module of approximately 223 m^2 (2,400 ft^2) would be constructed adjacent to the north side of the existing B801D, approximately 46 m (150 ft) southwest of the proposed Firing Chamber. This facility would provide administrative space for the B801 complex staff.

J.3.1.2 Construction

Site preparation would require site excavation and demolition work. The CFF design concept would require excavation of about 41,300 cubic meters (m^3) (54,000 cubic yards [yd^3]) of existing soil from adjacent hillsides. This material would be sampled and analyzed to verify that it is uncontaminated. Any identified hazardous, LLW, or mixed wastes would be appropriately packaged and labeled in accordance with all applicable regulatory, DOE, and LLNL requirements. Site preparation would also require removal of an underground utility bunker and the relocation of a 0.8 m (2.5 ft) storm drain line. Explosives tests would be diverted from the B801 complex to other firing facilities (principally to B851) during construction at B801. Site improvements would include excavation, grading, trenching, electrical service augmentation, underground utilities augmentation, curbs and gutters, and debris removal. Structures would be designed in accordance with the requirements of the most current edition of the Uniform Building Code.

J.3.1.3 Operation

When CFF is constructed and operational, it is estimated that approximately 100 explosives research and diagnostic experiments could be conducted annually. Quantities of explosives expended in most typical tests would be less than 25 kg (55 lb). Certain of these tests typically involve some components of beryllium and depleted uranium. General pre-test, test, and post-test activities at CFF are described below.

J.3.1.3.1 Pre-Test and Test Activities

Nonexplosive support fixtures and apparatus needed for the test assemblies would be assembled in the Support Facility, then transported to and set up in the Firing Chamber. This apparatus often includes heavy foundations or shot stands to support the explosive experiment, armored radiographic film cassettes, heavy steel momentum-transfer plates, mild steel and wooden shrapnel shields, glass optical turning mirrors and mounting hardware, expendable capacitor discharge units, high-pressure gas-filled devices, and other special diagnostic equipment. Much of this apparatus is expended in the test. Motor-driven cranes and forklifts may be used to move both the inert apparatus and the explosives, if needed. Strict administrative controls would be applied to restrict personnel movement and location while certain of these setup operations are conducted.

The explosive charge would usually be the last item to be placed at the Firing Chamber. When all other equipment has been readied, the explosives assembly would be brought by truck to the chamber from its assembly point at the Site 300 process area or from an explosives storage magazine and carefully set in position, with only essential personnel in attendance. System checks in the form of dry runs would be performed to show that all electrical and mechanical systems have been properly connected and to verify that proper time delays between individual events have been programmed.

When all dry run testing is complete, the chamber would be secured, personnel assembled and accounted for (mustered) within the protected control room (bunker), and the experiment conducted.

J.3.1.3.2 Post-Test Activities

Tests Not Involving Tritium. After an experiment that does not involve tritium, the Firing Chamber would be allowed to cool. Television cameras and infrared sensors would be used to survey the chamber interior for burning debris. Fires would be quenched by a short-duration water washdown or allowed to self-extinguish. The chamber purge system would draw air through scrubber, filtration, and exhaust systems (figure J.3.1.1.3-2). Gas sampling devices would monitor the chamber gas concentrations before and after purging.

After about 10 fresh-air makeup exchanges (and after observation of the television monitor indicates that entry is permissible), qualified explosives handlers (using breathing protection, if necessary) would reenter the chamber. Any smoldering materials or unreacted explosive would be rendered safe so that others could enter. Diagnostics data would be collected and the chamber cleaned in preparation for the next experiment.

The chamber washdown system, consisting of an articulating, ceiling-mounted nozzle would be used to periodically wash detonation test residue from the chamber walls (figure J.3.1.1.3-3). A manually operated hose would be used to complete the washdown once access is permitted. The washdown water would be supplied from Site 300's domestic water supply system, supplemented by recycled washdown water. This washdown water and spent scrubber liquid would be diverted to a holding tank, filtered, and reused, evaporated, or sent to LLNL's Hazardous Waste Management Division for processing. Floor drains, floor sinks, drainage trenches, wash basins, and emergency shower and eyewash drains from portions of the Support Facility would also be gravity-fed into a separate water collection system. This wash water would be monitored, filtered, and recycled for reuse as part of the Firing Chamber washdown system.

Evaporation would be used to substantially reduce the volume of wastewater. Waste residues from this process would be treated by methods that meet applicable criteria for handling industrial wastewater (e.g., treatment and/or stabilization). Sludge containing metals and other contaminants that would be typical residue from evaporating this form of wastewater would be routinely handled by LLNL's waste management facilities.

Tests Involving Tritium. Tests involving tritium-containing components are administratively limited to 20 milligrams (mg) (200 curies) tritium each, and it is estimated that a maximum of 10 such tests per year would be performed. After an experiment, the tritium scrubber system would be activated. The system would operate in a recirculating mode until monitoring and analysis indicated that most undesirable gases had been removed. Additional tritium removal would then be accomplished by adding a few liters of water as a mist to moisturize the air and chamber surfaces to help remove additional tritium (as tritiated water, HTO). (The chamber air would then be scrubbed again to remove additional tritium.) These moisturize/scrub cycles would be repeated until most readily exchanged tritium (as HTO) had been removed and monitored chamber tritium levels were deemed acceptable for reentry. Reentry scheduling would also be dependent on the levels of any other residual radiation, the intensity of which would also be monitored during and after an experiment. The tritium (as tritiated water vapor, HTO) would be absorbed and collected onto a solid medium, such as molecular sieves, during this air-scrubbing process.

As an adjunct to the air-scrubbing removal of tritium, a more aggressive water washdown of the chamber surfaces would be done with about 1,900 liters (L) (500 gallons [gal]) of water. The volume of this washdown water would be controlled to minimize generation of tritium-contaminated water. This would be achieved by regulating the flow into the articulating, ceiling-mounted nozzle, limiting washdown time, and/or manual washing of the chamber. Washdown water would separately be collected and may be reduced in volume, then be managed as low-level liquid (or solidified) radioactive waste. The estimated volume of the wastewater filtration sludge expected from this process would be approximately 85 L (22 gal).

It is estimated that up to 25 55-gallon (208 L) drums and 2 2.8 m *3* (100 ft *3*) boxes of solid LLW would be generated for each tritium-containing test.

J.3.1.4 Decontamination and Decommissioning (Closure)

A useful lifetime of 30 years is assumed for CFF. Projections of the need for D&D versus conversion to different usages for CFF after that time cannot yet be made. Such proposals, when identified, would be subject to separate NEPA review, if necessary.

J.3.2 Alternatives to the Proposed Action

J.3.2.1 No Action Alternative

The No Action alternative would leave B801 in its current configuration and would continue the routine detonation of explosives experiments outdoors. No construction disturbance would occur with this alternative. The primary effect of adopting the No Action alternative would be an annual release of emissions from up to an estimated 100 test detonations of explosives and associated materials, equipment, and assemblies directly into the atmosphere and surrounding soils or gravel; the continued generation of solid LLW from test debris and the periodic removal and processing of firing table gravel; and the continued noise levels and blast overpressure to the surrounding area.

An indication of the explosion-related product amounts released to the environment under the No Action alternative (continued outdoor testing) can be derived from the database of materials used in past outdoor explosives experiments at Site 300. Table J.3.2.1-1 shows the estimates of annual hazardous, radioactive, and other material dispersals that could be expected each year under the No Action alternative, based on compositions of tests at B801 for calendar years 1990 to 1994. Most of this material dispersal would be in the form of solid debris that is recovered after the test or is deposited in firing table gravel. Because the experiments were conducted outdoors, the remainder has, for the most part, been dispersed to the environment (primarily as metal or oxides). The materials listed in table J.3.2.1-1 are, therefore, an indication of what would constitute the source terms for waste streams and/or emissions that would likely result from conducting approximately 100 tests per year outdoors at B801 under the No Action alternative.

As noted above, solid LLW in the form of contaminated firing pad gravels after a series of outdoor tests involving radioactive material at B801 would continue if CFF is not built and operated. (By comparison, no contaminated gravel from enclosed B801 CFF operations would be generated under the preferred alternative.) Additional solid LLW in the form of test debris (such as wood, plastic, metal, and burlap bags) is generated each year under the No Action alternative; the generation of these types of test debris would likely continue under the No Action alternative as well as under the proposed action.

The organic explosives (noted in table J.3.2.1-1) used at B801 can be expected to oxidize very efficiently upon detonation to produce gaseous carbon dioxide less than 97 percent, water, and trace amounts of nitrogen, carbon monoxide, carbon (soot), oxides of nitrogen, and assorted volatile organic compounds (VOCs) (U.S. Army Armament, Munitions, and Chemical Command [AMCCOM] 1992).

Table J.3.2.1-1.--

Estimated No Action Hazardous Materials Release to the Environment (Air, Solid Debris, and Particulate)

Material	Estimated Dispersal per Year, kg [1], [2]
Barium	0.002
Beryllium	15.3
Chromium [3]	6.9
Cobalt	0.01
Copper [4]	580
Fluoride salts	3.6
Lead	4.1
Molybdenum	1.3
Nickel *c*	8.6
Silver	1.6
Vanadium	3.6
Zinc	0.1
Lithium salts	22.6
Depleted uranium [5]	430
(Explosives) [6]	(1,662)
Tritium [7]	0.0002

J.3.2.2 Build the Contained Firing Facility at an Alternative Site 300 Location (B851)

B851 is a 1,270 m^2 (13,681 ft^2) complex located in the northwest quadrant of Site 300. It features a gravel firing pad, an electron beam accelerator, and several laboratories, shop areas, and offices. B801 has a more powerful and modern accelerator (the FXR) than B851 and is therefore much more capable of performing a thorough data analysis of test results from certain tests than the facilities at B851.

Construction of CFF at the B851 site would have about the same construction-related impacts as construction at B801. Operational impacts would also be similar in terms of safety, potential accident impacts, and noise. Thus, although possibly a reasonable alternative, it offers no significant advantages and several significant disadvantages to the B801 site.

J.4 Description of the Affected Environment

A brief description of the environment surrounding the location of the proposed facilities is presented in this section. A more detailed description can be found in the 1992 EIS/EIR (DOE/UC 1992), which is incorporated by reference.

J.4.1 Topography

Site 300 is located in the Altamont Hills and consists of southeasterly trending ridges and canyons of moderate-to-high relief. These ridges vary in elevation from slightly more than 153 m (500 ft) at the Corral Hollow Creek entrance to the site to over 518 m (1,700 ft) at the highest point. The onsite drainage pattern is well-developed and flows generally east and south toward Corral Hollow Creek.

CFF would be built as a modification to B801 and would, therefore, be nestled among hills ranging from 34 to 104 m (110 to 340 ft) above its floor elevation to the north, east, and south. The floor level would be at approximately 323 m (1,060 ft) above mean sea level.

J.4.2 Seismicity

Site 300 is located on the eastern edge of the seismically active San Francisco Bay area. A number of active faults are considered capable of causing strong ground motion at Site 300. The nearest of these faults to Site 300 is the Carnegie-Corral Hollow Fault, which crosses the southwest portion of the site (Carpenter et al., 1991). No significant recorded earthquakes have occurred on any of the local faults. The effect of seismic activity at Site 300 is likely to be confined to ground shaking with no surface displacement. Raber and Carpenter (1983) have identified the principal seismic hazard at Site 300 as being the potential for strong ground shaking caused by an earthquake on the Greenville Fault, located about 8 kilometers (km) (5 miles [mi]) west of Site 300.

J.4.3 Climate

Site 300 has a semi-arid, Mediterranean-type climate. Annual mean precipitation is approximately 28 cm (11 in), most of which falls between October and April during major winter storms. Strong, persistent winds are characteristic of the Site 300 area as marine air flows through the canyons of the Site into Corral Hollow and the San Joaquin Valley to the east. This flow results in strong afternoon and evening winds with gusts up to 70 km/hour (hr) (44 mi/hr).

J.4.4 Air Quality

J.4.4.1 Criteria Air Pollutants

The California Air Resources Board conducts criteria pollutant monitoring for the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), which includes Site 300. Based on the California Air Resources Board's measurements, the district is classified as a nonattainment area for ozone and particulate matter smaller than 10 micrometers (or microns).

J.4.4.2 Hazardous Air Pollutants

Toxic air contaminants are subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP). NESHAP standards pertaining to operations at Site 300 are those for beryllium and radionuclides. Beryllium concentrations from test activities at Site 300 are monitored by LLNL and average 0.42 percent of the SJVUAPCD NESHAP standard. Airborne radionuclide concentrations also are monitored at Site 300. In 1994, uranium-238 and uranium-235 concentrations were 5x10^{-5} g/m^{3} and 3x10^{-7} g/m^{3}, respectively. In contrast, the derived concentration guide (a calculated concentration of radionuclides that could be continuously consumed or inhaled and not exceed the DOE primary radiation protection standard to the public of 100 millirem per year effective dose equivalent) for uranium-238 and uranium-235, respectively, were 0.3 g/m3 and 0.047 g/m3. The effective dose equivalent to the maximally exposed member of the public due to potential radionuclide releases from B801 testing in 1994 was 0.041 millirem (the NESHAP allowable standard is 10 millirem). Thus, the monitored concentrations for outdoor testing activities at Site 300 are already well below guideline levels, and operations also comply with the NESHAP limits.

J.4.5 Hydrology: Surface and Groundwater

Several ephemeral streams flow through Site 300 during the wet winter months and discharge into Corral Hollow Creek at the southern boundary of the site. Most flow is direct runoff with a very small contribution from both intermittent and perennial springs. Minor erosion results from both natural and induced conditions.

The groundwater of the Site 300 area is characterized by two regional aquifers or major waterbearing zones: (1) an upper water-table aquifer in the sandstones and conglomerates of the Neroly formation about 30 m (100 ft) below ground surface, and (2) a deeper, confined aquifer located in Neroly sandstones just above the Neroly/Cierbo contact, about 91 m (300 ft) below ground surface (Raber and Carpenter, 1983).

In addition to the two regional aquifers, several localized perched aquifers contain water at higher elevations above low-permeability layers (6 to 15 m [20 to 50 ft] belowground surface). Depth to groundwater beneath B801 is estimated as at least 30 m (100 ft). Neither the groundwater beneath firing tables at B801 nor B851 are known to be contaminated with tritium or uranium from past operations.

J.4.6 Vegetation

Five major vegetation types are found at Site 300. They are (1) introduced annual grassland, (2) native perennial grassland, (3) coastal sage scrub, (4) oak woodland, and (5) riparian (Taylor and Davilla, 1986). Most of the vegetation at Site 300 is grassland dominated by mixtures of introduced annual and native perennial grasses.

A detailed, systematic survey for populations of rare and endangered plants was conducted at Site 300 in the spring of 1986 (Taylor and Davilla, 1986); an additional survey was conducted in 1991 in support of the 1992 EIS/EIR (DOE/UC 1992). The only sensitive plant species known to exist at Site 300 is the large-flowered fiddleneck (Amsinckia grandiflora), listed as both federally-endangered and state-endangered. This species has been identified in two locations at Site 300. Neither are near the proposed B801 CFF site. Both Amsinckia grandiflora populations are closer to B851 than to B801.

J.4.7 Wildlife

The wildlife at Site 300 strongly reflects the dominance of grasslands. Twenty-six species of mammals, 70 species of birds, and 20 species of reptiles and amphibians were observed at Site 300 during threatened and endangered species surveys in 1986 and 1991. The 1991 survey was conducted for the 1992 EIS/EIR (DOE/UC 1992). Since the 1991 surveys, an additional 12 species have been identified: 1 mammal, 1 amphibian, 9 birds, and 1 nonsensitive fairy shrimp species. The only sensitive species that might be expected to exist in the vicinity of the proposed CFF are the burrowing owl (Athene cunicularia) and the American badger (Taxidea taxus), both state species of special concern. The 1992 EIS/EIR mitigation measures routinely implemented before conducting construction projects (such as the proposed CFF) include the field surveys for these latter two species. Burrowing owl dens are known to occur approximately 1.6 km (1 mi) north of the present B801 complex, in spite of the conduct of routine outdoor testing of explosives at that site. A burrowing owl den was identified in 1994 to be within 0.32 km (0.2 mi) (west) of B851 (figure J.4.7-1). Transient badgers also use ground squirrel dens in areas near B801 and B851.

Site 300 is located in the extreme northern portion of the range of the San Joaquin kit fox (Vulpes macrotis mutica) (Federal endangered species, state threatened species). Detailed surveys for the kit fox were conducted at Site 300 in 1980 (Rhoads et al., 1981), 1986 (Orloff 1986), and 1991 (DOE/UC 1992). Since that time, approximately 54 project-specific surveys for active kit fox dens have been made at Site 300; all have been negative. Neither the kit fox nor active dens were observed at Site 300 during any of these surveys. At present, the kit fox is not considered a resident species at Site 300, although the site may offer potential habitat. Field surveys for the presence of the kit fox are, however, still routinely performed before conduct of any ground-disturbing project (as they will be before construction of the proposed CFF) as part of the mitigation measure commitments implemented subsequent to issuance of the 1992 EIS/EIR ROD in January 1993.

J.4.8 Cultural Resources

Site 300 was surveyed for cultural resources in 1981, and 24 archaeological sites were identified (Busby, Garaventa, and Kobori, 1981). Of these 24 sites, 3 were prehistoric, 20 were historic, and 1 was a multicomponent site consisting of both prehistoric and historic materials. Also, recent archival research and field surveys were performed in support of the 1992 EIS/EIR (DOE/UC 1992). An additional 4 prehistoric and 1 historic sites have been located since 1992. One identified site is within approximately 396 m (1,300 ft) of B851 and another is within approximately 396 m (1,300 ft) of B801.

J.4.9 Land Use and Socioeconomic Factors

Most of Site 300 is located in San Joaquin County, with a small portion in Alameda County. The proposed action is located entirely within San Joaquin County. Site 300 is located approximately 13 km (8 mi) southwest of Tracy in a remote rural area in the Altamont Hills that has traditionally been used for cattle grazing and recreation. Much of the land adjacent to Site 300 is private ranch land and is used for grazing. Physics International, Inc. (adjacent to Site 300) and SRI International (south of Site 300) also have facilities that are used to routinely test explosives. The Carnegie State Vehicular Recreation Area off-road motorcycle park is located immediately south of Site 300 on Corral Hollow Road.

The San Joaquin County General Plan land-use designation for Site 300 is Public and Quasi-Public Other Governmental and Institutional (DOE/UC 1992). This designation allows the use of Site 300 for military installations and other major Government buildings. There is no prime agricultural land at Site 300, and grazing and other agricultural activities are excluded.

Since 1993, private developers have been pursuing a proposal to build residential units adjacent to Site 300's northern and eastern boundaries (Tracy Hills project) and commercial and industrial facilities further east of Site 300, astride Interstate 580 and west of the Tracy Municipal Airport. A project-specific EIR under provisions of the *California Environmental Quality Act* is being planned for preparation by the city of Tracy in 1995.

The 1993 population of Tracy has been estimated to be 34,000. Approximately 200 full-time LLNL employees and full-time support contractor staff work at Site 300; of this number, an average of approximately 20 employees work at the present B801/FXR complex.

J.4.10 Soils

Site 300 soils have developed on marine shales and sandstones, uplifted river terraces, and fluvial deposits. They are classified as loamy Entisols (young soils with little or no horizon development). Clay-rich soils (Vertisols) are also present and have been mapped as the AloVaquero complex. Vertisols are mineral soils, characterized by a high clay content, that are subject to marked shrinking and swelling with changes in water content. The Entisols erode easily; the Vertisols exhibit low permeability and are subject to moderate erosion. Soils in the B801 area are generally classified in the AloVaquero complex.

J.4.11 Wetlands

Wetlands at Site 300 were mapped during 1991 using the unified Federal method (Federal Interagency Committee for Wetland Delineation, 1989), and a total of 2.7 hectares (ha) (6.76 acres) of wetlands were identified (DOE/UC 1992) (figure J.4.7-1). These wetlands are small and are in areas associated with natural springs or runoff from several building complexes onsite. The majority of the wetlands 1.9 ha (4.58 acres) exist at springs in the bottom of deep canyons in the southern half of the site. Other wetlands 0.76 ha (1.88 acres) were formed from building runoff, including a small *Typha latifolia* wetland formed by B801 cooling tower drainage that begins approximately 61 m (200 ft) south-southwest of B801. A small wetlands patch 0.032 ha (0.08 acre) exists approximately 213 m (700 ft) southeast of B851 and another 0.072 ha (0.18 acre) exists immediately adjacent to the B851 complex.

J.4.12 Noise

Existing chronic noise sources at Site 300 include vehicular traffic and heating, ventilating, and air conditioning equipment. Acute sources include construction activities; a small arms range; and explosives testing. Background noise levels are generally low, ranging from 56 to 66 decibels (DOE/UC 1992).

Meteorological conditions at Site 300 are monitored before each test, so that noise levels can be projected through use of a well-established computer program. Based on the results of this computer modeling, the quantities of the explosives that can be tested at the present B801 outdoor firing table without adverse noise generation as measured at six Tracy-area receptor site locations (stations) are projected. These stations monitor peak noise levels for a period of 90 seconds, starting at detonation. The results of these noise-monitoring activities demonstrate that noise levels from explosives testing at LLNL Site 300 have not exceeded 126 decibels at the city of Tracy station locations.

J.4.13 Water Use

Water consumption for domestic, infrastructure operation, and programmatic activities at Site 300 averaged approximately 120 million liters per year (31.8 million gallons per year) during the period from 1986 to 1990 (DOE/UC 1992).

J.5 Potential Effects of the Proposed Action and Alternatives

J.5.1 Impacts Related to Construction Activities

Containment of firing operations at B801 would result in minor construction-related impacts at Site 300 in the vicinity of the B801 complex. Construction noise and dust would be experienced throughout a 21-month excavation and construction period. Soils from the hill to the north of the firing pad, and the berm to the east of the firing pad would be excavated and removed to provide space for the new facility. Dust suppression and stormwater pollution prevention (runoff) mitigation technologies would be applied to reduce these impacts to insignificance. Biological surveys for special status, threatened, and endangered species would be conducted prior to any land-disturbing activities. If sensitive species are observed, appropriate mitigation measures to avoid any significant impact would be taken, as outlined in the 1992 EIS/EIR (DOE/UC 1992) and its associated Mitigation Action Plan (MAP) and Mitigation Monitoring and Reporting Program (MMRP). These measures have been routinely applied at Site 300 since 1992. The closest archaeological site is approximately 396 m (1,300 ft) away and is not expected to be affected by the proposed action. Experimental tests would be scheduled at other firing facilities (principally at B851) during construction in the B801 area, possibly increasing the workload and traffic to this area to a minor degree.

j.5.1.1 Ground Disturbance Topography Change

Construction of CFF would require excavation of about 41,300 m *3* (54,000 yd *3)* of material surrounding the current facility. The proposed facility extends into hillsides to the northeast and southeast of the existing bullnose (the high-energy end of FXR, which is covered with protective armor) (figure J.3.1-3). Cut hillsides would be sloped and, where local geology allows, revegetated (using hydroseeding) to prevent erosion. The direction and volume of existing runoff would not be altered by the proposed site work because all earthwork would be accomplished within the same micro-drainage area below the division for adjacent watersheds. All construction and ground-disturbing activities would be done according to the requirements of the National Pollutant Discharge Elimination System California General Construction Activity Stormwater Permit.

All cut slopes, excavations, and/or fills would be designed and constructed in accordance with the Uniform Building Code Chapters 29 and 70 and any other applicable requirements. It is expected that the area of permanent ground disturbance immediately around the B801 complex would only be about 1.2 ha (3 acres) as a result of necessary slope contouring and construction of CFF.

J.5.1.2 Soils

In 1991, soils surrounding the existing firing pad were sampled and analyzed for 17 different metals and radioactivity (gamma radiation) using approved methods. LLNL has previously determined that surface soils contamination from beryllium cadmium, copper, and uranium-238 exists near the B801 firing pad (or table) (Webster-Scholten 1994). Samples will be taken and tested during construction to determine whether or not contamination exists. If isolated areas are determined to be contaminated, the soils would be handled in accordance with approved DOE procedures and all applicable Federal and state regulations.

Soils exposed by project construction, especially on the hillsides, are considered to be moderately vulnerable to erosion; their clay content provides slightly more resistance to erosion than does the high loam content of Entisols, which dominate Site 300 soil types. Erosion, if it occurs, would not be an important impact because of the brevity of the erosion event and the small quantity of soils expected to be lost. Erosion of the small hillsides surrounding the proposed project would not be expected beyond one growing season.

J.5.1.3 Air Quality

Construction could result in some short-term particulate matter emissions; dust suppression measures would be implemented to mitigate these emissions to levels that meet SJVUAPCD requirements. Site 300 air emissions from vehicle and equipment exhausts would be expected to increase approximately 15 to 20 percent temporarily (during the early months of the 21-month construction period). This incremental increase is expected to be an insignificant contributor to air basin emission levels, given the continued high rate of construction activity envisioned by the city of Tracy's growth projections noted in its 1993 Urban Management Plan/General Plan.

J.5.1.4 Cultural Resources

No impact is expected to one identified cultural resource site approximately 396 m (1,300 ft) from the proposed project at the existing B801 Facility. If culturally important artifacts are discovered during construction activities, work would stop until the discovery could be evaluated by a qualified archaeologist in accordance with the DOE MAP and the University of California MMRP, implemented in conjunction with the 1992 EIS/EIR (DOE/UC 1992).

J.5.1.5 Sensitive Species

No known Federal- or state-listed endangered plant or animal species are present within the zone of direct or indirect influence of project construction (1992 EIS/EIR DOE/UC 1992 and later surveys). However, a preconstruction survey monitoring for San Joaquin kit fox (Vulpes macrotis mutica) would be conducted not earlier than 60 days prior to the start of construction, as outlined by the mitigation measures discussed in the MAP, MMRP, and 1992 EIS/EIR (DOE/UC 1992). If kit fox is discovered within the project site, the steps prescribed in the MAP and MMRP would be followed prior to construction startup.

Dens of the American badger, a state species of special concern, have been identified within the vicinity of the proposed project in the past. Similarly, dens of the burrowing owl are known to occur within approximately 1.6 km (1 mi) (north) of the proposed site. The proposed project's impact on the badger is considered slight to none because of the relatively small portion of the badger's home range (less than 1 percent) occupied by the project, the large amount of unrestricted land at Site 300, and the widely recognized transient nature of badgers. Similarly, no impacts to burrowing owl dens are expected because they have actually become established during periods of road construction south of B801 and during long periods of outdoor explosives testing at the present B801 complex. A pre-construction survey for dens of American badger and burrowing owl would be conducted within 60 days of project start. If found, active dens of the badger or owl would be avoided by construction activity through the establishment of exclusion zones around the dens. If direct impact to an active den is considered unavoidable, the California Department of Fish and Game would be consulted for permission to reduce the size of the exclusion zone or for permission to relocate the animal to other lower-impact areas within Site 300, as outlined in the MMRP and the 1992 EIS/EIR.

J.5.1.6 Wetlands

Soil transport from stormwater runoff during construction would be controlled so as to ensure that there is no potential for adverse impact to the wetlands patch identified approximately 61 m (200 ft) south-southwest of the B801 complex.

J.5.1.7 Socioeconomic Factors

Construction of CFF will take place over a 21-month period during which CFF contractor construction crew and staff day-shift population may reach a maximum peak of 20 to 30 workers during a peak 6-month period, while being less during the remaining parts of the construction period. The addition of this incremental number of onsite, day-shift contractor crew is not expected to significantly affect Site 300 infrastructure and support services or facilities or city of Tracy support services for its 34,000 population.

J.5.1.8 Water Usage

A maximum of 3,800,000 L (1,000,000 gal) of water would be used for dust suppression and other related activities during construction.

J.5.2 Impacts Related to Facility Operations

J.5.2.1 Air Quality

It is expected that emissions (such as particulate metal oxides and soot, acid gases, and VOCs) from Firing Chamber operations would be below regulatory limits because of the extensive air scrubbing, filtration, and absorption systems that would be operated in conjunction with CFF. The bulk of the resulting emissions from the air control system should then be limited to those such as carbon dioxide, nitrogen, water, and, when tritium is used in the chamber, tritiated water as well as very minor amounts of activated air gas molecules.

It is expected that the projected scrubber removal rate for the gases ammonia (NH2), hydrogen cyanide (HCN), hydrogen fluoride (HF), and hydrogen chloride (HCl) would be 90 percent, and would be 50 percent for oxides of nitrogen (NOx) which may be produced. Although some removal of detonation-produced carbon monoxide (CO) by air scrubbing would occur, no reduction of CO is assumed, resulting in a conservative conclusion. Based on these factors, the following approximate levels of CFF-related emissions can be expected to reach the atmosphere annually from detonating explosives during 100 tests at CFF: NH2 < 1.8 kg (4 lb), HCN ~0.9 kg (2 lb), HF ~0.9 kg (2 lb), HCl < 1.4 kg (3 lb), and NOx < 12 kg (27 lb). Additionally, CO emissions would be expected to be less than 15 kg (33 lb) and all VOCs and semivolatile combustion products combined should be limited to approximately 0.2 kg (0.4 lb) (based on emission factors from trinitrotoluene detonation data contained in Volume 2 of the 1992 AMCCOM report). Particulate air emissions are expected to be negligible due to the extensive use of air scrubbing and filtration systems. These emission levels should have an insignificant (negligible) adverse impact on the air quality of the area air basin. The net impact of containing these 100 CFF tests per year by use of CFF (when compared to the No Action alternative) is beneficial.

The air emission of potentially greatest (bounding) impact is HTO. On approximately 10 tests per year, up to 200 curies (20 mg) of tritium may be used on each test. It is assumed that, as a worst case, all tritium would become converted to HTO. Of the 200 curies of tritium present in the chamber, 180 curies (90 percent) is expected to be vapor, and 20 curies (10 percent) would condense on the steel walls, floor, equipment, and debris. After completion of air scrubbing and chamber cleanup, it is expected that the 200 curies of tritium would be partitioned as follows: approximately 175 curies would reside in solidified waste from processing the various air scrubbing and filtration systems, 18 curies (from the 20 curies of HTO condensed on walls or solids) would also reside in a separate solidified waste from a water washdown of the chamber walls and surfaces, a maximum of 5 curies might escape to the atmosphere by leakage from the chamber, and 2 curies would remain adsorbed on interior surfaces and may, therefore, become transferred to waste water used after a non-tritium-containing test which would normally follow as the next test. This 2 curies of HTO would be evaporated to the atmosphere as part of the approximately 94,600 L (25,000 gal) of such wastewater. On balance, a possible maximum of 7 curies of the original 200 curies of tritium used in the test may escape as HTO to the atmosphere over a several-day to week-long period following each of the 10 tritium-containing tests; the remainder would be captured as LLW. By comparison, the amount of tritium contained in the typical theater exit sign is about 10 curies.

All appropriate and applicable air permits would be obtained for facility construction and operation. It is expected, based on a preliminary analysis of proposed normal facility operation, that Environmental Protection Agency Region IX approval and notification of startup for operations involving radionuclides will not be required. Provisions for sampling radionuclide air effluents would be incorporated into the design of CFF, and continuous monitoring, if required, would be performed according to NESHAP requirements.

J.5.2.2 Waste

A beneficial impact of the proposed action is that essentially all detonation products would be captured before release of remaining, mainly innocuous gases, to the environment. Two distinct waste streams would result from totally containing the tests at B801. The first waste stream consists of the shot debris, canisters, HEPA filters, scrubber fluids, and any other component of the pollution control system that becomes contaminated. The second stream is the washdown water itself and/or components of the washdown water system. The levels of the washdown water would be processed (filtered), stored, reused throughout an extended number of firings and eventually evaporated. Components of the processing system, such as used filters and washdown water system sludge, would be characterized and handled as hazardous, radioactive, or mixed waste.

The proposed facility, with its washdown and tritium removal system, would result in the generation of LLW and/or mixed waste because of the collection of sludge produced by the washdown operations. Conservative estimates are that 25 55-gal (208-L) drums of evaporator solids, tritium adsorption media, and stabilized washdown water, and 2 2.8 m^3 (100 ft^3) boxes of shot or test debris would be generated from each test with tritium. Generation of mixed waste is not expected, but to be conservative, a projection of 0.1 m *3* (3.7 ft *3*) of mixed waste per shot is assumed. The balance would be conservatively considered LLW. For tests performed without tritium, only one 2.8 m *3* (100 ft *3*) box of debris (LLW) would be generated. Because CFF would eliminate the use of firing table gravels, the total amount of solid waste that would be generated represents a significant reduction from the total amount of solid waste that is now generated annually during uncontained testing at B801.

The proposed CFF represents a decrease in waste generation from current and projected levels should the CFF not be constructed and operated. The types of waste generated at CFF would have some, but manageable, impact on waste handling activities at LLNL. Table J.5.2.2-1 shows the amounts of mixed, hazardous, and radioactive waste generated in activities conducted at LLNL and compares those values with the amounts of wastes, by type, expected to be generated at CFF annually. The CFF data in this table are based on the assumption that an average of 50 tests, and possibly up to 100 tests would be conducted annually, either at CFF or at the present B801 gravel firing pad (the No Action alternative). These projected annual test rates are based on recent (1991-94) testing data at the present B801 Facility. None of the waste types expected to be generated by the CFF/FXR would be unique to LLNL and each type would be processed and managed, stored, treated, disposed, or transported appropriately as is routinely done at LLNL for the same types of wastes from other current LLNL operations.

Table J.5.2.2-1.-- Comparison of Annual Lawrence Livermore National Laboratory and Contained Firing Facility Waste-Generation Rates (Weights Rounded)

Columns	**1**	**2**	**3**	**4**	
Category	**Waste Generation from All LLNL Activities (1992 EIS/EIR) (kg)**	**Waste Generation from Only S300 Activities (kg)**	**Waste Generation from B801 (50 Tests per year) (kg)[8]**	**Projected Waste Generation from CFF, (kg)**	
				50 Tests/ yr	**100 Tests/ yr**
Hazardous[9]	1,413,000	173,000	6,100	6,100	12,000
Low-level radioactive[10]	295,000	152,000	53,000	23,000	45,000

Mixed[11]	43,000	~900	~0	(0 to 2,200)	(0 to 4,400)
Transuranic[12]	36,000	0	0	0	0
Total	1,789,000	325,000	59,000	31,000	62,000

Waste generated by facility D&D is assumed to be all LLW and is conservatively estimated to be 110 percent of the volume of the Firing Chamber construction materials. This would be approximately 1,830 m *3 (64,610 ft3)* . If built at B851, as an alternative, these waste generation impacts should not be different than those for CFF that would be sited at B801. The waste would be handled in the same manner as other solid LLW generated from LLNL operations at that time.

J.5.2.3 Noise

The proposed action would have beneficial effects on the environment and on employees by reducing noise levels onsite and offsite, respectively. The current practice at the Site 300 firing areas relies on a combination of administrative and operating controls to ensure that neither site workers nor the public are adversely affected by exposure to high-impulse noise generated by the explosives test activities. These controls include restricted entry into the firing area when tests are scheduled, required accounting for all test-site-area personnel inside the protective building prior to testing, and limiting the size of the test (or precluding testing altogether) during unfavorable meteorological conditions. Containing the detonations of explosives would greatly reduce noise levels under all conditions and would eliminate the possibility that a test would need to be canceled or rescheduled because of potential noise levels resulting from inappropriate atmospheric conditions.

Noise sources anticipated during and following explosives tests in a containment facility would include low-energy impulse from the test, the relief of containment vessel overpressure, and other noises associated with the operation of the air handling system used to purge the containment vessel. These noises are not expected to be perceptible to Tracy-area residents or area ranchers, and they would not exceed the occupational noise exposure limits adopted by DOE for the protection of employees.

J.5.2.4 Ionizing Radiation

Detonations in the Firing Chamber could involve radioactive materials such as tritium (up to 20 mg on each of 10 tests), depleted uranium, and on some tests, thorium. Additionally, certain test configurations may occasionally generate small quantities of neutrons, which may then yield neutron-activation products. Because of the modest neutron production potential, (1016 neutrons per test on certain tests), the very effective shielding provided by the Firing Chamber, and the low specific activity of depleted uranium, the potential radiation impacts are dominated by tritium and activation-product buildup. These potential impacts to involved workers, noninvolved workers, and members of the general public are summarized in table J.5.2.5-1. Because these results are based on very conservative assumptions used when calculating projected impacts (as described below), they are considered bounding for routine CFF operations.

Some of the assumptions used in deriving table J.5.2.5-1 estimates were:

- A maximum of 10 detonation tests per year involving a maximum of 20 mg (200 curies) of tritium each.
- A maximum level of diagnostic neutron production (1016) per test, on a maximum of 10 tests per year.
- From each of 10 tests per year, up to 5 curies of released tritium as HTO from the Firing Chamber at ground level by leakage during chamber cooling and scrubbing, and an additional 2 curies of residual tritium released as HTO later during evaporation of washdown water through the facility stack that is also assumed released at ground level for purposes of dispersion modeling.
- Up to three involved CFF-area workers spend up to 2 days each within the Firing Chamber, entering the first day after detonation, and after air-scrubbing and chamber cleanup have reduced the tritium level in the chamber to approximately 5x10^{-6} curies/m^{3} ; all three workers are assumed to spend full time within 2 m of the shot location, where activation product doses would be maximized.
- Primary washdown water and dry air-scrubbing would yield an estimated maximum of 193 curies per test as solid low-level radioactive waste.

If the maximally exposed individual in the general public stayed at the nearest fenceline to CFF over the entire expected 30-year lifetime of the facility, the estimated lifetime fatal cancer risk to that individual from potential whole-body effective dose equivalent exposure to 3.8x10^{-5} person-rem would be 5.7x10^{-7} (that is, about one fatal cancer in 2 million). This potential dose is about 1,000 times less than the DOE guideline dose limit (that which might produce 1 fatal cancer per 2,000). Additionally, each of the three CFF workers who would be expected to accrue the greatest exposure dose (from removing debris from and cleaning the Firing Chamber after each test) should each receive a dose of less than 0.25 rem per year. This is less than 5 percent of the DOE worker exposure limit guideline of 5 rem per year. By comparison, the average annual dose received by an aircraft flight attendant is about 0.5 rem, or twice the dose expected for these CFF Firing Chamber workers.

J.5.2.5 Slope Stability

Document review suggests that existing B801 site slopes are stable. Unconsolidated overburden is only a few feet thick in the area and bedrock dips at a shallow angle (about 5 degrees) northeast. However, a recently active landslide deposit has been observed within about 244 m (800 ft) east of the site. This landslide is reported having generated a mudflow which reached the vicinity of the B801 site during a 15-year period prior to 1983. This mudflow appears to have been mitigated by placement of an earthen fill between the flow and the B801 site. Appropriate slope stabilization measures would be taken in design and construction of graded slopes (see also section J.5.1.1).

Table J.5.2.5-1.--

Maximum Potential Annual Radiation Exposure Impacts from Normal Contained Firing Facility Operations

Individual Potential Dose, Rem Per Year[13]

Individual or Group	**Tritium**	**Activation**	**Total**	**Excess Cancer Fatalities (per year)**[14]
Involved CFF-area worker	0.09	0.16	0.25	1.0x10 -*4*
Non-involved worker (50 m)[15]	5.2x10 -*3*	0	5.2x10 -*3*	2.1x10 -*6*
Total worker[16]	1.6	0.5	2.1	8.4x10 -*4*
Collective Potential Dose, Person-Rem Per Year				
Maximally exposed member of general public (site boundary, 1,340 m)	3.8x10 -*5*	0	3.8x10 -*5*	1.9x10 -*8*
Total general public[17]	0.32	0	0.32	1.6x10 -*4*

J.5.2.6 Water Use

It is expected that washdown of the CFF Firing Chamber, after considering the contribution of planned water recycling activities, would involve the use of 950,000 L (250,000 gal) of water annually. This water consumption level, plus that for cooling towers (1,100,000 L [300,000 gal]), and domestic uses 190,000 L (50,000 gal), would add a total of approximately 2,300,000 L (600,000 gal) annually to the Site 300 water consumption rate of approximately 120 million L (31.8 million gal) over projected groundwater use (DOE/UC 1992), which is less than a 3-percent increase.

J.5.3 Accident Scenarios

The reasonably foreseeable accident scenarios that could produce the greatest potential impacts are the following:

- Case 1: Accidental detonation of a test of a 60-kg (132-lb) charge of explosives at the B801 firing table. (Applicable to No Action alternative.)
- Case 2: Accidental detonation of a 60-kg (132-lb) test that could contain up to 20 mg (200 curies) of tritium with dispersal through an unsecured blast door during final preparation. No

neutron generation potential would exist, because blast doors would be closed before any accident scenario that would involve neutron generation (misfire). (Applicable to either B801 or B851 alternatives.)

One accident scenario that was considered but was not felt to be reasonably foreseeable included:

- Case 3: Same test configuration as in Case 2, but the planned detonation takes place yielding the potential for neutron generation; accidental rupture of the CFF Firing Chamber occurs (considered to be a beyond-design basis accident and therefore, not reasonably foreseeable). (Applicable to either B801 or B851 alternatives.)

In each case, the involved workers would probably be fatally injured from blast effects due to peak overpressure and debris, but there would be no injury offsite to members of the general public. No damage to current buildings offsite or in other areas of Site 300 would be expected, although window rattling might occur. Projected radiation effects from two scenarios are summarized in table J.5.4-1.

These projected radiation doses are still lower than DOE guideline limits for workers and for the general public; thus, the greatest effects would be fatalities or injuries to workers due to primary blast effects, as noted above.

J.5.4 Cumulative Impacts

Table J.5.4-1.-- Radiation-Related Dose Effects Due to Accidents; Contained Firing Facility and Alternatives

Scenario	**Involved Worker, 30 m, rem**	**Uninvolved Worker, 50 m, rem**	**Offsite Member of Public, 1,340 m, rem**	**Excess Cancer Fatalities, Offsite Member of Public[18]**
Case 1	0	0	0	0
Case 2	0.026	0.015	1.1x10 -*4*	5.5x10 -*8*
Case 3[19]	0.031	0.015	1.1x10 -*4*	5.5x10 -*8*

The primary negative impacts resulting from the proposed action would occur as a result of construction-related activities. These activities would be short term and are not expected to result in significant increases in ambient amounts of airborne dust or noise. Approximately 45,000 kg (20,500 lb) of solid LLW from Firing Chamber air-scrubbing and washdown following contained firing operations could be generated each year. This volume of waste represents a reduction from the levels that would be projected if the same number of detonations were to take place at the current facility (No Action alternative). The proposed project is expected to greatly reduce the air emission of detonation combustion products and to reduce cumulative buildup of LLW by eliminating outdoor explosive testing on gravel firing tables (which must be handled as LLW because some of the explosive test devices would contain radioactive components). The proposed action would therefore greatly reduce the release of emittants to the air and ground.

J.5.5 Conformity

Site 300 is in an air basin area designated as non-attainment with respect to ozone. The design, construction, operation, and ultimate D&D of CFF would not result in levels of emissions of ozone precursors (oxides of nitrogen and precursor organic compounds) that would place Site 300 above conformity thresholds; and the facility would not cause or contribute to any violation of the National Ambient Air Quality Standards. The facility would be operated in conformance with all rules and regulations of the SJVUAPCD which are included as part of the state implementation plans.

J.5.6 Socioeconomic Factors and Environmental Justice

J.5.6.1 Staffing

The addition of another 5 to 6 full-time LLNL employees (for CFF operation) to augment the present B801/FXR operating staff (which averages 20 employees) will be an insignificant incremental impact over that of operating the current FXR Facility and its associated firing table.

J.5.6.2 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs and activities on minority and low-income populations. DOE is developing official guidance on the implementation of the Executive Order. However, given the demographic makeup of Tracy and its surrounding agricultural areas, it is expected that there would be insignificant or no potential for differential or disproportionate impacts from the proposed action (or from its alternatives) to offsite populations that could be characterized as predominantly minority or low-income.

J.6 Persons and Agencies Contacted

No persons or agencies outside the LLNL and DOE have been contacted.

J.7 References

AMCCOM, 1992, "Development of Methodology and Technology for Quantifying Emission Products from Open Burning and Open Detonation Thermal Treatment Methods." Field Test Series A, B, and C. Volumes 1 and 2, U.S. Army Armament, Munitions, and Chemical Command, Washington, DC, January.

Busby, C.I., M. Garaventa, and L.S. Kobori, 1981, "A Cultural Resource Inventory of Lawrence Livermore National Laboratory's Site 300, Alameda and San Joaquin Counties, California," Report S-2675, on file, Central California Information Center, California State University, Stanislaus, CJ.

Carpenter, D.W., J.R. Copland, J.L. Lamarre, R.S. Mateik, M.J. Taffet, and W.M. Wade. 1991. "Investigation of Holocene Faulting Near Decommissioned Landfill Pit 6, Lawrence Livermore National Laboratory Site 300, Lawrence Livermore National Laboratory, Livermore, CA," UCRL-ID-106316.

ERD Final Sitewide Remedial Investigation Report (SWRI), Lawrence Livermore National Laboratory Site 300, Webster Scholten (author), April 1994, UCRL AR-108131.

Federal Interagency Committee for Wetland Delineation, 1989, Federal Manual for Identifying and Delineating Jurisdictional Wetlands, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S. Department of Agriculture Soil Conservation Service, Washington, DC.

Lawrence Livermore National Laboratory, 1995, "Conceptual Design Report, Site 300 Contained Firing Facility, Project Number 96-D-105," prepared by Holmes and Narver, Orange, CJ.

Orloff, S., 1986, "Wildlife Studies of Site 300 Emphasizing Rare and Endangered Species, Lawrence Livermore National Laboratory, San Joaquin County, California, BioSystems Analysis, Inc., Sausalito, CA," prepared for Lawrence Livermore National Laboratory, Livermore, CA, UCRL-15865.

Raber, E. and D.W. Carpenter, Eds., 1983, "An Evaluation of the Hydrogeology and Groundwater Chemistry Associated with Landfills at LLNL's Site 300, Lawrence Livermore National Laboratory, Livermore, CA," UCRL-53416.

Rhoads, W.J., T.P. O'Farrell, and M.L. Sauls, 1981, "Occurrence and Status of Endangered Species, San Joaquin Kit Fox (Vulpes macrotis mutica) and Large-flowered Fiddleneck (Amsinckia grandiflora) on Lawrence Livermore National Laboratory, Site 300, CA," U.S. Department of Energy, Nevada Operations Office.

Taylor, D.W., and W. Davilla, 1986, "Vegetation of Site 300, Lawrence Livermore National Laboratory, San Joaquin County, California," prepared for Lawrence Livermore National Laboratory by BioSystems Analysis, Inc., Santa Cruz, CJ.

U.S. Department of Energy and the University of California, 1992, Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, DOE/EIS-0157, SCH90030847, August, 1992.

Webster-Scholten, C.P., 1994, *Final Site-Wide Remedial Investigation Report, Lawrence Livermore National Laboratory Site 300, Livermore, CA* , UCRL-AR-108131, April.

FOOTNOTES

1

Projected future dispersals per year based on the estimated composition of 100 tests. The basis for these projections is the B801 shot materials database for the previous 5 years (1990 to 1994), during which the number of tests ranged from 21 to 97 per year and averaged 50 per year.

2

Only a very small fraction of the weights of the metallic materials and salts listed in this table would be expected to be volatilized as gaseous or aerosol products.

3

Source is primarily alloying materials on test hardware, such as nuts, bolts, etc. Most of this material is large enough to be retrieved by hand following an experiment, so that it can be disposed of in a managed waste stream, or recycled.

4

Source is primarily electrical leads and wire. Most pieces of this material are large enough in size as to be retrieved by hand following an experiment, where it is disposed of in a managed waste stream or recycled.

5

In rare instances, thorium may be used in place of depleted uranium.

6

This weight of explosives would be converted to thermodynamically stable products of combustion (such as carbon dioxide and water) very efficiently upon detonation.

7

Tritium has not been used in the most recent past few years. However, the 1992 DOE/UC EIS/EIR discusses an administrative limit of 20 milligrams (mg) of tritium, an environmental emission that can be expected under the No Action alternative. This projection is based on an estimated maximum of ten tests per year at 20 mg each.

Model results.

8

The selection of the 50-tests-per-year level analyzed here is based on an annual average of tests done at B801 from 1990 through 1994. The maximum annual testing level was approximately 100 tests a year. Waste projections were based on average annual data from 1991 to 1994. If 100 tests per year were conducted (the No Action alternative), waste projections shown in this column would be doubled.

9

Columns (1), (2), and (3) reflect hazardous waste generation data found in tables B-15 and B-17 of the 1992 EIS/EIR. This waste consists primarily of waste oil, oil-contaminated rags and equipment as well as film processing solids and solutions used in support operations. The solid portion is approximately 4,000 kg (8,800 lb). Liquid volumes were converted into kg using 1,000 kg per m3. Column (4) represents wastes projected from CFF operations at a level of 50 tests per year (average annual) and 100 tests per year (maximum annual).

10

Columns (1), (2), and (3) reflect LLW values. Column (1) data was derived from tables B-10 and B-12 of the 1992 EIS/EIR for the Livermore Site, plus Site 300 data from Column 2. Column (2) was derived by averaging annual Site 300 shipping log information from 1989 to 1994. Column (3) was derived from annual average from 1991 to 1994. Column (4) data includes an estimated expected 25-percent reduction in the weight of waste debris below that of current operations and complete elimination of the generation of gravel waste since the CFF would not use a gravel firing table and would not use tent structures as are presently used at B801.

11

Columns (1) and (2) reflect mixed waste values derived from Table B-13 and the discussion in Section B.4.3.3 of the 1992 EIS/EIR. Column (4) estimates were derived from conservative assumptions that operation of CFF could generate up to 0.1 m *3* (440 kg per m *3*) of mixed waste from each test although none is expected. This waste would derive from evaporator sludge, from water washdown activities, and spent filter media. This further assumes that all CFF wastes would potentially be contaminated by low-level radioactivity after the first test that involves uranium, thorium, or tritium.

12

Transuranic (TRU) wastes are not now generated from explosives testing at Site 300. Table B-11 of the 1992 EIS/EIR shows 6 months of generation at the LLNL Livermore Site in 1990 to be 36 m^{3} (1,271 ft^{3}). Thus, a year's generation would be estimated to be 72 m^{3} (2,543 ft^{3}). An average density of 500 kg per m3 was used to convert volume to weight (Column [1]).

DOE/UC 1992.

13

See discussions, section J.5.2.4.

14

Based on DOE dose-to-risk conversion factor of $4x10^{-4}$ (4 in 10,000) latent cancer fatalities per person-rem for workers and $5x10^{-4}$ (5 in 10,000) for the general public.

15

Assumed to be all Site 300 noninvolved workers (approx. 260) standing 50 m from CFF resulting in an extremely conservative estimate.

16

The total worker cumulative dose is the sum of doses to both the involved CFF workers and noninvolved workers within 50 m of the CFF.

17

Using the EPA-approved computer code, CAP88-PC, version 1.00, the total general public cumulative dose estimate was calculated by considering the approximate population within 80 km (50 mi) of Site 300 and using annual site meteorological data.

Model results.

18

See footnote b, table J.5.2.5-1, for conversion factors used.

19

Beyond-design basis accident considered not to be reasonably foreseeable.

Model results.

Chemical Symbols

HCl	hydrogen chloride
HCN	hydrogen cyanide
HF	hydrogen fluoride
NH3	ammonia
NOx	nitrogen oxides

APPENDIX K: ATLAS FACILITY PROJECT-SPECIFIC ANALYSIS

K.1 Purpose and Need for Agency Action

K.1.1 Background

This project-specific analysis for the proposed Atlas Project is intended to provide specific information about the siting and construction of Atlas at the Los Alamos National Laboratory (LANL) in Los Alamos, NM. The purpose and need set forth in this document is focused on the additional capabilities that the Atlas Project would provide to LANL. Environmental impacts resulting from this proposed action are assessed for LANL only. Information relating the Atlas Project to the broader assessment of complex wide Stockpile Stewardship and Management environmental impacts is found in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (PEIS).

Modeling of nuclear weapons to assess and ensure safety, reliability, and performance as weapons age or are modified or remanufactured, is part of the science-based stockpile stewardship mission. Without nuclear testing, mathematical calculations based on experimental data would be the only way to obtain needed information on weapons performance and reliability. However, the Department of Energy (DOE) has not yet determined how to predict this behavior with sufficient accuracy from calculations alone. Developing and verifying more accurate predictive modeling requires both empirical data on underlying physics and benchmarking of computational predictions against experimental observations. This is particularly necessary in the case of nuclear weapon stewardship, for which substantial simplifications of physics are necessary for practical computational models. To ensure that the physical approximations and models are adequate, and provide proper physical data and adequate benchmarking, experiments must be done in regimes of appropriate physical parameters.

It is the requirement as presented in the Stockpile Stewardship and Management PEIS for experimental data in the regimes of extreme physical parameters common to nuclear weapons that underlie the need for high-energy-density experimental facilities. Lasers and pulsed-(electrical)-power experimental facilities are complementary in providing these capabilities. High-energy lasers provide the highest temperatures and pressures in small experimental volumes for a few billionths of a second. High energy pulsed-power facilities make different aspects of this high-energy-density regime accessible because pulsed power can focus much higher total energy on a larger (e.g., centimeter [cm] scale) experimental target for a much longer time, albeit at somewhat lower temperature and pressures. Pulsed power will be of most value to the science-based stockpile stewardship program in addressing properties of materials, implosion hydrodynamics, and radiation flow physics. These are some of the areas identified by DOE as the most significant concern to weapons scientists.

LANL already has capability in pulsed power in the microsecond regime and applies it to stockpile stewardship. In particular, LANL uses the Pegasus II 4-megajoule (MJ[1]) capacitor bank, as well as high-explosive (HE)-driven pulsed power generators such as the Procyon generator, which are used in single-shot experiments at appropriate HE firing locations. Typically, the pulsed electrical currents produced by the capacitor bank or HE generator create strong magnetic fields that implode a cylindrical "liner," which would impact a centimeter-scale target to produce hydrodynamic pressure. Alternatively a liner accelerated to high velocity toward the axis of the cylinder could produce soft x rays when it impacts. The 4-MJ Pegasus II capacitor bank is already used for a variety of experiments associated with the physics of both primaries and secondaries. Heavy liners can provide highly symmetric and smooth implosion drive, with asymmetries of 0.5 percent or less, that can help weapons scientists isolate and study certain physical phenomena without complicating effects.

K.1.2 Purpose and Need

DOE must maintain the safety, security, and reliability of the U.S. nuclear weapons stockpile. As a result of the moratorium on underground nuclear testing and pursuit of a Comprehensive Test Ban Treaty, DOE is forming a science-based stockpile stewardship program. This program is being carried out by the weapons laboratories using a variety of technologies, including lasers and pulsed power to support the computer modeling of nuclear weapons' performance over time as the stockpile ages.

As a result of the stockpile stewardship mission, LANL is tasked with enhancing their pulsed-power capability, resulting in the ability to accurately benchmark calculations on weapon performance. An extensive amount of high-energy shots need to be performed for a variety of potential physical defects such as cracks, voids, corrosion, or other modifications to material that may be caused by aging or introduced from remanufacturing. The capability and energy of existing facilities is insufficient to reach the pressures, volumes, and energy densities needed to accurately benchmark weapon-related computational predictions as required to support the stockpile stewardship mission at LANL. In particular, existing facilities cannot support large-scale experiments in the ionized regime, an important capability for analyzing primary and secondary-physics issues, such as implosion hydrodynamics, materials properties, and interactions.

K.2 Description of Alternatives

K.2.1 Proposed Action

K.2.1.1 Description

The need to perform experiments with macroscopic pulsed-power targets, as well as with lasers, exists not only because of the limits of measurement diagnostics or improved ease of measurement at larger scale, but also because some of the physical phenomena that must be investigated cannot be readily scaled down to smaller sizes without affecting some parameters of importance. For example, DOE must perform experiments to develop and benchmark calculations on weapon performance for a variety of potential physical defects such as cracks, voids, corrosion, or other local modifications to material that may be caused by aging or introduced from remanufacturing. Studying the hydrodynamic effects of such perturbations in a pulsed-power experiment and comparing the results to calculations is one of the means used. Figure K.2.1.1-1 illustrates this hydrodynamic process. If the perturbations being investigated were scaled down to the volumes accessible by laser experiments, in many cases the perturbations would be of a similar size to natural material grains or pores, which would complicate or even obscure the experimental results.

However, the energy of Pegasus II is insufficient to reach the pressures and volumes needed to accurately benchmark weapon-related computational predictions. In particular, Pegasus is not adequate to drive dense hydrodynamic targets into the ionized regime, an important capability for analyzing some secondary-physics issues.

Atlas has been designed to provide enhanced pulsed-power capability specifically to address these areas. Atlas has been conceptually designed as a 36-MJ inductive energy store capacitor bank that would nominally deliver 25 to 30 megamperes (MA) (60 MA peak) to an imploding liner or plasma. For hydrodynamic experiments, Atlas would implode heavy precision liners to velocities of over 2 cm/microsecond with final kinetic energies of 2 to 5 MJ. Pressures of >5 to >30 megabars would be achieved (depending on design of the experiment). One dimensional calculations benchmarked to past HE pulsed-power results predict that Atlas will produce x-ray yields > 2 MJ with temperatures >100 electron volts (eV). In a switched mode of operation, Atlas x-ray output would approach 200 eV temperature.

For study of material properties and development of dynamic materials models, Atlas would produce pressures and strain rates in cubic centimeter (cc) scale samples at least 5 to 10 times greater than possible with the present Pegasus Facility.

Fidelity of scaled implosion hydrodynamics experiments is essential for them to be used to verify predictions of design codes. Even the simplest set of physical equations governing compressible hydrodynamics have four parameters that should be the same for fidelity. High-energy density hydrodynamic flow calculations must be validated by experiments with an energy density high enough to get materials into the appropriate state of matter, to ensure adequate fidelity of the important parameters.

A key need satisfied by the Atlas Facility would be the capability of doing large-scale hydrodynamic experiments at high temperatures to ionize the material. This is important for understanding physics phenomena associated with late stages of primary as well as secondary implosion. Atlas will be the first pulsed-power facility that will have the capability for generating the state of matter -- ionized, highly correlated materials -- that governs two of the most important of these similarity parameters, compressibility and Reynolds number. For metals, this requires 500 kilojoules (kJ)/cc, and for plastics 200 kJ/cc. To access this energy density regime, a typical experiment large enough to have easily resolved features needs to be driven with 2 to 5 MJ of kinetic energy. Solid-liner kinetic energies in this range cannot be achieved on presently operating pulsed-power facilities.

Atlas would provide these conditions in large experimental volumes (cc) for benchmarking and verifying models used to evaluate effects of aging (e.g., high aspect ratio cracks), or changes due to remanufacturing, on weapon performance and reliability. Atlas would make available an order of magnitude increase in dynamic pressure over Pegasus, which would greatly enhance DOE's ability to study such important phenomena as melting and hydrodynamics in primaries, early and late time spall in converging geometries, distortion in implosion systems, and effects of gaps.

The expected lifetime of the Atlas Facility is 20 years. After that time, the facility would be cleaned up and decommissioned, which would generate an estimated quantity of nonhazardous waste totaling approximately 841 cubic meters (m^{3}) (30,000 cubic feet [ft^{3}]). This waste would be recycled or disposed of at a sanitary landfill. A separate *National Environmental Policy Ac*t (NEPA) analysis would be conducted at that time.

K.2.1.2 Facility

The Atlas Facility would be located at LANL's Technical Area (TA)-35 (see figure K.2.1.2-1). TA-35 is used primarily for research and development (R&D) activities in the fields of physics, chemistry, fusion, and materials science. Construction of the facility would involve renovating existing buildings for use in performing pulsed-power experiments. The construction phase would also involve the installation of high-power electrical Special Facilities Equipment (SFE). To accommodate the facility and its support requirements, five existing buildings within TA-35 would be modified, and external concrete pads, transportable office/diagnostic space, and storage tanks would be added. These relatively minor modifications have an estimated cost of $2.5 million and would be completed within 6 to 9 months of the facility construction start-date.

Atlas operations would require the following major SFE elements: 1,430 megawatt (MW) generator (existing); 80 MW alternating current to direct current (ac-to-dc) converter; 50 MJ inductive energy transfer system; 36 MJ capacitor bank; target chamber; and various control, diagnostic, and data acquisition equipment. The facilities and infrastructure requirements necessary to support this SFE include heavy lab construction with overhead material handling capability, vibration-free high-power generation, electromagnetically-shielded and security-hardened data acquisition areas, and dielectric fluid storage and transfer equipment. All SFE and supporting facilities/infrastructure meet or will be designed to meet the construction requirements for a "low hazard, non-nuclear" facility.

The Atlas Facility would use portions of Buildings 124, 125, 126, 294, and 301 at TA-35 (see figure K.2.1.2-2) in the following manner to meet these SFE facility and infrastructure requirements:

TA-35-P>	**Atlas Experimental Area,**
124/125	Control Room and Coordination Center

TA-35-126	Mechanical Services Building
TA-35-294	Power Supply Building
TA-35-301	Generator Building

Detailed building-use information, including building modifications, is included in the following paragraphs. Up to 35 construction workers would be involved in the building modifications and equipment installations at any given time; the workers would be a combination of relocated workers from other completed construction sites and a limited number of new hires as needed. Approximately 15.3 m^3 (20 yd^3) of noncontaminated construction waste would be generated during construction.

Buildings 35-124 and 35-125 . The total space the Atlas Facility would use in these buildings is approximately 1,151 square meters (m^2) (11,770 square feet [ft^2]). Buildings 124 and 125 are proposed to house the primary Atlas Facility components because they could provide safe, secure, and convenient working and experimentation space; access to the Atlas capacitor bank could be controlled and limited; and diagnostic support platforms are available for conducting and analyzing proposed experiments. These buildings have the following special features:

- *Heavy-industrial, high-bay construction.* Atlas requires, at a minimum, 929 m^2 (10,000 ft^2) of high-bay building with a heavy-duty gantry crane to house the capacitor bank and user-support facilities. Building 124 and 125 were designed for large-scale experimental work and have high ceilings with heavy duty gantry cranes that can access the entire interior space. Buildings 124 and 125 satisfy all the Atlas space requirements.
- *Reinforced walls and ceiling.* Atlas requires reinforced walls and ceilings to protect workers and the public against shrapnel from possible high-energy electrical faults in the capacitor bank. Buildings 124 and 125 were designed to house the power amplifiers and target chamber of a laser-fusion facility. To protect the public from associated hazards, the buildings were constructed with concrete walls and roofs. This type of construction is ideal for a high-energy capacitor bank because shrapnel from possible faults will be contained within the building. The walls and ceiling will also contain any diagnostic x rays produced. Buildings 124 and 125 satisfy all the containment requirements of Atlas.
- *Collocation with the 1430-megavolt ampere (MVA) generator.* Atlas would utilize a multi-hundred MVA generator to charge the capacitor bank rapidly. The facility housing this generator (Building 301) includes a spring-mounted generator pad which isolates vibrations due to generator operations from surrounding experimental areas. This rapid charging technique is similar to other large physics facilities for which power from the existing electrical grid is insufficient to meet the facility technical requirements. In the case of Atlas, this requirement stems from a common fault mode for large capacitor banks; premature electrical breakdown (prefire) of a capacitor switch. A prefire usually destroys the target and much of the rest of the experimental assembly, both of which are expensive and require days to replace. Since the probability of prefire is proportional to the time during which the switches must hold high voltage, the problem is greatly diminished by rapidly charging the capacitor bank and then quickly triggering the switches.

Due to the large number (300) of capacitor switches in Atlas and the programmatic and cost impacts of recovering from frequent prefires, Atlas will use rapid charging to satisfy its reliability requirements. Because of the extremely large energy storage required, even multi-megawatt power lines would still take 10 to 20 seconds to charge the Atlas capacitor bank. DOE has estimated that a faster charging rate will be required to provide sufficient confidence that Atlas will meet its reliability requirements. Buildings 124 and 125 are proposed to house Atlas because a 1430-MVA generator, located adjacent to these buildings in Building 301, is available and is capable of charging the capacitor bank in as little as 0.04 seconds. This configuration forms the basis of the Atlas conceptual design.

- *Electromagnetically shielded, data-acquisition room for classified data.* Atlas will require an electromagnetically shielded, data-acquisition room for classified data. The laser-fusion machine, for which Building 124 was originally designed, has many similarities to Atlas' operational requirements, including the capability to retrieve and store classified data. Inside the building is an electrically shielded data acquisition room that is also protected by a concrete wall. During classified tests, the entire building could be secured, and all classified data could be electronically routed to this room. This room satisfied the requirement for a secure site for classified data for the laser-fusion machine, and would also satisfy the Atlas requirement.
- *Electromagnetically shielded room for machine-control and unclassified data.* Atlas requires a machine-control room that is isolated from the machine and provides space for unclassified data acquisition. Just outside Building 124 in Building 125 is an 86 m^2 (925 ft^2) electrically shielded control and data acquisition room that was originally constructed to control the laser-fusion facility. This room already has conduit to Building 124 for machine-control and unclassified data acquisition lines. This room satisfies Atlas requirements for machine-control and unclassified data acquisition.
- *Oil storage.* Atlas will likely require storage capabilities for electrically insulating mineral oil. Just outside Building 125 are 3 underground oil storage tanks with a total capacity of 90,850 liters (L) (24,000 gallons [gal]). These tanks were installed to support the laser-fusion pulsed-power systems. Ownership of these tanks recently became available, and if Atlas uses oil for capacitor-bank insulation, these tanks would help satisfy Atlas oil-storage requirements.

Figure K.2.1.2-3 provides a perspective of the Atlas primary facility components, including the SFE, proposed for installation at TA-35. These consist of:

- Target chamber containing implosion target
- Imaging radiography darkrooms
- 36 MJ capacitor bank
- Target assembly clean room
- Laser diagnostic systems
- Satellite control room
- Diagnostic screen rooms
- Diagnostic trailer
- Axial diagnostics

- Spare Marx module
- Vacuum pumps
- Structural platforms and stairwells
- Flat-plate radial transmission line
- Oil storage and transfer system
- Transmission line ballast
- Chilled water, nitrogen, and compressed air systems

Structural modifications and improvements to Buildings 124 and 125 and surrounding areas required to accommodate the Atlas Facility components would include the following:

- The heating, ventilation, and air conditioning may be modified or relocated. Stairwells may require installation in the floor to permit access to and from the interior of the capacitor bank inner area. A 300 L (80 gal) liquid nitrogen storage tank and a supplemental 151,400 L (40,000 gal) non-polychlorinated biphenyl mineral oil storage tank would be stationed aboveground outside these buildings and piping connecting the tanks to the facility would be added. The oil storage tank would be bermed or similarly contained and would comply with all Spill Prevention Control and Countermeasures requirements.
- Support utilities such as compressed air, chilled water and electrical distribution systems would be added or improved to support the SFE equipment.
- A new 16.8-meter (m) by 24.4-m by 15-cm (55-feet [ft] by 80-ft by 6-inch [in])-thick concrete slab would be installed to accommodate two portable diagnostic trailers, a mobile air conditioning unit, and a power pedestal. The pad would slope slightly from north to south to provide positive drainage.
- A diagnostics data center, project management office, and a visitor center would be constructed and housed in Building 125.

All other facility requirements already exist in Buildings 124 and 125, and no other facility modifications would be required.

Building 35-126. Building 126 was constructed in 1980 of concrete block and cast-in-place concrete with exterior-applied insulation. The roof system is made of precast concrete tees with insulation and single-ply roofing. The 640 m^2 (6,900 ft^2) building houses the existing heating, ventilation, and air conditioning and major electrical equipment that serves Building 125 and 294. No modifications to this building would be required.

Building 35-294. Building 294 was constructed in 1990 of steel framing with synthetic stucco panels at the east and west ends. The building is approximately 75.6 by 20 by 11.6 m (248 by 66 by 38 ft) in size. The building fills the space between Building 124 to the north and Building 125 to the south and shares the exterior north and south walls of these buildings. The Atlas Facility components in this building would occupy about 163.5 m^2 (1,760 ft^2). Atlas component equipment to be installed in this building includes an ac-to-dc converter, communication circuits, and the switching system.

The only building modifications would be the addition of internal trenches and cable tray supports for the communication and electrical systems.

Building 35-301. Building 301 was constructed in 1990. The structure is a pre-engineered steel building set on a concrete pad. The 1087 m^2 (11,700 ft^2) building houses a 1430 MVA generator, unique in the DOE-Defense Program complex, which can rapidly charge the Atlas capacitor bank. This building has several significant features to isolate generator vibrations from surrounding buildings. The generator and associated controls and alarms currently serves the National High Magnetic Field Laboratory (NHMFL), located in Building TA-35-127. The NHMFL would continue to use the generator when it is not in use serving the Atlas Facility. Only one application would be run by the generator at any one time. No modifications are planned for this building.

K.2.1.3 Operations

The heart of the Atlas Facility would be a pulsed-power capacitor bank that would deliver a large amount of electrical and magnetic energy to a centimeter-scale target in a very short time (<10 microseconds [(ms]). Each experiment would require extensive preparation of the experimental assembly and diagnostic instrumentation. The Atlas Facility would be designed to handle up to 100 experiments per year, but not more than 3 experiments per week. Approximately 15 workers would be employed at TA-35 in support of the Atlas Facility once it is operational. The workers would be a combination of relocated workers from currently operating facilities and a limited number of new hires as needed.

Atlas would support many related types of experiments. For example, in a typical experiment, a hollow cylindrical piece of metal (such as aluminum, copper, or gold) fabricated with known cracks, voids, or other defects would be placed in the target chamber. Heavy (e.g., 30 gram (g) [1.1 ounce {oz}]) targets would be used in such experiments designed to validate computer simulations of the hydrodynamic effects of such defects, which in turn support evaluation of potential defects in aging weapons. Light (e.g., 50 milligram [0.00175 oz]) targets would be imploded to produce a hot plasma source of soft (<200 eV) x rays to study radiation physics pertinent to stockpile stewardship.

During an experiment, electromagnetic energy would go sequentially from the generator to the ac-to-dc converter, through the inductor (optional), to the capacitor, and would finally be delivered to the target.

The Atlas capacitor bank would be designed to be flexible enough so that it has the capability to transfer energy in various quantities and within a spectrum of time intervals. The following is a description of what would happen during an experiment requiring maximum possible currents and generating the maximum possible magnetic fields from the facility.

When such an experiment setup was completed, power from the LANL electrical grid would be used to spin the generator to 1,800 revolutions per minute (rpm) over a period of 15 to 20 minutes (the generator may already be spinning for NHMFL experiments). When full speed is reached, a switch would close to allow electricity to flow from the generator to an 80-MW ac-to-dc converter. This converter would transform the high-voltage ac output of the generator to a low-voltage dc charging current in the inductor. The converter would provide this charging current for 3 to 5 seconds. When the peak current of 28 kiloamperes is reached, a switch would disconnect the converter from the inductor. The inductor would produce peak magnetic fields of 40,000 gauss (G) at the coil surface during this few-second interval.

When the inductor reaches 50 MJ of stored energy, various switches would close and open, and energy would be transferred to the capacitor bank, which consists of an array of Marx modules. Within 40 milliseconds, each stage in the Marx modules would acquire a voltage of 60 kilovolts. When the capacitor bank reaches full charge, switches would connect all of the modules into a series configuration, producing many times the original voltage (nominally <1 MV) at the terminals of the transmission line. At this time, the 36 MJ of energy stored in the capacitor bank would be discharged as electric current through the transmission line into a load or liner in the target chamber. The discharge would take approximately 10 ms. If the experiment requires low energy x-ray production, then Atlas may utilize a "plasma flow switch" in the electrical transmission section near the target to decrease the implosion time from several ms down to half a ms or less.

This very large current would produce a large magnetic field in the localized area around the target, causing it to implode, and possibly vaporize or melt, depending on the thickness of the metal. A light liner used inside the target would collide with itself on axis, producing a plasma and low energy x rays. A heavy liner used within the target would compress sample materials to high pressures or, when driven into a central target, would produce extremely high shock pressures that can produce partial material ionization. Solid shrapnel and vaporized molecules would be generated but would be stopped by the walls of the target chamber. Vaporized molecules would deposit onto the walls of the target chamber.

The target chamber would be equipped with a number of ports to allow connection of diagnostic equipment and data acquisition equipment. Diagnostic equipment would include air monitoring devices, voltage probes, current probes, and magnetic field measuring instruments. Data acquisition equipment would consist of cameras, lasers, x-ray detectors, and other similar equipment. Experiments with heavy targets would yield laser holographic images and x-ray radiographs of the implosion which would be captured and recorded to determine the hydrodynamic behavior of the experiment. Experiments with light targets would measure the quantity and energy of radiation (x rays) generated during the implosion and investigate the interaction of this radiation with other parts of the experimental assembly.

After each experiment, LANL personnel would clean the target chamber of metallic debris and deformed metallic targets. Up to 150 L (42 gal) of ethanol would be used each year for cleaning. Discarded materials following each experiment would consist mostly of small amounts of aluminum, copper, very small quantities of gold, and oxides of these metals, or other similar nonradioactive heavy metals. Any metal pieces recovered would be salvaged for reuse. Personnel would also perform routine maintenance, such as replacement of worn dielectric insulation. All waste would be sampled and analyzed in accordance with LANL procedures to determine whether *Resource Conservation and Recovery Act* (RCRA)-regulated hazardous materials are present in regulated quantities. For purposes of this analysis it is assumed that a small amount (<1 m3 annually) of liquid or solid hazardous waste would be generated by occasional experiments involving lead or other simulant materials. This waste would be staged in the onsite hazardous waste accumulation area and shipped to off-site commercial RCRA-permitted treatment, storage and disposal facilities. Uncontaminated waste (such as paper waste), expected to be about 0.15 m3 (5 ft *3*) per week, would be disposed of at the Los Alamos County Landfill.

K.2.2 Continued Operations Alternative (No Action)

K.2.2.1 Description

For the purpose of this analysis, Pegasus II would remain at its current energy level and current rate of experiments. The Pegasus II Facility is located at TA-35 and features a capacitor bank consisting of 8 Marx modules that store up to 4.3 MJ of electrical energy. The Pegasus II Facility is being used by personnel in the weapons physics community to perform experiments in hydrodynamics and radiation transport. It has served as a test bed and will continue to provide important data for experiments in a particular energy regime.

The No Action alternative analysis provides an environmental baseline from which to measure the potential impacts of the proposed action and other alternatives against. However, the No Action alternative does not meet DOE's purpose and need for action. Continued operation of only the Pegasus II Facility would mean that pressure and temperature regimes, critical to understanding weapon aging effects, will not be attained. For instance, in hydrodynamic experiments, Pegasus does not have sufficient power to drive shock pressures that can ionize dense materials. In radiation transport experiments, Pegasus does not have sufficient power to produce >1 MJ of x rays with temperatures >100 eV. Both of these capabilities are important to study relevant issues associated with thermonuclear secondary devices. For experiments relevant to primary physics, Pegasus has insufficient power to drive the larger-scale hydrodynamic targets required for high-fidelity diagnostic access. Operation of only Pegasus II would prevent DOE from providing adequate experimental validation of computer predictions of the effects of certain aging phenomena.

The expected lifetime of the Pegasus II Facility is 15 to 20 years; it became operational in 1987. Future decontamination and decommissioning activities associated with the Pegasus II Facility would require separate NEPA analyses.

The Pegasus II Facility is included as part of the No Action alternative for the Stockpile Stewardship and Management PEIS (DOE 1995a).

K.2.2.2 Facility

The Pegasus II Facility is located at TA-35, Building 86 (see figure K.2.1.2-1). The Pegasus II capacitor bank is situated in Room 100, and the control center, data collection room, and office areas are located in Rooms 101 and 205. The detonators used in firing the capacitor bank are stored in a non-propagating container in a steel safe in Room 101.

The Pegasus II Facility occupies 1,300 m^2 (14,000 ft^2) of combined laboratory and office space. The building is constructed of prefabricated metal building components (steel columns, sheet metal siding, and masonry brick) on a concrete pad. The lower level (Room 100) houses the experimental area.

No construction or remodeling of the Pegasus II Facility is anticipated under the No Action alternative.

K.2.2.3 Operations

The heart of the Pegasus II Facility is a 4.3 MJ capacitor bank used to deliver a pulse of electrical and magnetic energy to a target. The capacitor bank has eight modules and uses air as the dielectric between the individual capacitors. The Pegasus II Facility is used for up to 24 experiments per year. In a typical experiment, a metal cylinder is placed in the target chamber, diagnostic equipment is attached to the target chamber, and the air in the chamber is pumped out with a vacuum system to form a vacuum condition for the experiment. Operators in Room 100 prepare the power supply system, and personnel are evacuated from the room. Operators in Room 205 open and close switches to charge up the individual capacitors and allow the eight modules to be hooked up in the test configuration. HE detonator switches then fire to transfer energy from the capacitor bank. The 4.3 MJ of energy stored in the capacitor bank discharges as a 12 MA current through a transmission line to the target. The discharge rises in about 6 ms. For experiments which require production of low energy x rays, a special switch ("plasma flow switch") can be placed just before the target to decrease the discharge rise time to only a few tenths of a microsecond.

After each experiment, LANL personnel clean the target chamber of metallic debris and deformed metallic targets. About 5 L (1.3 gal) of ethanol are used per year to clean the target chamber and other parts. Discarded materials generated from each experiment consist mostly of aluminum and copper and oxides of these metals. Any metal parts are salvaged for reuse. About 0.06 m^3 (2 ft^3) of uncontaminated waste (such as paper waste) per month is disposed of at the Los Alamos County Landfill. No hazardous waste is generated.

The detonator switches use a total of 19.2 g (0.672 oz) of HE per experiment, for a total of about 461 g (16.2 oz) per year. All HE is destroyed during detonation. After the test shot is complete, switches are disposed of at the Los Alamos County Landfill.

K.2.3 Alternatives Considered but Eliminated from Further Consideration

The following alternatives were considered but eliminated from further analysis in this project-specific analysis because they fail to meet the purpose and need for DOE action. Failure to meet this purpose and need results from programmatic deficiencies identified in the Stockpile Stewardship and Management PEIS or from technical inadequacies which preclude these alternatives from being reasonable alternatives to the proposed action.

K.2.3.1 Build Atlas at Another DOE Site

DOE considered, but dismissed as unreasonable, the alternative of locating, constructing, and operating the Atlas Facility at a site other than LANL and other than at the Pegasus II Facility. As discussed in section 2.1.1, Atlas would expand the capabilities of the existing Pegasus II Facility through the addition of enhanced pulsed-power and other equipment sufficient to reach the temperatures necessary to ionize materials. Other sites at LANL, as well as other DOE sites which have a hydrodynamic testing infrastructure, do not have the existing special equipment provided by the Pegasus II Facility. Although it would be possible to duplicate this special equipment elsewhere, DOE considers this to be an unreasonably expensive option.

K.2.3.2 Use An Alternate Building at LANL

Under this alternative, DOE would construct and operate the Atlas Facility at a LANL location other than TA-35. The requirements for an alternate site at LANL are the same requirements as those described in section K.2.1.2. Siting and construction of a new building at LANL to house the Atlas Facility would require placement near the 1430-MVA generator building. Additional environmental disturbances from foundation and utility work would occur. Although other existing buildings could fulfill requirement 1, with extensive and costly modifications, none of these sites fulfill requirements 2 to 6. Therefore, this alternative has been eliminated from further consideration.

K.2.3.3 Modify Pegasus II to Conduct Atlas Experiments

Action under this alternative would involve modifying the existing Pegasus II Facility so that it could function at the Atlas Facility power level to meet DOE's purpose and need for action. Currently, the Pegasus II Facility supplies limited data regarding weapons physics, but the facility does not have sufficient energy capability to reach all the conditions required to adequately investigate primary and thermonuclear secondary issues. Modifying the Pegasus II Facility would require extensive expansion of the existing building housing the facility. During this expansion process, which would include construction, procurement, and verification testing, the current Pegasus II operations could not be conducted. The current Pegasus II operations are critical to DOE's existing nuclear weapons stockpile stewardship and management mission. Due to direct conflicts with the existing critical operations of Pegasus II, this alternative does not meet DOE's purpose and need for action.

K.2.3.4 Explosive-Based Pulsed Power Technology

As an alternative to the proposed action, DOE could rely solely on conducting tests using explosive-based pulsed power technology, such as that used by the Procyon generator at LANL. Procyon currently furnishes limited data regarding weapons physics. Although the explosive-based pulsed-power technology would apply to the type of experimental tests needed, this technology can only support a maximum of 12 to 15 experiments per year due to test preparation time constraints, scheduling of detonation, and subsequent site cleanup following detonation. The Agency need for action requires a capability of conducting up to 100 experiments per year. Because of this factor, this alternative has been eliminated from further consideration.

K.3 Affected Environment

This section presents a summary of information regarding the general environmental setting of LANL and the immediate TA-35 site vicinity. More extensive information about the LANL environment is presented in the annual LANL Environmental Surveillance Report (LANL 1994b), as well as LANL's Site-Wide Environmental Impact Statement (DOE 1979).

K.3.1 General Site Setting

LANL and the associated residential and commercial areas of Los Alamos and White Rock are located in Los Alamos County in north-central New Mexico (figure K.3.1-1). LANL facilities cover approximately 560 hectares (1400 acres) of the Federal land managed by DOE in Los Alamos County. The LANL developed area is divided into 30 active TAs for administrative purposes (figure K.2.1.2-1). Unoccupied land area surrounds LANL buildings, providing security, safety buffer zones, and a reserve for future development.

TA-35 is located near the center of Pajarito Mesa, a southeast-trending mesa immediately north and east of Pajarito Canyon in Los Alamos County. Pajarito Road bounds the proposed Atlas Facility site less than 0.8 kilometer (km) (0.5 mile [mi]) to the south, and Pecos Drive bounds the site directly to the north. Although the general public is currently allowed free access to these roads, and Pajarito Road has heavy public traffic, access to all roads in the general site area are DOE-controlled. They can be closed for brief periods as needed. The proposed TA-35 site is surrounded by adjacent TAs -63, -50, -55, -48, -60, and -52. These TAs include facilities conducting a variety of ongoing R&D that may involve use of chemicals and radioactive materials. The site is generally considered highly developed.

Los Alamos County has an estimated population of approximately 18,115 (U.S. Census 1994); the Los Alamos town site has an estimated population of 11,400, and White Rock has an estimated population of 6,800. There is a small, privately owned residential area, Royal Crest Trailer Park, surrounded by LANL property. Royal Crest Trailer Park is situated approximately 1.6 km (1 mi) northwest of the proposed project area with an estimated population of 500 (Morris 1994). The principal population centers are Santa Fe, Espanola, and the Pojoaque Valley located within an 80 km (50 mi) radius of LANL with an approximate population of 214,707 people. Fourteen pueblos are located within a 80 km (50 mi) radius of LANL. The populations of the four closest pueblos are as follows: the San Ildefonso Pueblo has a population of 1,499; the Santa Clara Pueblo has a population of about 3,000; the Cochiti Pueblo has a population of 1,342 people; and the Jemez Pueblo has a population of 1,750 people (Commerce 1991). LANL employs approximately 12,250 people (LANL 1994b) principally living within 80 km (50 mi) of LANL.

K.3.2 Environmental Issues Considered But Dismissed

The following environmental issues were not discussed as part of the affected environment because they either do not exist in the proposed action site vicinity (since the proposed action is in an existing building in a developed area) or neither the proposed action nor the No Action alternative would have any identified effect on these resources:

- Hydrology: surface and groundwater
- Vegetation
- Wildlife (Biotic Resources) -- threatened, endangered and sensitive species, critical habitat, and migratory birds; wild horses and burros; wetlands and floodplains; wild and scenic rivers; coastal or tundra zones
- Cultural and Paleontological Resources
- Land Resources -- mineral and timber resources; prime or unique farmlands
- Socioeconomics
- Water Quality -- drinking water from surface or underground aquifers
- Soils and geology
- Parks, Monuments, Public Recreational Areas
- Site Infrastructure
- Visual Impacts
- Transportation

Under Executive Order 12898, Federal agencies are responsible for identifying and addressing the possibility of disproportionately high and adverse health and environmental impacts of programs and activities on minority (all people of color, exclusive of white non-Hispanics) and low-income (household incomes less than $15,000 per year) populations. Within a 16 km (10 mi) radius of the proposed Atlas site, about 14 percent of the population is of minority status. Within an 80 km (50 mi) radius, about 54 percent of the population is of a minority status. In terms of low-income populations, 8 percent of the households within a 16 km (10 mi) radius have annual incomes below $15,000. Within an 80 km (50 mi) radius of the site, 24 percent of the households have annual incomes below $15,000. Detailed environmental justice information is contained in the *Dual-Axis Radiographic Hydrodynamic Test* (DARHT) *Facility Final Environmental Impact Statement* (EIS) (DOE 1995b)[2] .

TA-35 is situated on top of a mesa in a developed, disturbed area. Any impacts associated with building construction have already occurred and no new impact potential has been identified for the proposed action or the No Action alternative.

K.3.3 Environmental Issues Considered

K.3.3.1 Air Quality

Prevailing winds at LANL are affected by several factors, including large-scale atmospheric wind patterns, regional weather disturbances (thunderstorms and cold fronts), complex surface terrain, and local cold-air drainage across the Pajarito Plateau. Winds in Los Alamos consist of light westerly surface winds that average 2.8 meters per second (m/s) (6.3 miles per hour [mph]). The strongest winds typically occur between March and June, when intense seasonal storms and cold fronts move through the region. During this season, sustained winds blow from the southwest to the northeast and can exceed 11 m/s (25 mph), with peak gusts exceeding 22 m/s (50 mph). Historically, no tornadoes have been reported to have touched down in Los Alamos County. Strong dust devils can produce winds up to 34.4 m/s (77 mph) at lower elevations in the area. The irregular terrain at Los Alamos affects wind motion and spreading. Localized wind gusts may not be in the same direction as average wind patterns. The wind behavior results in greater dilution of air contaminants that are released into the atmosphere.

Air quality in the LANL area is typical of arid-climate clean air. Median visibility ranges between 106 and 161 km (66 and 100 mi). The New Mexico Environment Department under the Environmental Protection Agency designated the LANL area as an air quality attainment area under the *Clean Air Act* or National Ambient Air Quality Standards in which all regulated ambient air quality standards are to be met. These standards apply to the following air emissions: total suspended particulates (TSP), particulate matter less than or equal to 10 microns in diameter (PM *10*), sulfur dioxide, total reduced sulfur, hydrogen sulfide, carbon monoxide, and nitrogen oxides (New Mexico Environmental Improvement Board [NMEIB] 1981). Current emissions from operations around the proposed project site are within the required and existing permitted thresholds for LANL.

K.3.3.2 Human Health

As part of ongoing operations at LANL, several TAs, including TA-35 and those in close proximity to it, have facilities that conduct experiments involving electrical hazards and the generation of magnetic fields and x rays. Ongoing experiments and operations are conducted according to strict guidelines established by existing LANL standard operating procedures. Under these standard operating procedures, engineering and administrative controls are implemented to minimize worker and public exposure to electrical hazards, magnetic fields, and x rays. The magnitude of electrical hazards and x rays present from these experiments is regulated by Occupational Safety and Health Administration standards implemented under specific DOE orders. In addition, magnetic field threshold limit values have been developed as guidelines by the American Conference of Governmental Industrial Hygienists.

Generation and potential exposure to x rays is closely monitored under the implementation of existing health and safety requirements for maintaining worker exposure to as low as reasonably achievable standards, but not to exceed the current threshold of 5 rem per year. Magnetic fields are generated by the NHMFL at TA-35. These fields will not be additive to the fields produced during the charging of the Atlas capacitor bank because only one application can be conducted at a time. The public exposure to static magnetic fields in the TA-35 area is much less than the current pacemaker warning limit (10 G). Members of the public receive less than a 0.1 rem dose from x-ray sources generated in the TA-35 area or less than the admissible dose under DOE orders regulating public exposure to radiation.

K.3.3.3 Waste Management Facilities

RCRA-regulated hazardous chemical waste management is conducted at TA-54, Area L. TA-54, Area J, has a landfill dedicated to administratively controlled sanitary, non-hazardous wastes. All other sanitary waste is disposed in the Los Alamos County Landfill located near TA-3 along West Jemez Road.

K.4 Environmental Consequences

Neither the proposed action nor the No Action alternative would pose a disproportionate adverse health or environmental effect on minority or low-income populations within an 80 km (50 mi) radius of the proposed site.

K.4.1 Environmental Issues Considered

A summary of environmental issues is presented in table K.4.1-1. A discussion of the issues associated with the proposed action and the No Action alternative follows in the succeeding paragraphs.

Table K.4.1-1.-- Environmental Issues Considered for Normal Operations/ Accidents

Issue	Proposed Action Alternative	No Action Alternative
Air Quality	Potential impacts discussed in appendix section K.4.2.1. Per experiment: minor metals (copper, aluminum, gold [less than 1 g]); and solvent (1.5x103 g ethanol) air emissions. Occasional small (<30 g) quantities of isopropyl alcohol, trichloroethylene and 1,1,2-trichloroethane may also be used as solvents.	Potential impacts discussed in appendix section K.4.3.1. Per experiment: minor metals (same as proposed action for copper and aluminum, no gold used), solvent (18.1 g ethanol), and high explosive (12.7 g carbon monoxide, 34.0 g nitrogen

		oxides, 95.2 g PM$_{10}$, 0.91 g volatile organic compounds, all per year) air emissions.
Human Health	No radioactive materials; potential health effects of electricity, magnetic fields, x rays discussed in appendix sections K.4.2.2 (normal operations) and K.4.4 (accidents).	No radioactive materials; potential health effects of electricity, magnetic fields, x rays discussed in appendix sections K.4.3.2 (normal operations) and K.4.4 (accidents).
Waste	Disposal of uncontaminated construction waste (15.3 m3), other uncontaminated, nonhazardous solid waste, such as paper, dielectric insulation, etc. (7 m3 per year), and small amounts (<1 m3 annually) of liquid or solid hazardous waste would be generated by occasional experiments involving lead or other simulant materials. Within normal scope of LANL waste management activities, appendix section K.4.2.3.	Disposal of uncontaminated, nonhazardous solid waste, such as paper and dielectric insulation, etc. (0.7 m3 per year), within normal scope of LANL waste management activities, appendix section K.4.3.3.

K.4.2 Proposed Action

K.4.2.1 Air Quality

The air emissions expected due to operations at the Atlas Facility are presented in table K.4.2.1-1, along with the health-based New Mexico Air Quality Control Regulations (AQCR) 702-regulated levels. All expected emissions generated during normal operations would be below current regulatory levels. No permitting would be required under AQCR 702 or under the National Emission Standards for Hazardous Air Pollutants (NESHAP). No use of facility air filters or scrubbers would be required. Most of the metal targets used during experiments would vaporize and deposit onto the inside surface of the target chamber. Only minute quantities of metals would stay volatilized. Other nonradioactive heavy metals may also be used, but the metals listed in table K.4.2.1-1 are representative of any metals that would be used. The majority of the ethanol used for cleaning would evaporate. Small amounts of hazardous chemicals such as isopropyl alcohol, trichloroethylene and 1,1,2-trichloroethane may occasionally be used as cleaning solvents and would also evaporate. The quantity of air emissions as shown in table K.4.2.1-1 would not harm workers, collocated workers (those at TA-35 but not involved with the Atlas project), or members of the public. Small amounts of dust would be generated due to outdoor excavation activities. Standard dust suppression techniques, such as watering, would be used as needed.

Table K.4.2.1-1.-- Air Emissions from the Atlas Facility

Constituent	Calculated Emissions[3]	AQCR 702 Limit
Aluminum	less than 1 g (0.0022 lb)	0.133 lb/hr
Copper	less than 1 g (0.0022 lb)	0.0133 lb/hr
Gold	less than 1 g (0.0022 lb)	0.42 lb/hr
Ethanol	less than 1.5x10 *3* g[4] (3.3 lb)	10 lb/hr
Isopropylalcohol	less than 30 g[5]	65.3 lb/hr
Trichloroethylene	less than 30 g [5]	18.01 lb/hr
1,1,2-Trichloroethane	less than 30 g[5]	3 lb/hr

K.4.2.2 Human Health

This section presents potential health hazards to site workers, collocated workers, and the general public during normal operations of the Atlas Facility experiments. The identified hazards to human health are electrical hazards, magnetic field hazards, and radiological hazards.

Electrical. Normal operations at the Atlas Facility during conduct of experiments would include electrical hazards to researchers, technicians, and other Atlas Facility personnel because the capacitors associated with Atlas would be charged to a high-voltage. The Atlas capacitor bank could deliver an instantaneous lethal current if special operating precautions are not taken. To minimize electrical risks associated with Atlas experiments, all applicable electrical codes specified by DOE Order 6430.1A (such as adequate grounding and lightening protection) would be incorporated into the Atlas capacitor bank and facility and related electrical components. In conjunction with meeting local electrical codes and DOE Order requirements, the Atlas capacitor bank would be isolated in an interlocked room where access would be controlled. During the actual charging, discharging, and energy release of the system, personnel access to the room would be denied. To aid in assuring no admittance takes place, guards would also be posted at the entrance. Other engineering safety features would be built into the Atlas Facility, such as:

- All switches would be fail-safe; i.e., either a loss of compressed air or electrical power would disengage the switches.
- A direct cut-off to the Atlas Facility systems would be available to the control room operator should the master computer malfunction. The direct cut-off would automatically return systems to their normal fail-safe position.
- Switches could not be operated until all interlocks have been made.
- If an interlock is broken during a charge cycle, shutdown would occur.

These Atlas Facility engineering controls, as well as administrative controls such as personnel training and standard operating procedures, would significantly decrease the probability of an electrical accident occurring during normal operations.

Magnetic Fields. The generator located in Building 301 would be running for 15 to 20 minutes at the beginning of each experiment. The generator would generate magnetic fields during operations of either the Atlas Facility or the NHMFL, but only one operation would be conducted at any one time; therefore, no cumulative impacts to workers would be expected due to magnetic fields resulting from generator operations. The ultimate magnetic field generated would have a frequency dependent on the final rotation speed of the generator (1800 rpm); this frequency would be approximately 60 cycles per second. Workers and members of the public are shielded from the magnetic field by the building's walls, and the generator itself is designed with adequate shielding so that a magnetic field of less than 10 G would exist near the generator. The magnetic field due to the generator would be less than 1 G at Pecos Drive, the nearest public-access roadway, about 75 m (245 ft) from Building 301.

A second source of magnetic field would come from the energy transfer into the inductors' storage coils. During the 3 to 5 seconds that it would take to transfer energy into the inductor, a dc current would be present in the coils of the inductor located on the roof of Building 124. This dc current would have an associated magnetic field of 40,000 G near the coils. There would be a few-second duration magnetic field of less than 10 G at Pecos Drive, which is approximately 33 m (110 ft) from Building 124.

All Atlas Facility workers and nearby collocated workers would be informed of the magnetic hazards associated with individual proposed experiments and those with pacemakers, etc., would be moved to a safe location. Administrative and engineering controls would be in place during experiments to keep magnetic field exposure as low as reasonably achievable. Atlas Facility workers and nearby collocated workers would be exposed to the two magnetic fields during each experiment, for a total of up to 100 times per year. Atlas Facility workers and nearby collocated workers without pacemakers, etc., would not be exposed to more than an instantaneous magnetic field exceeding 500 G.

Magnetic fields of as much as 20,000 G are not considered harmful to individuals who do not have pacemakers or other metallic body inclusions (ACGIH 1993). A magnetic field (such as that produced by the generator) of 1 G can affect some types of cardiac pacemakers; larger fields can also exert a force on suture staples, aneurysm clips, prostheses, etc. Administrative controls, such as exclusion from Buildings 124, 125, and 294 during individual experiments, would be placed on employees with pacemakers or metallic inclusions so that exposure to excessive magnetic levels would be avoided for these individuals. If there is a potential for the public to be exposed to non-static magnetic fields of 1 G or more generated during experiments, warning signs and other administrative controls (such as road blocks) would be in place prior to operation of the Atlas Facility for conduct of those experiments. Magnetic fields would be monitored at various locations at and near the Atlas Facility during experiments to ensure that these levels are not exceeded.

Radiological. The Atlas Facility experiments would utilize a target chamber which would have walls of stainless steel 2.54 cm (1 in) thick, twice the thickness of the Pegasus II Facility's target chamber walls. An individual target implosion would produce an estimated one to four MJ of 100 to 200 eV x rays at the time of the experiment. These low-energy x rays are not expected to penetrate the stainless steel target chamber; the energy would be converted into heat and dissipated into the target chambers' walls.

Neither Atlas Facility workers, collocated workers, nor members of the public onsite or offsite would be exposed to these x rays because x rays would be contained within the target chamber and because personnel would be excluded from the area of the target chamber during an experiment. Standard LANL radiological protection procedures would be followed, including standard operating procedures developed for the Pegasus II Facility, and revised as needed.

Diagnostic apparatus used to take x rays of the events occurring during experiments within the target chamber would be located outside the chamber and would use high-energy x rays, similar to medical x rays. The diagnostic apparatus operation would be interlocked to the entrances to the target area such that the apparatus would not operate if an exterior door were opened. Existing standard operating procedures and facility shielding would be used to protect workers. In addition, personnel protection staff would conduct surveys in and around the target area to measure radiation produced by the diagnostic x-ray apparatus when they are operated. Additional shielding would be added if needed.

Collocated workers or members of the public, either onsite or offsite, would not be exposed to high-energy x rays. These x rays would be shielded and contained within the interlocking room housing the capacitor bank.

K.4.2.3 Waste Management Facilities

Uncontaminated waste (such as paper waste and dielectric insulation), expected to be about 7 m *3* (240 ft *3*) per year, would be disposed of at the Los Alamos County Landfill. The landfill would not require expansion due to the waste generated by the Atlas Facility. For purposes of this analysis it is assumed that a small amount (<1m3 annually) of liquid or solid hazardous waste would be generated by occasional experiments involving lead or other simulant materials. This waste would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. Construction waste (about 15.3 m *3* [20 yd *3*]) would be disposed of at the Los Alamos County Landfill.

K.4.3 No Action Alternative

K.4.3.1 Air Quality

The air emissions due to the Pegasus II Facility are presented in table K.4.3.1-1, along with the health-based New Mexico AQCR 702-regulated levels and the AQCR 707 (Prevention of Significant Deterioration)-regulated levels. All emissions are below current regulatory levels. No permitting is required under AQCR 702, AQCR 707, or NESHAP. No special air filtration or scrubber is required for the Pegasus II Facility. Most of the metals would vaporize and deposit onto the inside surface of the target chamber. Only minute quantities of metals would stay volatilized. The majority of the ethanol used for cleaning would evaporate. The quantity of air emissions would not harm workers, collocated workers (those at TA-35 but not involved with the Pegasus II project), or members of the public.

Table K.4.3.1-1.-- Air Emissions from the Pegasus II Facility

Constituent	Calculated Emissions[6]	AQCR 702/707 Limits
Aluminum	less than 1 g (0.0022 lb)	0.133 lb/hr
Copper	less than 1 g (0.0022 lb)	0.0133 lb/hr
Ethanol	18.1 g (0.04 lb)	10 lb/hr
High Explosives[7]	12.7 g (0.028 lb) carbon monoxide 34.0 g (0.075 lb) nitrogen oxides 95.2 g (0.21 lb) particulate matter 10 microns or smaller 0.91 g (0.002 lb) volatile organic compounds	200,000 lb/yr 40,000 lb/yr 25,000 lb/yr 40,000 lb/yr

K.4.3.2 Human Health

Electrical. Normal operations during conduct of experiments at the Pegasus II Facility present electrical hazards to researchers, technicians, and other Pegasus II Facility personnel because the Pegasus II capacitor bank is charged to a high voltage. The Pegasus II capacitor bank could deliver an instantaneous lethal current if special precautions are not taken during experiments. Engineering controls and administrative controls the same as or similar to those described for the proposed Atlas Facility, such as interlocked rooms, fail-safe switches, standard operating procedures, and direct cut-offs, significantly decrease the probability of an electrical accident occurring during normal operations.

Magnetic Fields. Magnetic fields are not generated during the conduct of experiments under the No Action alternative; power for charging the Pegasus II capacitor bank is obtained from the existing LANL electrical power grid and does not require the use of a separate facility power generator.

Radiological. Experiments conducted at the Pegasus II Facility produce up to 0.2 MJ of low-energy x rays, 10 percent of the level expected during the same type of experiment from the proposed Atlas Facility (2.0 MJ). Operating experience has demonstrated that these low-energy x rays do not penetrate the target chamber. Neither Pegasus II Facility workers, collocated workers, nor members of the public either onsite or offsite would be exposed to x rays from continuing to operate the Pegasus II Facility experiments.

K.4.3.3 Waste Management Facilities

About 0.7 m3 (24 ft3) of uncontaminated waste (such as paper waste and dielectric insulation) per month is disposed of at the Los Alamos County Landfill. No RCRA-regulated hazardous waste is generated.

K.4.4 Impacts Associated With Accidents

This section considers bounding case accidents that could be associated with the operation of the Atlas Facility that could affect site workers, collocated workers, the public, and the environment. Accidents with the highest consequence to workers have the likelihood of occurring once in 100 years. Accidents with the highest consequence to collocated workers, the public, and the environment have the likelihood of occurring once in 10,000 years. This information is summarized in section K.7. Other accident scenarios are contained within the Preliminary Hazard Analysis for the proposed Atlas project (LANL 1995). Accidents analyzed in this project-specific analysis are summarized in table K.4.4-1.

Table K.4.4-1.-- Accidents Analyzed

Accidents	Likelihood of Event	Worst Consequence

Worker Mechanical collapse of crane; High-energy power source electrocution	Less than 1 in 100 years	Serious worker injury or death
Collocated worker Fire resulting from capacitor bank failure and release of smoke and sprinkler system water	Less than 1 in 10,000 years	Irritation or discomfort but no permanent health effects
Public Fire resulting from capacitor bank failure and release of smoke and sprinkler system water	Less than 1 in 10,000 years	Irritation or discomfort but no permanent health effects
Environment Fire resulting from capacitor bank failure and release of smoke and sprinkler system water	Less than 1 in 10,000 years	Release of smoke and effluent discharge containing sprinkler system water and mineral oil

LANL 1995.

K.4.4.1 Site Worker

The bounding case accident for a site worker involves electrocution from a high-energy power source or mechanical collapse of the overhead crane. Of these scenarios, both have an equal likelihood of occurrence. The impact to a site worker in these scenarios could be death; however, the likelihood of occurrence is less than once in 100 years of operation.

K.4.4.2 Collocated Worker

The most likely accident scenario that could result in an impact to collocated workers involves exposure to emissions and effluents from a capacitor bank fire. In this scenario, a collocated worker would receive minimal exposure to smoke and sprinkler system water containing mineral oil spilled from a Marx module. The impact to a collocated worker in this scenario would be temporary irritation and discomfort; however, the likelihood of occurrence is less than once in 10,000 years of operation. In the event of a fire, all site and collocated workers would be evacuated immediately.

K.4.4.3 Public

The most likely accident scenario that could result in an impact to the public involves exposure to emissions and effluents from a capacitor bank fire. In this scenario, a member of the public could receive minimal exposure to smoke. The impact to a member of the public in this scenario would be less than that experienced by a collocated worker. Exposure to smoke could result in very mild and temporary irritation and discomfort. The likelihood of this accident occurring is less than once in 10,000 years of operation. In the event of a fire, all members of the public would be evacuated from the site area immediately and road closures and exclusion zones would be implemented, as appropriate. Based on the accident scenario and impact analysis in section K.7, there are no probable accidents which would result in an adverse impact to the public.

K.4.4.4 Environment

The bounding case accident scenario that could result in an impact to the environment involves the release of emissions and effluents from a capacitor bank fire. In this scenario, smoke and sprinkler water containing spilled mineral oil could be released to the environment. The impact to the environment in this scenario would be temporary and minimal. Smoke from a fire in this scenario would disperse quickly and the sprinkler water containing mineral oil would be contained by site soils and controlled drainage systems. Water containing mineral oil does not present a serious environmental concern given the nonhazardous nature of mineral oil, and in the event of a fire, spill prevention control measures would be implemented immediately. The likelihood of such an accident occurring under normal operating conditions is once in 10,000 years.

K.5 Agencies and Persons Consulted

No external agencies or persons were consulted for the project-specific analysis of the proposed Atlas Facility.

K.6 Permit Requirements

No external regulatory or permit requirements have been identified for the Atlas Facility.

K.7 Supplementary Information: Accidents

Tables K.7-1 and K.7-2 provide a summary of the types of hazards and scenarios that could result in impacts to the public, environment, collocated worker or the facility worker. Listed in table K.7-2 are the risk ranks resulting from the likelihood and consequence of a given scenario and hazard.

Table K.7-1.-- Hazard Sources for Atlas Preliminary Hazard Assessment Chart

Electricity	-High voltage current -Static electricity
Radiant energy	-Electromagnetic fields
Radiation	-X rays
Mechanical structures	-Failure and collapse of critical structural assemblies -Leaks from storage tanks
Chemicals	-Toxic materials -Flammable materials -Asphyxiant gas
Implosion/ explosion	-Target chamber malfunction
Fire	-Mechanical/electrical malfunction -Target chamber malfunction

LANL 1995; Model results.

Table K.7-2 shows that the highest consequence of any Atlas hazard scenario would have the greatest impact on the facility worker (Column 5, Impact on Worker). This is indicated by three hazards (radiation, mechanical structures, and fire) showing a risk ranking factor of two. The other impact receptors (e.g., collocated worker or environment) all have maximum risk ranks of 3 which means that risks are acceptable with sufficient controls and safeguards in place. Information charts on the following pages of this project-specific analysis have been provided to present the methodologies used to determine risk categories, probabilities, consequences, and requirements for risk mitigation during the typical preliminary hazard assessment process. The final preliminary hazard assessment risk reduction recommendations would be incorporated into the project design or in the project standard operating procedures.

Table K.7-2.-- Summary of Hazards and Impacts with Risk Ranks from the Atlas Preliminary Hazard Assessment

Hazard	Scenario	Impact on Public (Risk Rank)	Impact on Collocated Worker (Risk Rank)	Impact on Worker (Risk Rank)	Impact on Environment (Risk Rank)	Highest Consequence (Risk Rank)
Electricity	Access Breach	No	No	Yes (3)	No	Potential fatality
Radiant energy (EMF)	Inadvertent access of personnel to roof during charging	No	No	Yes (3)	No	Potential exposure of personnel to EMF
Radiation (x rays)	Implosion of experiment	No	Yes (4)	Yes (2)	No	Potential exposure of facility/ collocated workers
Mechanical structures	Failure and collapse of critical structures	No	No	Yes (2)	No	Potential worker injury/ fatality
Mechanical structures	Leaks from storage tanks	No	No	No	Yes (3)	Release of untreated fire suppression water
Chemicals	Marx tank oil leak	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Mineral oil is leaked to the facility and possibly to the environment

Chemicals Asphyxiant	Sulfur hexafluoride resupply hose leaks	No	No	No	Yes (3)	Sulfur trifluoride vaporizes and escapes; Potential exposure of facility/co-located workers
Explosion	Capacitor explodes	No	No	Yes (3)	No	Debris and mineral oil released to facility, possible worker injury
Implosion	Target chamber malfunction	No	No	No	No	Loss of vacuum and operational capability
Fire	Generator fire during power generation	No	No	Yes (3)	No	Worker injury from inhalation of fire combustion products
Fire	Marx generator capacitor banks fail	Yes (3)	Yes (3)	Yes (2)	Yes (3)	Fire in capacitor banks, potential injury to facility worker

Consequence Likelihood Categories

I (1 to 0.1)	Normal Operations: Frequency as often as once in 10 operating years or at least once in 10 similar facilities operated for 1 year.
II (0.1 to 0.01)	Anticipated Events: Frequency between 1 in 10 years and 1 in 100 years or at least once in 100 similar operating facilities operated for 1 year.
III (10^{-2} to 10^{-4})	Unlikely: Frequency between 1 in 100 years and 1 in 10,000 years or at least once in 10,000 similar facilities operated for 1 year.

IV (10^{-4} to 10^{-6})	Very Unlikely: Frequency between 1 in 10,000 years and once in 1 million years or at least once in a million similar facilities operated for 1 year.
V	Improbable: Frequency of less than once in a million years.

EMF - electromagnetic force.

LANL 1995.

Consequence Severity Categories, Maximum Possible Consequence

Category	Public	Collocated Worker	Worker	Environment
A	Immediate health effects	Immediate health effects	Loss of life.	Substantial offsite contamination
B	Long-term health effects	Long-term health effects	Severe injury or disability.	Substantial contamination of originating facility/activity, minor onsite contamination; no offsite contamination.
C	Irritation or discomfort but no permanent health effects	Irritation or discomfort but no permanent health effects	Lost-time injury but no disability	Minor or no contamination of originating facility/activity; no offsite contamination
D	No substantial offsite release	No substantial offsite effect	Minor or no injury and no disability	Minor or no contamination of originating facility/activity; no offsite contamination

Offsite: Public, private, or Indian lands that are not part of Laboratory property; Onsite: Laboratory property but not necessarily the originating technical area; Facility: Originating technical area of the Laboratory.

Risk Ranking Matrix

Likelihood of Consequence

Severity of Consequence	**I**	**II**	**III**	**IV**	**V**
A	1	1	2	3	3
B	1	2	2a	3	4
C	2	3	3	4	4
D	3	4	4	4	4

a Assign risk rank of 3 if severity category rank of B is based upon worker injuries and offsite consequence severity is less than B.

Risk Rank	Recommendation
1	Unacceptable: Should be mitigated to risk rank 3 or lower as soon as possible.
2	Unacceptable: Should be mitigated to risk rank 3 or lower within a reasonable time period.
3	Acceptable with Controls: Verify that procedures, controls, and safeguards are in place.
4	Acceptable as is: No action is necessary.

Further information may be found in the preliminary hazard assessment for Atlas (LANL 1995).

K.8 Glossary

Angstrom (Å): Unit of length equal to 1x10-10 meter.

Dielectric: A nonconductor of electric current.

Electrolyte recirculation system: A water circulation system with salt additives which is used for controlling resistance near the capacitors.

Electron volt (eV): The energy equivalent (1.602x10-19 Joules) of an electron passing through a voltage differential of 1 volt.

Environmental impact statement: A document required by the *National Environmental Policy Act*

(NEPA) of 1969, as amended, for proposed major Federal actions involving potentially significant environmental impacts.

Foil implosion: To burst inward; i.e., the effect of applying large doses of electrical current to a thin walled cylinder.

Gauss (G): Unit of magnetic induction in the electromagnetic and Gaussian systems of units. Equal to 1 maxwell (measure of magnetic flux through an area) per square centimeter.

High-energy pulsed-power: A technique used in compressing electrical energy and storing it at high levels and then releasing it to a target in a very short time period.

High-energy x ray: An x ray in the 0.03 to 1 Angstrom wavelength range (e.g., medical x rays).

High explosives: Any chemical compound or mechanical mixture that, when subjected to heat, impact, friction, shock, or other suitable initiation stimulus, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressures in the surrounding medium; the term applies to materials that detonate.

Joule: Unit of energy equivalent to one watt-second.

Low-energy x ray: An x ray in the 1 to 10 Angstrom wavelength range. Low-energy x rays do not have enough energy to penetrate a sheet of paper.

Marx modules: Assemblage of electric capacitors charged in parallel and discharged in a series are said to be of a "Marx Configuration."

Megajoule (MJ): One million joules which is a measure of energy or work in the meter-kilogram-second system of units, equal to 1 Newton.

Micron: A unit of length equal to one-millionth of a meter; one meter equals 3.2 feet.

National Emission Standards for Hazardous Air Pollutants: Hazardous air pollution standards established through the *Clean Air Act* , as amended.

Plasma flow switch: An electrical switch used to open a circuit through the use of ionized gas (plasma).

Prevention of Significant Deterioration: Refers to provisions in the *Clean Air Act* , as amended, and state air quality regulations, to ensure that an area in attainment with the National Ambient Air Quality Standards will stay in attainment.

Rem: Roentgen equivalent man; unit for measuring radiation dose equivalence. The rem takes into account the energy absorbed (dose) and the biological effect on the body (quality factor) due to the different types of radiation.

Resource Conservation and Recovery Act of 1976: Establishes a comprehensive "cradle-to-grave" approach to the regulation of hazardous waste. Also establishes a framework for instituting corrective action for releases of hazardous wastes.

Reynolds Number: A dimensionless numerical value relating fluid density and viscosity to particle size and relative velocity.

Roentgen: A unit of exposure to ionizing x- or gamma radiation equal to or producing one electrostatic unit of charge per cubic centimeter of air.

Science-based stockpile stewardship: DOE program to develop a new approach, based on scientific understanding and expert judgment, to ensure continued confidence in safety, performance, and reliability of the nuclear weapons stockpile.

SOP: *Standard operating procedures; written and authorized procedures for conducting an activity.*

Special facilities equipment (SFE): An assemblage of high power electrical equipment and systems to support Atlas (i.e., target chamber, vacuum equipment, etc.).

Swale: A low-lying stretch of land where water could collect or puddle.

Threshold limit value: Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects.

K.9 References

ACGIH 1993: American Conference of Governmental Industrial Hygienists, "1993-1994 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices," Cincinnati, OH, 1993.

Commerce 1991: U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Census, "1990 Census of Population and Housing: Summary Population and Housing Characteristics - New Mexico," 1990-CPH-1-33, August 1991.

DOE 1979: U.S. Department of Energy, "Final Environmental Impact Statement: Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico," DOE/EIS-0018, 1979.

DOE 1995a: U.S. Department of Energy, "Notice of Intent to Prepare a Programmatic Environmental Impact Statement for the Stockpile Stewardship and Management Program," Office of Reconfiguration, U.S. Department of Energy, Alexandria, VA, Federal Register, June 6, 1995.

DOE 1995b: U.S. Department of Energy, "Final Environmental Impact Statement: Dual Axis Radiographic Hydrodynamic Test Facility," DOE/EIS-0228, August 25, 1995.

LANL 1991: Los Alamos National Laboratory, "Preliminary Hazard Analysis for Pegasus II," Los Alamos, NM, September 1991.

LANL 1994a: Los Alamos National Laboratory, "Conceptual Design Report for Atlas," Los Alamos, NM, April 1994.

LANL 1994b: Los Alamos National Laboratory, "Environmental Surveillance at Los Alamos During 1992," Report LA-12764-ENV, 1994.

LANL 1995: Los Alamos National Laboratory, "Preliminary Hazard Analysis for the Atlas Project," Los Alamos, NM, September 1995.

Morris 1994: Telephone conversation with D. Morris, co-owner of Royal Crest Trailer Park, June 16, 1994.

NMEIB 1981: New Mexico Environmental Improvement Board, "Air Quality Control Regulation 201: Ambient Air Quality Standards," June 15, 1981.

U.S. Census 1994: U.S. Bureau of the Census, "County and City Data Book: 1994," Washington, DC.

1

1 megajoule is 0.28 kilowatt-hrs of electricity.

2

The DARHT Final Environmental Impact Statement was issued on August 25, 1995. The Record of Decision for DARHT was issued on October 11, 1995.

3

Amount calculated is per experiment using that specific type of metal or cleaning solvent. Any emissions would occur after the target chamber is repressurized to ambient pressure and temperature.

4

Scientific notation (see glossary for explanation).

5

Total for isopropyl alcohol, trichloroethylene, and 1,1,2-trichloroethane.

Model results; NMEIB 1981.

6

Amount calculated is per experiment using that specific type of metal. Any emissions would occur after the target chamber is repressurized to ambient pressure and temperature.

7

Emissions due to high explosives are calculated for one year, not per experiment.

Model results; NMEIB 1981; 40 CFR 52.21.