RFI Work Plan for Operable Unit 1130

Environmental Restoration Program

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A Department of Energy
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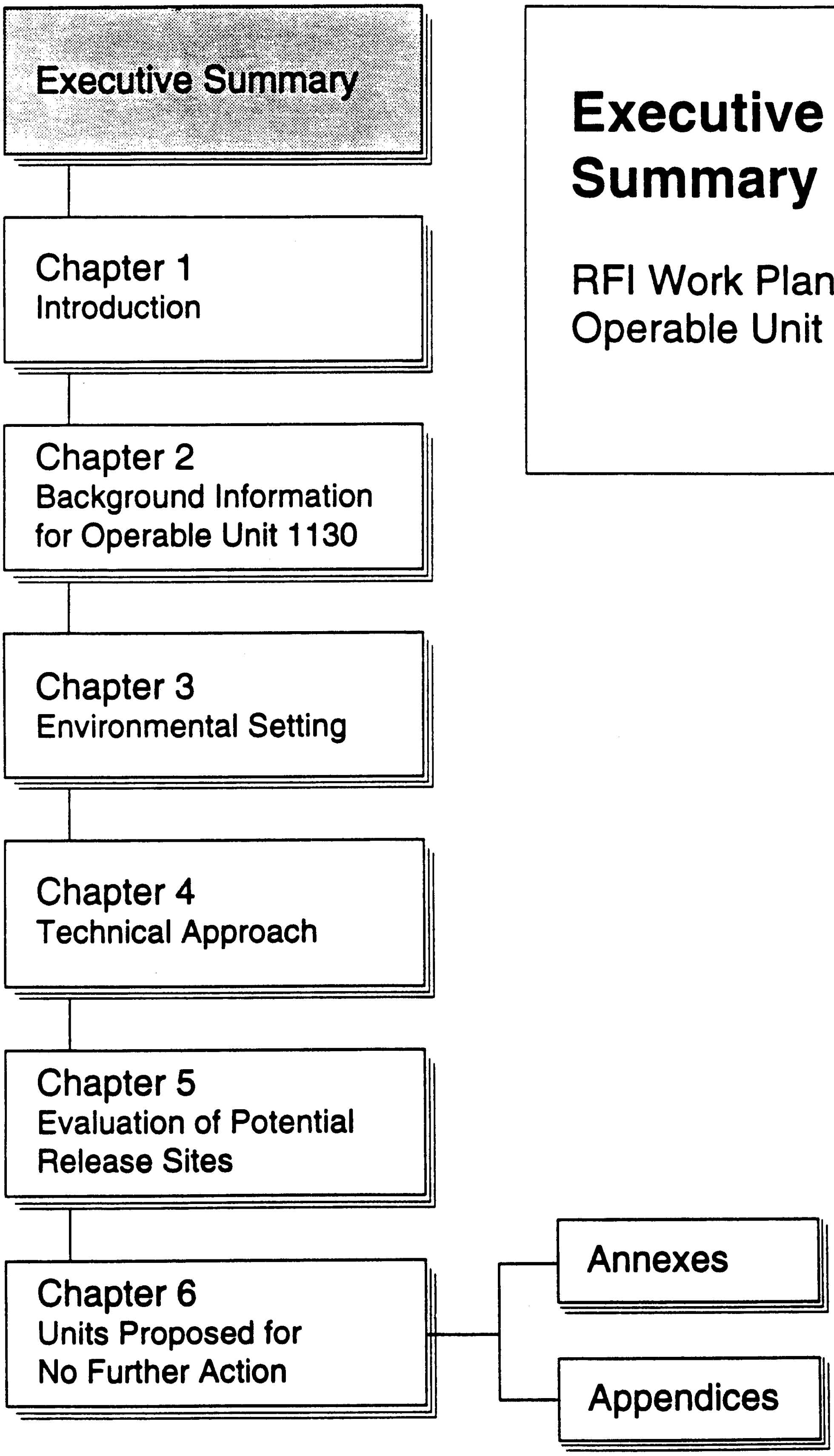
Executive Summary

RFI Work Plan for Operable Unit 1130



EXECUTIVE SUMMARY

Purpose

The primary purposes of this Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) work plan are to determine the nature and extent of releases of hazardous wastes or hazardous constituents from solid waste management units (SWMUs) in Operable Unit (OU) 1130 and to determine the need for corrective measures studies (CMSs). This work plan also satisfies the regulatory requirements contained in Los Alamos National Laboratory's (the Laboratory's) permit to operate under RCRA. Module VIII of the permit, known as the Hazardous and Solid Waste Amendments (HSWA) Module, was issued by the Environmental Protection Agency (EPA) to address potential corrective action requirements for SWMUs at the Laboratory. OU 1130 comprises technical areas (TAs) -36, -68, and -71, all of which are on land controlled by DOE in Los Alamos County in northcentral New Mexico. These permit requirements are addressed by the Department of Energy's (DOE's) Environmental Restoration (ER) Program at the Laboratory. This work plan describes the sampling plans that will be followed to implement the RFI at OU 1130. This work plan, together with nine other RFI work plans submitted to the EPA in May 1993 and the work plans already submitted by the Laboratory, meet the HSWA Module requirement to address a cumulative percentage of the Laboratory's SWMUs in RFI work plans by May 23, 1993.

Installation Work Plan

The HSWA Module required the Laboratory to prepare an installation work plan to describe the Laboratory-wide system for accomplishing the RFI and CMSs. The Installation Work Plan for Environmental Restoration (IWP) was originally submitted to the EPA in November 1990; it is updated annually, and the most recent revision was published in November 1992. The IWP identifies the Laboratory's potential release sites (PRSs), describes their aggregation into 24 OUs, and presents the Laboratory's overall management plan and technical approach for meeting the requirements of the HSWA Module. When information relevant to this work plan has been provided in the IWP, the reader is referred to the 1992 version.

This work plan addresses PRSs that may contain radioactive materials and hazardous substances not subject to RCRA regulations. Sites that potentially contain only non-RCRA materials are called areas of concern (AOCs). The term PRS is the inclusive term for both SWMUs and AOCs. It is understood that the language in this work plan pertaining to subjects outside the scope of RCRA is not applicable to the Laboratory's operating permit.

Background

TA-36 is an active unit that has been used for explosives detonation testing since it was established in the late 1940s. TAs -68 and -71 are considered buffer areas and have not been used for Laboratory operations. They are not SWMUs, but they may receive firing site debris, particularly TA-68.

OU 1130 borders TA-15 on the northwest. To the northeast, it is bounded by TA-18 and Pajarito Road. On the south and east, it extends past State Road 4 and borders the community of White Rock. It also shares the boundary with TA-39 to the west. OU 1130 straddles Potrillo Canyon, and is bounded to the north by Pajarito Canyon and to the south by Water Canyon. Topography is rugged, characterized by narrow mesa tops separated by long, narrow canyons. The differences in elevation range from 100 ft to approximately 1,510 ft between the mesas and the canyons. The entire OU is underlain by volcanic deposits comprising the Bandelier Tuff, which outcrops along the sides of the nearly vertical canyon walls. Precipitation or snowmelt causes ephemeral streamflow in Potrillo, Pajarito, Fence, and Water Canyons and their respective tributaries. There is no evidence that this water enters the deep groundwater aquifer.

There are 25 PRSs identified at OU 1130. They are all at TA-36 and include six SWMUs that are listed in the HSWA Module. The SWMUs listed in the HSWA Module consist of a material disposal area [36-001], a sump (36-002), three septic systems [36-003(a), 36-003(b), and 36-003(c)], and a boneyard (surface storage area for large waste items) (36-005). The other PRSs include five active firing sites, a surface disposal area, a septic system, several satellite storage areas, a portable chamber used for confining shots, and a bazooka impact area. The chamber used for confining shots has been subjected to previous decontamination activities. The potential contaminants of concern include depleted uranium, mercury, lead, beryllium, chromium, barium, other metals, explosives, and organic compounds.

Previous investigations have included surface radiological surveys, soil sampling at various sites, and a study of uranium transport in the Potrillo watershed, which is the drainage area for most of the firing sites. Ten PRSs have been identified as requiring no further action (NFA). The NFAs include six satellite storage areas, two septic systems, a magazine, and a surface disposal area.

Technical Approach

For the purposes of designing and/or implementing the sampling and analysis plans described in this work plan, a few PRSs (e.g., the active firing sites) are grouped into aggregates. Most of the PRSs, however, are investigated individually as necessary. This work plan presents the description and operating history of each PRS or aggregate, together with an evaluation of the existing data (if any), to develop a preliminary conceptual exposure model for the site. On the basis of this review, NFA was proposed for ten sites; these sites are discussed in Chapter 6. The units that are proposed for NFA consist of septic systems [36-003(c) and 36-003(d)], Moe magazine 36-004(f), satellite storage areas [36-007(a), 36-007(b), 36-007(c), 36-007(d), 36-007(e) and 36-007(f)], and the surface disposal area (C-36-002). For active sites, this review is sufficient to determine that investigation and remediation (if required) may be deferred until the site is decommissioned; these sites are discussed in Section 5.4. The remaining sites for which RFI field work and/or voluntary corrective actions are proposed are also discussed in Chapter 5.

The technical approach to field sampling followed in this work plan is designed to refine the conceptual exposure models for the PRSs or aggregates to a level of detail sufficient for baseline risk assessment and the evaluation of remedial alternatives (including voluntary corrective actions). A phased approach to the RFI is used to ensure that any environmental impacts associated with past and present activities are investigated in a manner that is cost-effective and that complies with the HSWA Module. This phased approach permits intermediate data evaluation with opportunities for additional sampling, if required.

For PRSs in which there are insufficient data and little or no historical evidence that a release may have occurred, the Phase I sampling strategy will consist of reconnaissance sampling of the areas most likely to have been contaminated to find possible release sites. If hazardous or radioactive contaminants are detected at concentrations above screening action levels, it may be necessary to perform a baseline risk assessment or a CMS to assess the need for further corrective action, or a voluntary corrective action may be proposed. If conducted, the baseline risk assessment will be used to determine the need for further corrective action. If the data collected during Phase I are insufficient to support a baseline risk assessment, additional RFI Phase II sampling will be undertaken to characterize the nature and extent of the release in more detail.

For some PRSs in OU 1130, there are existing data and/or strong historical evidence to support the hypothesis that a release has occurred. In these cases, the existing information has been evaluated to determine whether it is sufficient to support a baseline risk assessment and/or the evaluation of remedial alternatives. If the evidence or data are found to be insufficient, more data will be collected as part of the Phase I investigation to refine the site conceptual exposure model; however, the pathways and human receptors components will not be evaluated during the Phase I investigation.

Data quality objectives, developed for the RFI Phase I sampling and analysis plans, provide means of assuring that the right type, amount, and quality of data are collected. Field work for many sites includes field surveys, and field mobile laboratory screening of samples on which the selection of samples for laboratory analysis will be based. Sample analyses will be performed primarily in fixed analytical laboratories.

The body of the text in this work plan is followed by five annexes that consist of project plans that correspond to the five program plans listed in the IWP: project management, quality assurance, health and safety, records management, and community relations.

Schedule, Costs, and Reports

The RFI field work described in this document requires 2.5 years to complete. A single phase of field work is expected to be sufficient to complete the RFI for most PRSs; however, a second phase will occur if warranted by the results of the first phase. If a second phase is required, the field work may take longer than 2.5 years to complete.

Cost estimates for baseline activities at OU 1130 are provided in Table ES-1. The estimates for costs and schedule are the latest estimates available from the FY 93 baseline request.

The HSWA Module specifies that monthly reports and quarterly technical progress reports must be submitted. In addition, RFI phase reports will be submitted at the completion of each of the sampling plans. The RFI phase reports will

- summarize the results of initial site characterization activities;
- propose modifications to the sampling plans as suggested by the initial findings;
- recommend either voluntary corrective action, deferred investigation, or no further action (mechanisms for delisting PRSs that are shown by the RFI to have acceptable health-based risk levels);
- summarize the results of sampling; and
- describe the next phase of sampling, when required.

At the conclusion of the RFI, a final RFI report will be submitted to the EPA.

TABLE ES-1

ESTIMATED COSTS OF CONDUCTING RFI OU 1130

Estimate to Complete	$ 9,034,000
Escalation	$ 1,129,000
Prior Years	$ 462,000
Total at Completion	$ 10,625,000

Public Involvement

HSWA mandates public involvement in the corrective action process. Therefore. the Laboratory provides a variety of opportunities for public involvement including holding public meetings (as needed) to disseminate information, discuss significant milestones, and solicit informal public review of draft work plans: distributing fact sheets summarizing completed and future activities; and providing public access to plans, reports, and other ER Program documents. These materials are available for public review at the ER Program's public reading room at 2101 Trinity Drive in Los Alamos between 9:00 a.m. and 4:00 p.m. on Laboratory business days, and at the main branches of the public libraries in Los Alamos, Española, and Santa Fe. Information specific to activities at OU 1130 will be included in the public information sources indicated in Table ES-2.

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ACRONYM AND ABBREVIATION LIST FOR OU 1130 WORK PLAN

ALARA	as low as reasonably achievable
AOC	area of concern
BRET	Biological Evaluation Resource Team
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	corrective measures study
cpm	counts per minute
DOE	Department of Energy
DU	depleted uranium
EBW	exploding bridge wire
EM	environmental management
EPA	US Environmental Protection Agency
ER	environmental restoration
FID	flame ionization detector
FIMAD	Facility for Information Management, Analysis, and Display
FY	fiscal year
HMX	cyclotetramethylene tetranitramine
HSWA	Hazardous and Solid Waste Amendments
IWP	Installation Work Plan
LANL	Los Alamos National Laboratory
MDA	material disposal area
Mya	Million years ago
NFA	no further action
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
OU	operable unit
OUPL	Operable Unit Project Leader
PBX	plastic-bonded explosives
PCB	polychlorinated biphenyl
PETN	pentaerythritol tetranitrate
PID	photo ionization detector
PIXY	pulse-intense x-ray machine
ppm	parts per million
PRS	potential release site
PQL	practical quanitation limit
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDX	cyclonitrite, cyclotrimethylenetrinitramine
RFI	RCRA facility investigation

ACRONYM AND ABBREVIATION LIST FOR OU 1130 WORK PLAN (concluded)

RG	remediation goal
SAL	screening action level
SOP	standard operating procedure
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TA	technical area
TCLP	Toxicity Characteristic Leaching Procedure
TNT	trinitrotoluene
TSD	treatment, storage, and disposal
VCA	voluntary corrective action
VOC	volatile organic compound
XRF	X-ray fluorescence
XTX	extex or extrudable explosives

Executive Summary

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Chapter 2
Background Information for Operable Unit 1130

Chapter 3
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Chapter 5
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Chapter 1

- Statutory and Regulatory Background
- Installation Work Plan
- Description of OU 1130
- Document Organization

1.0 INTRODUCTION

This chapter presents both the statutory and regulatory background for the work plan and relates the work plan to the Installation Work Plan for Environmental Restoration (IWP) (LANL 1992, 0768). A brief description of Operable Unit (OU) 1130 and of the organization of this work plan are also provided.

1.1 Statutory and Regulatory Background

In 1976, Congress enacted the Resource Conservation and Recovery Act (RCRA), which governs the day-to-day operations of hazardous waste treatment, storage, and disposal (TSD) facilities. Sections 3004(u) and (v) of RCRA established a permitting system, which is implemented by the Environmental Protection Agency (EPA) or by a state authorized to implement the program, and set standards for all hazardous-waste-producing operations at a TSD facility. Under this law, Los Alamos National Laboratory (the Laboratory) qualifies as a treatment and storage facility and must have a permit to operate. The state of New Mexico, which is authorized by EPA to implement portions of the RCRA permitting program, issued the Laboratory's RCRA permit.

In 1984, Congress amended RCRA by passing the Hazardous and Solid Waste Amendments (HSWA), which modified the permitting requirements of RCRA by, among other things, requiring corrective action for releases of hazardous wastes or constituents from solid waste management units (SWMUs). EPA administers the HSWA requirements in New Mexico at this time. In accordance with this statute, the Laboratory's permit to operate (EPA 1990, 0306) includes a section, referred to as the HSWA Module, that prescribes a specific corrective action program for the Laboratory. The HSWA Module includes provisions for mitigating releases from facilities currently in operation and for cleaning up inactive sites. The primary purpose of this RCRA field investigation (RFI) work plan is to determine the nature and extent of releases of hazardous waste and hazardous constituents from potential release sites (PRSs). The plan meets the requirements of the HSWA Module and is consistent with the scope of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The HSWA Module lists SWMUs, which are defined as "any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste." Table A of the HSWA Module identifies 603 SWMUs at the Laboratory, and Table B lists SWMUs that require prompt investigation. In addition, the Laboratory has identified areas of concern (AOCs) that do not meet the HSWA Module's definition of a SWMU. AOCs may contain radioactive materials and hazardous substances not listed under RCRA. SWMUs and AOCs are collectively referred to as PRSs. The ER Program uses the mechanism of recommending no further action (NFA) for AOCs and SWMUs; however, using this approach for AOCs does not imply that AOCs fall under the jurisdiction of the HSWA Module. Except where the term SWMU is a direct quotation from the permit or SWMU reports, PRS will be used for both AOCs and SWMUs in this work plan.

For the purposes of implementing the cleanup process, the Laboratory has aggregated all PRSs into 24 geographically related OUs and has developed a RCRA facility investigation (RFI) work plan for each one. This work plan addresses the PRSs for OU 1130, which includes Laboratory technical areas (TAs) -36, -68, and -71. The primary purpose of this RFI work plan is to determine the nature and extent of releases of hazardous waste and hazardous constituents from PRSs. This plan meets the requirements of the HSWA Module and is also consistent with the scope of CERCLA.

As more information is obtained, the Laboratory proposes modifications in the HSWA Module for EPA approval. While applications to modify the permit are pending, the Environmental Restoration (ER) Program submits work plans consistent with current permit conditions. Once permit modifications are approved, program documents, including RFI reports and the IWP, are updated and phase reports are prepared to reflect the changes.

The HSWA Module outlines five tasks to be addressed in an RFI work plan. Table 1-1 lists these tasks and indicates the ER Program equivalents. Table 1-2 indicates the location of HSWA Module requirements in ER Program documents.

TABLE 1-1

RFI GUIDANCE FROM THE HSWA MODULE

SCOPE OF THE RFI	ER PROGRAM EQUIVALENT	
The RCRA Facility Investigation consists of five tasks:	**LANL Installation RI/FS* Work Plan**	**LANL Task/Site RI/FS**
Task I: Description of Current Conditions	I. LANL Installation RI/FS Work Plan	I. Quality Assurance Project Plan
A. Facility Background	A. Installation Background	A. Task/Site Background
B. Nature and Extent of Contamination	B. Tabular Summary of Contamination by Site	B. Nature and Extent of Contamination
Task II: RFI Work Plan	II. LANL Installation RI/FS Work Plan	II. LANL Task/Site RI/FS Documents
A. Data Collection Quality Assurance Plan	A. General Standard Operating Procedures for Sampling Analysis and Quality Assurance	A. Quality Assurance Project Plan and Field Sampling Plan
B. Data Management Plan	B. Technical Data Management Program	B. Records Management Project Plan
C. Health and Safety Plan	C. Health and Safety Program	C. Health and Safety Project Plan
D. Community Relations Plan	D. Community Relations Program	D. Community Relations Project Plan
Task III: Facility Investigation	III.	III. Task/Site Investigation
A. Environmental Setting		A. Environmental Setting
B. Source Characterization		B. Source Characterization
C. Contamination Characterization		C. Contamination Characterization
D. Potential Receptor Identification		D. Potential Receptor Identification
Task IV: Investigative Analysis	IV.	IV. LANL Task/Site Investigative Analysis
A. Data Analysis		A. Data Analysis
B. Protection Standards		B. Protection Standards
Task V: Reports	V. Reports	V. LANL Task/Site Reports
A. Preliminary and Work Plan	A. LANL Installation RI/FS Work Plan	A. Quality Assurance Project Plan, Field Sampling Plan, Technical Data Management Plan, Health and Safety Plan, Community Relations Plan
B. Progress	B. Annual Update of LANL Installation RI/FS Work Plan	B. LANL Task/Site RI/FS Documents and LANL Monthly Management Status Report
C. Draft and Final	C. Draft and Final	C. Draft and Final

*RI/FS - remedial investigation/feasibility study.

TABLE 1-2

LOCATION OF HSWA MODULE REQUIREMENTS IN ER PROGRAM DOCUMENTS

HSWA MODULE REQUIREMENTS OR RFI WORK PLANS	INSTALLATION WORK PLAN AND OTHER PROGRAM DOCUMENTS	DOCUMENTS FOR OU 1093
Task I: Description of Current Conditions		
A. Facility Background	IWP Section 2.1	
B. Nature and Extent of Contamination	IWP Section 2.4 and Appendix F	
Task II: RFI Work Plan		
A. Data Collection Quality Assurance Plan	IWP Annex II (Quality Program Plan)*	RFI Work Plan Annex II
B. Data Management Plan	IWP Annex IV (Records Management Program Plan)	RFI Work Plan Annex IV
C. Health and Safety Plan	IWP Annex III (Health and Safety Program Plan)	RFI Work Plan Annex III
D. Community Relations Plan	IWP Annex V (Community Relations Program Plan)	RFI Work Plan Annex V
E. Project Management Plan	IWP Annex I (Program Management Plan)	RFI Work Plan Annex I
Task III: Facility Investigation		
A. Environmental Setting	IWP Chapter 2	RFI Work Plan Chapter 3
B. Source Characterization	IWP Appendix F	RFI Work Plan Chapter 5
C. Contamination Characterization	IWP Appendix F	RFI Work Plan Chapters 4 and 5
D. Potential Receptor Identification	IWP Section 4.2	RFI Work Plan Chapters 4 and 5
Task IV: Investigative Analysis		
A. Data Analysis	IWP Section 4.2	Phase Report and RFI Report
B. Protection Standards	IWP Section 4.2	RFI Report
Task V: Reports		
A. Preliminary and Work Plan	IWP, Rev. 0	Work Plan
B. Progress	Monthly Reports, Quarterly Reports, and Annual Revisions of IWP	Phase Reports
C. Draft and Final		Draft and Final RFI Report

* Annex II of the IWP addresses these requirements by reference to controlled documents: the generic Quality Assurance Project Plan (LANL 1991, 0412) and the ER Program's standard operating procedures (LANL 1991, 0411).

1.2 Installation Work Plan

In accordance with the HSWA Module requirements, the Laboratory has prepared the IWP to describe Laboratory-wide systems for accomplishing all RFIs and corrective measures studies. The IWP is also consistent with the EPA interim final RFI guidance (EPA 1989, 0088) and proposed Subpart S of 40 CFR 264 (EPA 1990, 0432), which will implement the cleanup program mandated in Section 3004(u) of RCRA. The IWP was first prepared in 1990 and is updated annually. This work plan follows the requirements specified in Revision 2 of the IWP (LANL 1992, 0768).

The IWP (Section 3.4.1) describes the aggregation of the Laboratory's PRSs into OUs. Chapter 2 of the IWP presents a facilities description; a structural description of the Laboratory's ER Program is presented in Chapter 3; and Chapter 4 describes the technical approach to corrective action at the Laboratory. Annexes I-V of the IWP contain the Program Management Plan, the Quality Assurance Program Plan, the Health and Safety Program Plan, the Records Management Program Plan, and the Community Relations Program Plan, respectively. The document also contains a proposal to integrate RCRA closure and corrective action and a strategy for identifying and implementing interim remedial measures. The reader is directed to the 1992 revision of the IWP, rather than to earlier versions, for information relevant to this work plan.

1.3 Description of OU 1130

OU 1130 is on land controlled by the DOE in Los Alamos County in northcentral New Mexico. Figure 1-1 shows OU 1130 in relation to the rest of Los Alamos County and New Mexico. Appendix A is a detailed map showing the buildings, the roads, and the PRSs that are to be addressed in this work plan. The three canyons that dissect the OU are Potrillo Canyon, Fence Canyon, and Water Canyon. Pajarito Canyon forms the northern border, and TA-15 shares the western boundary of this OU. The southern boundary runs along the southern margin of Water Canyon, and to the east, the area borders on New Mexico State Highway 4 and the residential community of White Rock. The topography of OU 1130 is rugged, characterized by relatively flat, narrow mesa tops separated by long, narrow canyons.

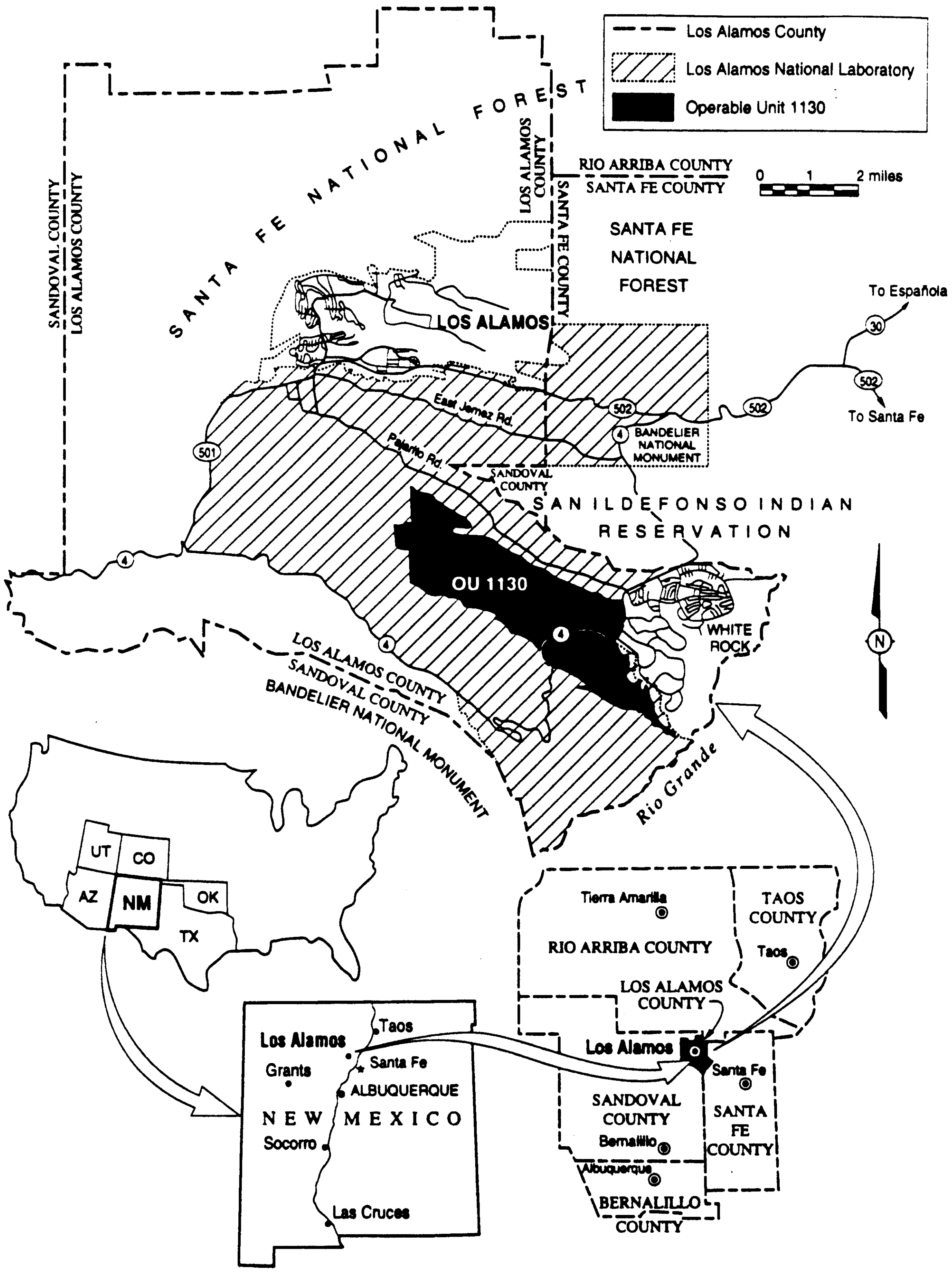


Figure 1-1. Location map of OU 1130 within Los Alamos National Laboratory, Los Alamos County, New Mexico.

The average annual rainfall at OU 1130 is estimated to range from 14 to 16 in. Predominant wind direction is from the southwest, although there is considerable local variation. Temperatures range from 45°F to 95°F during the summer months and from 15°F to 50°F during the winter months. Geologically, OU 1130 is underlain by the Bandelier Tuff, a thick sequence of volcanic ash flows and ash falls on the Pajarito Plateau derived from the volcanic eruptions of the Valles Caldera.

OU 1130 comprises TAs -36,-68, and -71 (Figure 1-2), which are contiguous and cover a total of about 7 sq mi. The latter two TAs are areas in which no Laboratory activities are performed; the PRSs in this OU (Appendix C, LANL 1990, 0145) are all in TA-36 (Figure 1-3). Table 1-3 lists all of the PRSs that have been identified in OU 1130 and provides the approximate location of each PRS. It also identifies PRSs that are in Table A of the HSWA Module and those that are identified for field sampling, deferred investigations, and NFA (EPA 1990, 0306).

TA-36, the site of the Laboratory group currently designated as M-8, is an explosives-testing area comprised of five firing sites that are used to conduct a total of approximately 1,500 explosives tests annually. Other activities include the storage and assembly of prefabricated metal and explosives components, detonators, cables, and instrumentation (including several x-ray machines) for shots. TA-36-1 houses office facilities for M-8 personnel and a photoprocessing facility. Past disposal practices have included burial, surface disposal, burning, and liquid discharge through outfalls. Detailed descriptions of the PRSs, which include four septic systems, a sump, a boneyard, a surface disposal area, a material disposal area, five active firing sites, and several satellite storage areas are given in Chapters 5 and 6 of this work plan.

In the 1990 SWMU report (LANL 1990, 0145), 25 PRSs are listed for OU 1130. Six of these PRSs (SWMUs 36-001, 36-002, 36-003(a), 36-003(b), 36-003(c), and 36-005) are listed in Table A of the Laboratory's Hazardous Waste Permit as requiring an RFI. The following three PRSs are listed as being priority SWMUs in the HSWA Module: 36-003(a), 36-003(b), and 36-003(c) (EPA 1990, 0306). Twenty-four of the twenty-five PRSs listed in the 1990 SWMU report are

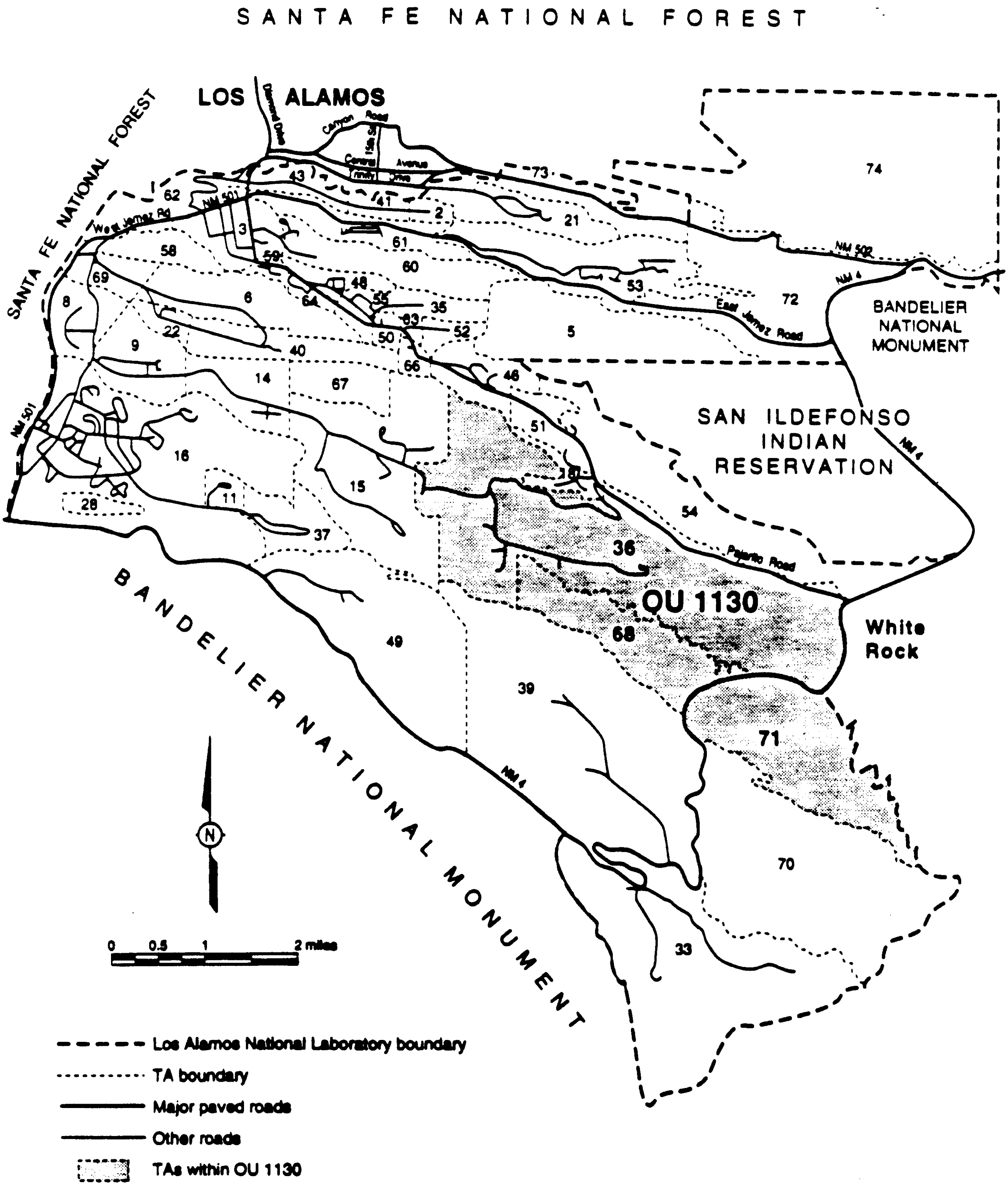


Figure 1-2. Location of OU 1130 with respect to Laboratory TAs and surrounding landholdings.

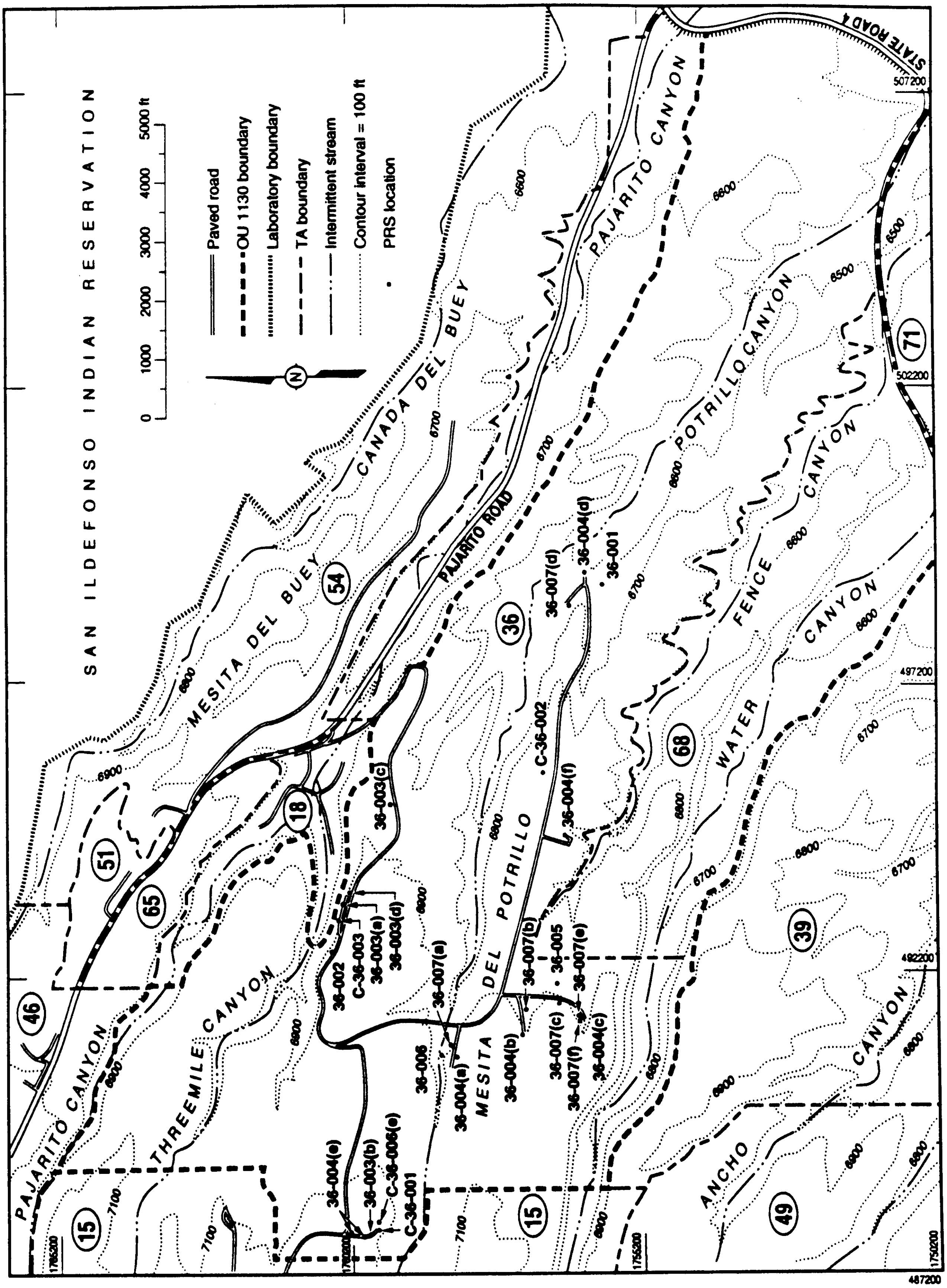


Figure 1-3. Location of PRSs in OU 1130.

TABLE 1-3

POTENTIAL RELEASE SITES IDENTIFIED AT OU 1130

PRS NO.	DESCRIPTION/LOCATION	SWMU LISTED IN TABLE A OF HSWA MODEL	FIELD INVESTIGATION	DEFERRED INVESTIGATION	NO FURTHER ACTION
36-001	MDA AA Lower Slobbovia	X	X		
36-002	Sump, Building 48	X	X		
36-003(a)	Septic System, Building 1	X	X		
36-003(b)	Septic System, I-J Site	X	X		
36-003(c)	Septic System Guard Station, Building 69	X			X
36-003(d)	Septic System, Building 84				X
36-004(a)	Eenie Firing Site			X	
36-004(b)	Meenie Firing Site			X	
36-004(c)	Minie Firing Site			X	
36-004(d)	Lower Slobbovia Firing Site			X	
36-004(e)	I-J Firing Site			X	
36-004(f)	Moe Magazine				X
36-005	Boneyard, Near Building 123	X	X		
36-006	Surface Disposal, Near Eenie			X	
36-007(a)	Explosives Waste Container, Building 4				X
36-007(b)	Explosives Waste Container, Building 5				X
36-007(c)	Explosives Waste Container, Building 7				X
36-007(d)	Explosives Waste Container, Building 11				X
36-007(e)	Explosives Waste Container, Building 8				X
36-007(f)	Explosives Waste Container, Minie				X
C-36-001	Containment Vessel Near I-J Firing Site			X	
C-36-002	Surface Disposal				X
C-36-003	Photo Outfall, Building 1		X		
C-36-006(e)	Projectile Testing Site			X	
36-009	Bazooka Impact Area	Addressed in OU 1093 Work Plan as PRS 27-003			

addressed in this RFI work plan. The PRS that is not addressed is an explosives impact area in Pajarito Canyon known as the Bazooka Impact Area (SWMU 36-009). This PRS is also listed in the 1990 SWMU Report as SWMU 27-003 because it lies partly within TA-27 of OU 1093. The RFI Work Plan for OU 1093 includes SWMU 27-003, and therefore, this work plan will not address it.

Section 3.5 of the IWP (LANL 1992, 0768) states that each OU work plan may contain an application for a Class III permit modification to amend Table A of the HSWA Module (EPA 1990, 0306) when it is determined that a SWMU needs no further investigation or when it is necessary to add SWMUs to the current listing. Table 1-3, which lists the PRSs identified in OU 1130, includes the Table A SWMUs to be addressed in this work plan. Table 1-4 lists the PRSs proposed for NFA; EPA approval of this work plan has the effect of delisting these SWMUs, unless otherwise specified by that agency. Official delisting is by permit modification, if appropriate.

1.4 Organization of This Work Plan and Other Useful Information

This work plan follows the generic outline provided in Table 3-2 of the IWP (LANL 1992, 0768). Following this introductory chapter, Chapter 2 provides background information on OU 1130, including a description and history of the OU, a description of past waste management practices, and a description of current conditions at TAs within the OU.

Chapter 3 describes the environmental setting at OU 1130, and Chapter 4 presents the technical approach to the field investigation. Chapter 5 contains an evaluation of all the PRSs in OU 1130 for which RFI field work is proposed and includes a description and history of each PRS, a conceptual exposure model, remediation alternatives and evaluation criteria, data needs and data quality objectives, and a sampling plan. Chapter 6 provides a brief description of each PRS proposed for NFA and the justification for each such recommendation.

Five annexes follow the text and correspond to the program plans in the IWP: project management, quality assurance, health and safety, records management and, community relations.

TABLE 1-4

PRSs IN OU 1130 PROPOSED FOR NFA

PRS Number	PRS Description	Location of Discussion
36-003(c)	Septic system	Section 6.1
36-003(d)	Septic system	Section 6.1
36-004(f)	Moe magazine	Section 6.3
36-007(a)	Explosives waste container	Section 6.2
36-007(b)	Explosives waste container	Section 6.2
36-007(c)	Explosives waste container	Section 6.2
36-007(d)	Explosives waste container	Section 6.2
36-007(e)	Explosives waste container	Section 6.2
36-007(f)	Explosives waste container	Section 6.2
C-36-002	Surface disposal area	Section 6.4

Appendix A is a large, detailed fold-out map of OU 1130, and Appendix B contains a list of contributors to this work plan. Appendix C details the field investigation approach and methods.

The units of measurement used in this document are expressed in either English or metric units, depending on which units are commonly used in the discipline being discussed. For example, English units are used in text pertaining to engineering, and metric units are often used in discussions of geology and hydrology. When information is derived from some other published report, the units are consistent with those used in that report. A conversion table is provided at the end of this work plan.

A list of acronyms precedes Chapter 1. A glossary of unfamiliar terms is provided in the IWP (LANL 1992, 0768).

REFERENCES FOR CHAPTER 1

EPA (US Environmental Protection Agency), May 1989. "Interim Final RCRA Facility Investigation (RFI) Guidance, Volume I of IV, Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations," EPA/530-SW-89-031, OSWER Directive 9502.00-6D, Office of Solid Waste, Washington, DC. (EPA 1989, 0088)

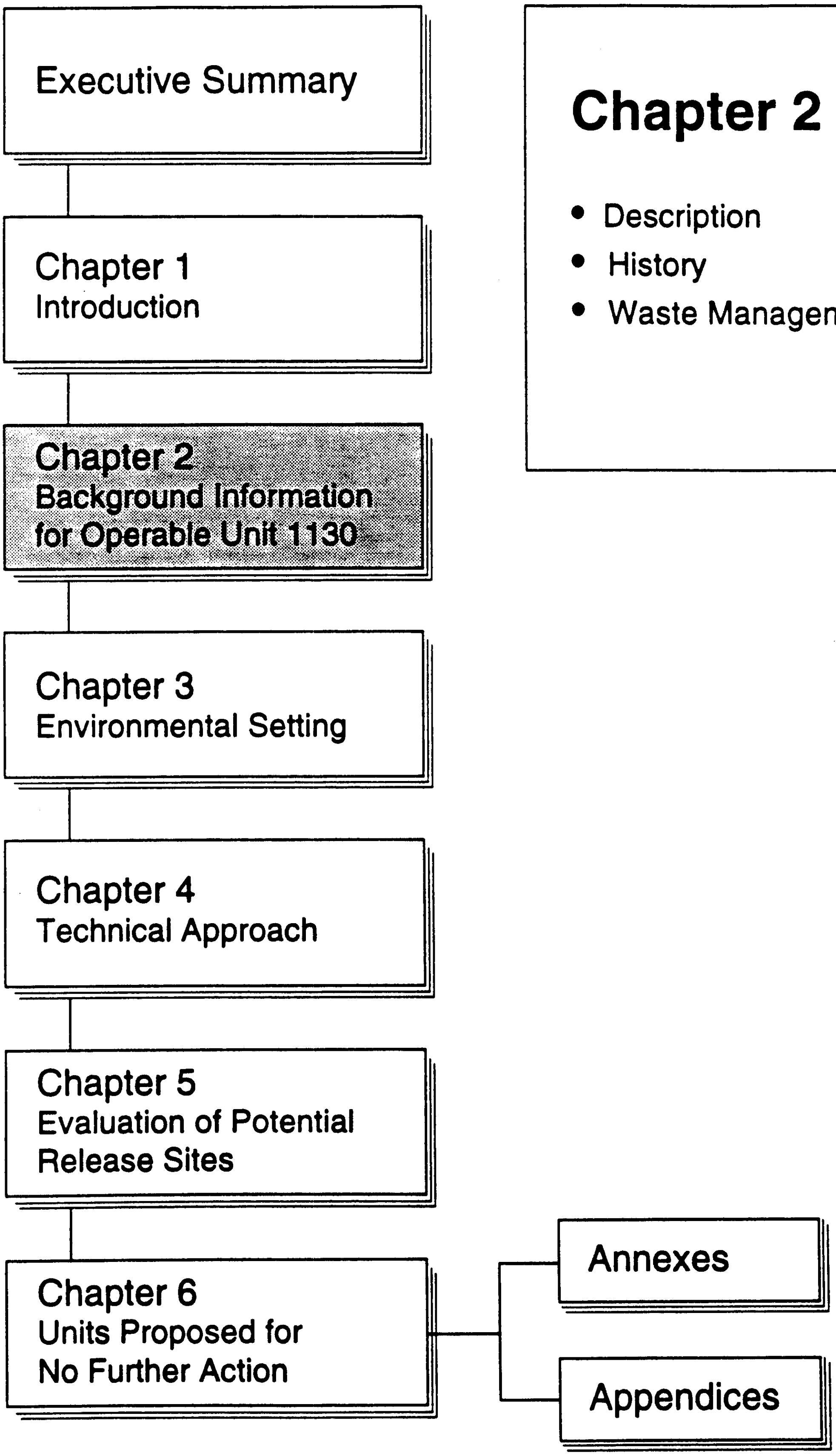
EPA (US Environmental Protection Agency), April 10, 1990. Module VIII of RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 0306)

EPA (US Environmental Protection Agency), July 27, 1990. "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," proposed rule, Title 40 Parts 264, 265, 270, and 271, Federal Register, Vol. 55. pp. 30798-30884. (EPA 1990, 0432)

LANL (Los Alamos National Laboratory), November 1990. "Solid Waste Management Units Report," Volumes I through IV, Los Alamos National Laboratory Report LA-UR-90-3400, prepared by International Technology Corporation under Contract 9-XS8-0062R-1, Los Alamos, New Mexico. (LANL 1990, 0145)

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan," Rev. 0, Environmental Restoration Program, Los Alamos, New Mexico. (LANL 1991, 0412)

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-92-3795, Los Alamos, New Mexico. (LANL 1992, 0768)



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2.0 BACKGROUND INFORMATION FOR OPERABLE UNIT 1130

This chapter presents a description of OU 1130 and a brief overview of the Laboratory's past and current activities and practices there. More detailed information about the OU, including information specific to each potential release site (PRS) within the OU, is provided in Chapters 5 and 6.

2.1 Description of OU 1130

OU 1130 comprises Technical Areas (TAs) -36, -68, and -71, and covers a total of approximately 7 sq mi (Figure 1-2). The three contiguous TAs are on property controlled by the DOE in Los Alamos County in northcentral New Mexico (Figure 1-1). TA-36 lies in the northwestern portion of the OU, bounded to the west by TA-15 and to the northeast by TA-18, which in turn borders on Pajarito Road. To the south, TA-36 borders on TA-68 and TA-39. TA-36 extends southeastward to New Mexico State Highway 4, where it borders on TA-71. TA-71 is somewhat triangular in shape and is bordered by New Mexico State Highway 4 to the northwest and the Rio Grande to the southeast. TA-71 is immediately south and west of the community of White Rock. The OU straddles Potrillo Canyon and is bounded to the north by Pajarito Canyon and to the south by Water Canyon. The environmental setting of OU 1130 is further detailed in Chapter 3 of this work plan.

2.2 History of OU 1130

Much of Pajarito Plateau, including the location of OU 1130, was part of the Ramon Vigil Land Grant. In the late 1800s and early 1900s, Pajarito Plateau was used for ranching, farming, and logging. The area now constituting OU 1130 was made part of the US Government's conservation land in 1934 and was added to the Santa Fe Forest Reserve in 1939. In 1943, the Manhattan Engineer District acquired the Jemez Section from the US Forest Service.

TA-36, also called Kappa site, is used by the current Explosives Applications Group (M-8). In 1947 and 1948, Norris Bradbury, with the assistance of the site selection committee headed by Stanley W. Burris, selected the locations for Kappa site and other Laboratory sites. TA-36 was put into operation in 1950 by the group then known as GMX-8. GMX-8 changed its name to M-3, and later to its current name, M-8. There have been only three different group leaders (Wayne Campbell, Jim Travis, and Jim Straight) at the site since its inception. The facilities comprised the group office and sanitary facilities; four firing sites, Eenie, Meenie, Minie and Lower Slobbovia, [36-004(a) through (d)]; and a storage magazine at Moe, 36-004(f). A total of approximately 30,000 test shots have been fired at Kappa site. It is estimated that approximately 2,200 to 4,400 lb of depleted uranium have been expended there (Kelkar 1992, 13-0001; Venable 1990, 13-0007). This is a small amount of the total Laboratory depleted-uranium expenditure of approximately 220,460 lb (Becker 1991, 0699). In 1983, the boundary of TA-36 was shifted to incorporate I-J site [36-004(e)]. I-J site, formerly part of TA-15, was established in the late 1940s and was used by group M-4 (which became GMX-4 and later reverted to the name M-4) for explosives testing. Explosives-testing operations continue at the five previously named TA-36 firing sites.

The explosives tests that have been conducted at TA-36 can be broadly grouped into two categories: stationary tests and penetration tests. In a stationary test, a prefabricated shot assembly, together with detonator cables and monitoring instrumentation, is placed on a wooden table at the firing point and detonated. Shot assemblies typically contain explosives and sometimes include various amounts of diverse metals and plastics. The resulting shot waste products may vary widely in terms of particle size, from fine dust to shrapnel. Larger pieces of shrapnel typically travel farther, sometimes up to 3,000 ft. Metal pieces that are projected downward can penetrate the ground to a depth of several yards. In a penetration test, a projectile is fired out of a barrel toward a target. The projectile either fragments on impact, becomes embedded in the target, or penetrates through the target. Metal shields are used behind the targets to absorb any materials that penetrate, but projectiles do occasionally penetrate cliff faces behind the targets. Testing has also been conducted against an exposed cliff face at I-J site. Some drop-tests, in which mock-up weapons were dropped from a predetermined height to a pad below, were conducted at Lower Slobbovia. The kinds of explosives used through the years at TA-36 have included 2,4,6-trinitrotoluene, baratol, boracitol, hexanitrosol, cyclotetramethylene tetranitramine, plastic-bonded explosives, and triaminotrinitrobenzene. A variety of metals have been used in the tests, including steel, copper, aluminum, cadmium, cobalt, lead, lithium-magnesium alloys, antimony, mercury, zinc, and depleted and natural uranium. Before TA-36 was established in 1950, a few shots of bare explosive were detonated on the mesas there; however, all subsequent explosives-testing activity has been confined to the designated firing sites: Eenie, Meenie, Minie, Lower Slobbovia, and I-J.

Archival search, examination of aerial photographs, and interviews with former Laboratory employees indicate that TAs -68 and -71 were never used throughout the Laboratory's operating history. No Laboratory testing, storage, or disposal activities have been performed in these areas; however, debris that has been shot from other firing sites or carried along migration pathways may be present. Currently, TA-68 is a secure area and is institutionally controlled. In the past, part of TA-71 was used by private citizens for target-shooting activities, but the area is currently patrolled by Bandelier National Monument employees to prevent further use of the land for such purposes. The area is closed to vehicle traffic, but is accessible to hikers and horseback riders.

2.3 Waste Management Practices at OU 1130

Several types of waste have been produced at OU 1130 as a result of firing site activities. The following summarizes past and present waste disposal and treatment practices at OU 1130.

Currently, firing site debris comprises mainly wood scrap, cardboard, and burlap; this is treated at an open-air burn site on the soil surface near the Lower Slobbovia firing site bunker. In the past, this debris was burned in pits near the present open-air burn pad. These two to four pits, which were opened and closed sequentially, have been designated as Material Disposal Area AA 36-001 (described in Chapter 5.1 of this work plan). In May 1989, the burn pits were closed in accordance with New Mexico Solid Waste Management closure requirements. In the early 1950s, a different burn pit, on the north side of Potrillo Drive east of Moe magazine, was used to destroy the wood and other flammable remnants of detonations. A depression in the ground marks the location of this burn pit.

Depleted-uranium-contaminated metals remaining from experiments at the firing sites are monitored for radiation contamination and then shipped to TA-54 for disposal in the Laboratory's low-level-radioactive-waste burial pits. All metals are inspected for explosive contamination before they are shipped. Waste explosives and materials that are found to be explosive-contaminated are either flash-burned or detonated at the Minie firing site or at TA-16, an interim status open burn area that is operated by WX-3. Potentially explosive-contaminated plastics and foams are also sent to WX-3 for flash-burning treatment. This is a long-standing waste treatment technique at the Laboratory.

Solvents and photochemical wastes are stored in hazardous waste satellite storage areas [36-007(a) through (f)] until they are collected and properly disposed of by EM-7, the Laboratory's Waste Management Group. Until the late 1980s, solvent wastes were discarded in the trash, which was then taken to the County Sanitary Landfill. Photo wastes were diluted and poured into the sanitary drain in building TA-36-1, which was served by the septic system for that building.

2.4 Current Activities at OU 1130 Technical Areas

Active operations have not occurred at TAs -68 and-71; there are no Laboratory facilities on either TA, even though TA 68 may have received firing site debris thrown from explosions at the firing sites in TA-36. TA-68 is a secure area controlled by the Laboratory; access to the area requires M-Division approval. TA-71 is controlled by DOE and is patrolled by employees of Bandelier National Monument. TA-36, where explosives-testing operations are routinely carried out, is the site of group M-8 operations.

All but two of the OU 1130 PRSs are within the secure area (i.e., within a fenced area) that can be accessed only by Q-cleared badge holders and escorted personnel. The firing sites, Eenie, Meenie, Minie, Lower Slobbovia, and I-J, are actively used by M-8 to conduct a total of approximately 1,500 explosives tests annually. Building TA-36-1 houses a photoprocessing facility and office facilities for M-8 personnel. The photo chemicals are collected in containers, and only the rinse water from the photo process enters the septic system.

Neither manufacturing, machining, nor casting of uranium or explosive materials are performed at TA-36. Rather, there are two general categories of activities: the storage and assembly of prefabricated metal and explosives components, detonators, cables, and instrumentation (including several x-ray machines) for shots; and the actual detonation of these shots. The post-shot debris is handled as described in Section 2.3 of this work plan. Explosives tests at OU 1130 are conducted only at the above-specified firing points.

One of the two PRSs outside the secure area is a septic system connected to the remote guard building TA-36-69. Protection Technology Los Alamos personnel use this building and, consequently the septic system, only infrequently. The other PRS outside the secure area is a bazooka-impact area in Pajarito Canyon. This area was used during World War II for ordnance testing. Now marked by "No Trespassing" signs, the area is not used for any Laboratory activities.

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Kelkar, S., June 1992. "Meeting with Marvin L. Price," Los Alamos National Laboratory Memorandum EES-4-92-188, ER ID Number 9046, Los Alamos, New Mexico. (Kelkar 1992, 13-0001)

Venable, D., February 1990. "GMX-11's Explosive Dispersal of U, Be, and Pb (Via Weapon-Related Testing, through March 1971)," Los Alamos National Laboratory ADNWT: 90-25, ER ID Number 5628, Los Alamos, New Mexico. (Venable 1990, 13-0007)

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- Topography
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3.0 ENVIRONMENTAL SETTING

The environmental setting of the Laboratory is described in Section 2.5 of the Installation Work Plan for Environmental Restoration (IWP) (LANL 1992, 0768). A discussion of the environmental setting, including topography, climate, geology, hydrology, and a conceptual hydrogeologic model of Operable Unit (OU) 1130 and the surrounding area, is presented in the following sections and provides the information required to evaluate potential contaminant transport pathways and conceptual exposure models at OU 1130.

3.1 Topography

OU 1130 encompasses a roughly trapezoid-shaped area of land measuring approximately 1.5 by 5.8 mi (Figure 3-1). The northern boundary is, in effect, defined by the southern rim of Pajarito Canyon and a small segment of Threemile Canyon. The area is bordered to the south by Technical Area (TA)-39, and by TA-70 along the southern margin of Water Canyon. TA-15 borders OU 1130 to the west, and New Mexico State Highway 4 and the residential community of Pajarito Acres border the site to the east. The topography is rugged, characterized by relatively narrow mesa tops separated by long, narrow canyons; the predominant axis of the mesas and canyons is from the west-northwest to the east-southeast.

Beginning with the northernmost, the three canyons that transect the OU are Potrillo Canyon, Fence Canyon, and Water Canyon. A portion of Threemile Canyon also lies in the OU; however, Threemile Canyon enters into OU 1093 and converges with Pajarito Canyon just north of OU 1130. Water Canyon heads on the flanks of the Sierra de Los Valles. As a result, its watershed area is relatively large compared with most other watershed areas on the Pajarito Plateau, which typically originate down on the plateau. Water Canyon is also the deepest canyon in the OU. Potrillo Canyon is a small, narrow canyon originating in OU 1086, due west of OU 1130. Fence Canyon is a small, narrow canyon that begins in OU 1130 near the Meenie and Minie firing sites. Fence Canyon enters into Potrillo Canyon a short distance south of New Mexico State Highway 4. Approximately 0.6 mi downstream from this confluence, Potrillo Canyon joins

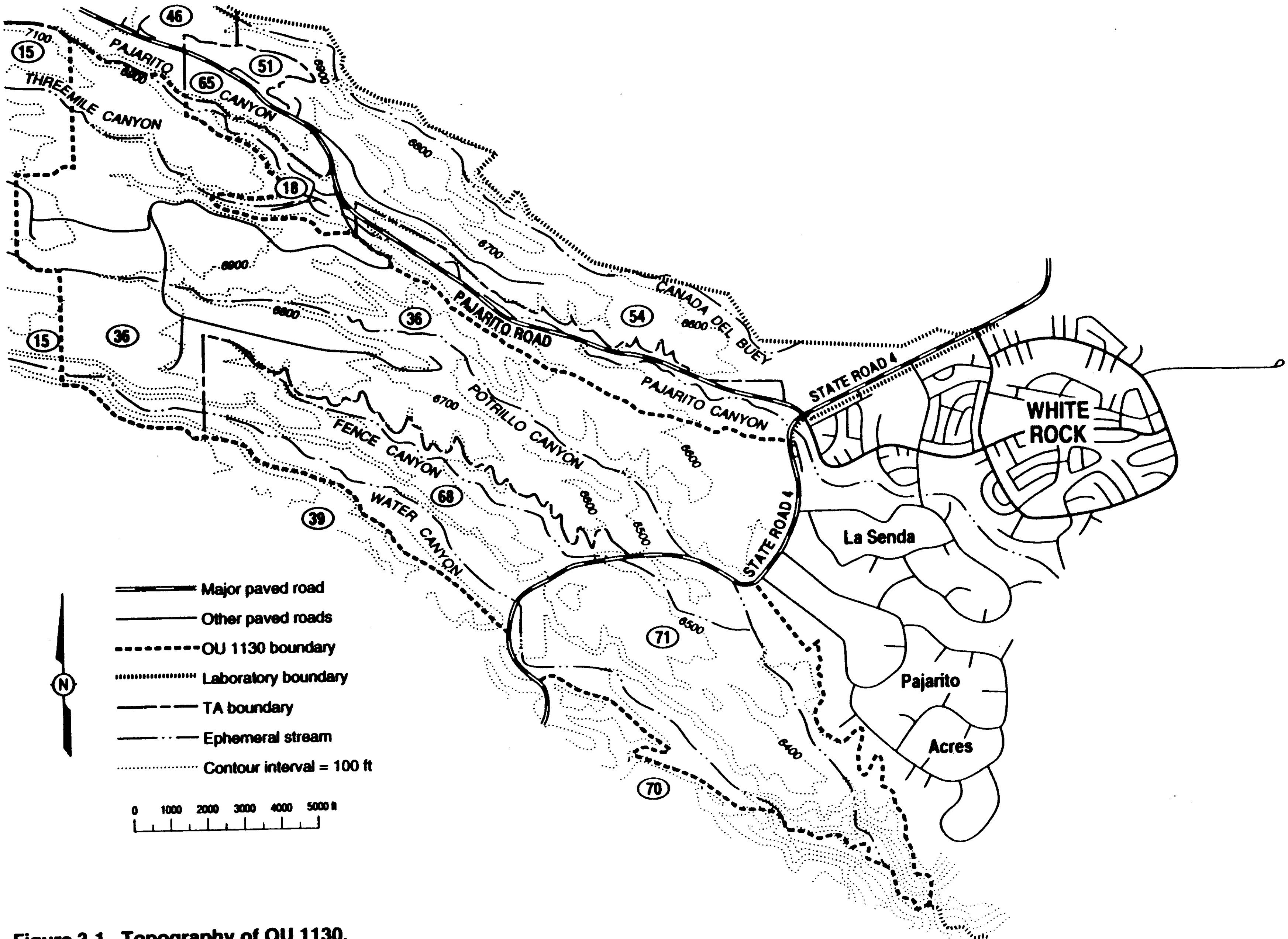

Figure 3-1. Topography of OU 1130.

Water Canyon. Water Canyon enters into the Rio Grande along White Rock Canyon. There is no perennial flow in any of these canyons.

The difference in elevation between mesa tops and canyon bottoms ranges from approximately 100 ft to 350 ft. The maximum elevation in OU 1130 is 7,150 ft on the mesa west of the I-J firing site; the minimum elevation in the OU is 5,640 ft in Water Canyon near the Rio Grande. Mesa tops are generally flat with a gentle slope to the east-southeast. Canyon walls are steep to nearly vertical. Small, discontinuous talus deposits and scattered boulders lie at the junction of the canyon walls and the canyon bottoms. Canyon bottoms are generally narrow, typically less than 700 to 800 ft, with steep stream channel gradients (up to 5%).

All rock exposures in the OU are of Bandelier Tuff; however, just east of the OU, south of State Highway 4, are outcrops of the Unit 2 basalts of the Cerros del Rio volcanic field. The canyon floors consist of volcanic-derived alluvium and are underlain by welded and nonwelded Bandelier Tuff.

3.2 Climate

Climate plays an important role in contaminant migration through wind-driven transport processes, the magnitude and frequency of surface water runoff events, and the resultant effects on erosion rates and contaminant-transport properties.

The Laboratory maintains two climatological data-collection stations near OU 1130. Until recently, the Laboratory's major climatological data-collection station, which provides the information for climatologic summary (including data for the IWP), was at TA-59. In January 1990, this station was moved to its current location at TA-6, approximately 2.2 mi northwest of the I-J firing site. A second climatological data-collection station, which began operating in 1987, is about 1.6 mi southwest of the Minie firing site. Both stations report precipitation, wind direction and speed, relative humidity, temperature, and solar radiation. Cooperative observer rainfall records have been collected at the I-J, Eenie, and Meenie firing sites in the past.

The climate at OU 1130 varies only slightly from the description of the Los Alamos area climate presented in Section 2.5.3 of the IWP (LANL 1992, 0768). Precipitation on the Pajarito Plateau strongly correlates with topography and with proximity to the Sierra de los Valles. There is a pronounced annual precipitation gradient from west to east, with the largest values on the west end closest to the Sierra de los Valles, which has the highest altitude in the area. Because OU 1130 is farther east and topographically lower than the climatological data-collection station at TA-59, the average annual precipitation at OU 1130 is estimated to vary from 16 to <14 in., or at least 2 in. less than the 18 in. reported at TA-59 (Bowen, 1990, 0033). The snowfall contribution to total precipitation is also smaller at OU 1130 than at the TA-59 data-collection station.

Because of the area's complex terrain, surface winds vary with time of day, location on the plateau, and height above ground level. The predominant large-scale wind direction in the area is from the southwest (Figure 3-2). Superimposed up on this regional average is a convective upslope wind (flowing from southeast to northwest) that develops over the plateau during periods of sunshine and when the large-scale wind velocities are relatively small. During clear, relatively calm nights, the flow direction reverses and a shallow drainage wind (flowing from west to east down the canyons) can develop. These upslope and drainage winds prevail at locations fairly distant from the Rio Grande, and they are likely to be observed at OU 1130. Near the eastern boundary, during periods of sunshine and relatively calm winds, the winds are expected to be influenced by the Rio Grande drainage winds, with prevailing upslope (northward) winds during the day and downslope (southward) drainage winds during the evening.

The winter temperatures in the area generally range between 15°F and 25°F at night, and 30°F and 50°F in the daytime; summer temperatures are usually in the 70°F to 90°F range in the afternoon hours and drop to the 50°F to 60°F range during the night (Bowen 1990, 0033). The mean maximum temperatures for all months are higher, and the mean minimum temperatures are generally lower, in White Rock than in Los Alamos. Mean maximum and mean minimum temperature differences between White Rock and Los Alamos are usually less than 5°F. Temperatures at OU 1130 near the firing sites generally fall between

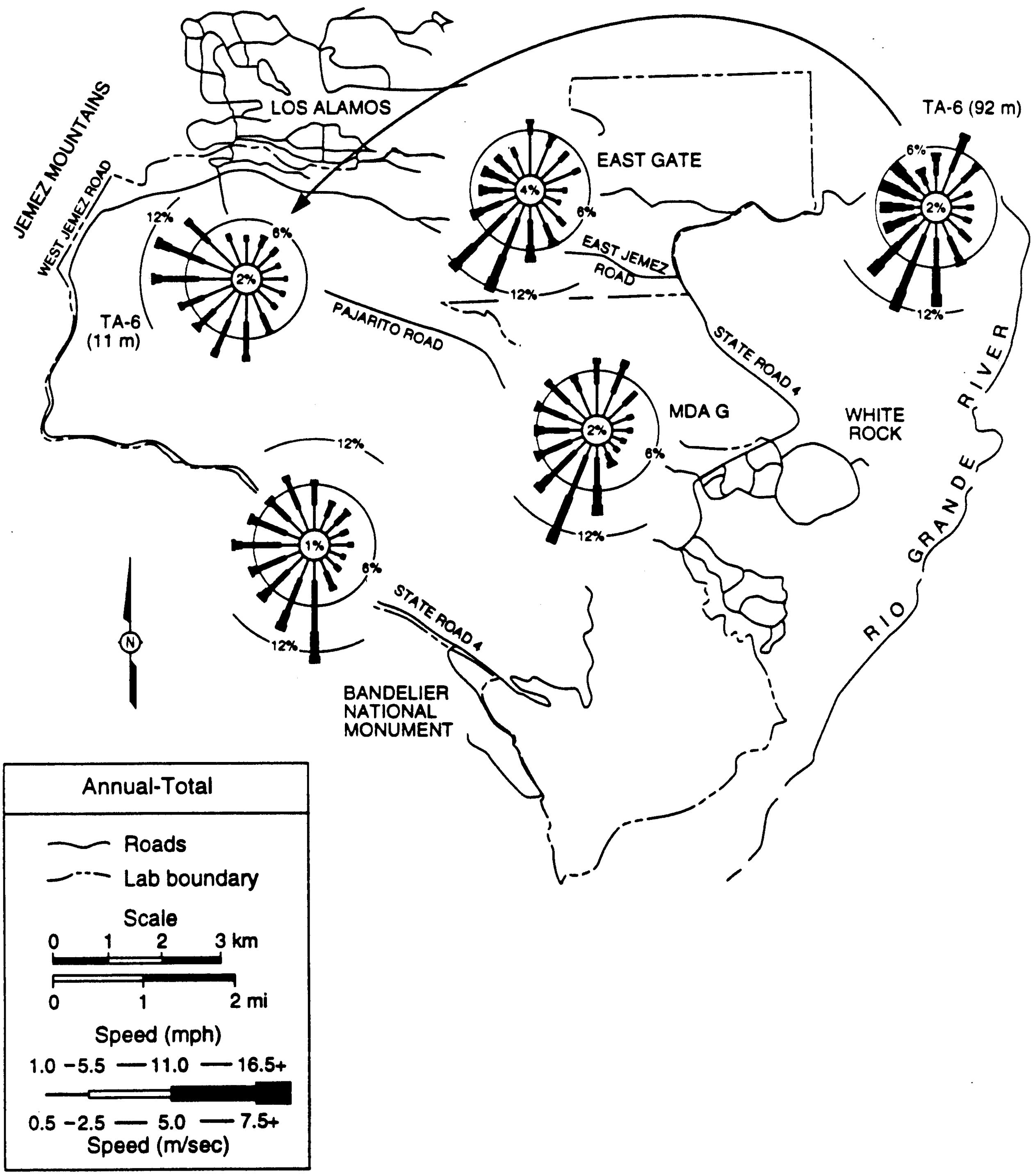

Figure 3-2. Average total wind roses at Laboratory stations. Surface wind data for TA-6 (upper left), East Gate, MDA G, and Bandelier are presented. TA-6 winds at the 92-m level are also shown.

the Los Alamos and the White Rock values. At the eastern margin of the OU, temperatures are generally similar to those observed in White Rock.

3.3 Biological and Cultural Resources

Biological resource field surveys have been conducted at OU 1130 for compliance with the Federal Endangered Species Act of 1973; the New Mexico Wildlife Conservation Act; the New Mexico Endangered Plant Species Act; Executive Order 11990, "Protection of Wetlands"; Executive Order 11988, "Floodplain Management"; 10 CFR 1022; and DOE Order 5400.1. A cultural resource survey has also been conducted at OU 1130, as required by the National Historic Preservation Act (amended).

3.3.1 Biological Resource Evaluation

During 1992, field surveys were conducted by the Biological Resource Evaluations Team of the Environmental Protection Group (EM-8). A summary of initial results from these surveys is presented below. Further information concerning the biological field surveys for OU 1130 is contained in the full report "Biological Assessment for Environmental Restoration Program, Operable Unit 1130" (Foxx in preparation, 13-0090). The Biological Assessment will contain specific information on survey methodology, results, and mitigation measures. This assessment will also contain information that may aid in defining ecological pathways and vegetation restoration.

3.3.1.1 Methodology

The purpose of the surveys was threefold: to determine the presence or absence of any critical habitat for any state or federal sensitive, threatened, or endangered plant or animal species within the OU boundaries; to identify the presence or absence of any sensitive areas, such as floodplains and wetlands, that might be present within the areas to be sampled, and the extent and general characteristics of such areas; and to provide additional plant and wildlife data concerning the habitat types within the OU.

These data provide further baseline information about the biological components of the site characterization and determination of presampling conditions. This information is also necessary to support the National Environmental Policy Act documentation and determination of a Categorical Exclusion for the sampling plan for site characterization.

After a search of the database maintained in EM-8 containing the habitat requirements for all state and federally listed threatened or endangered plant and animal species known to occur within the boundaries of the Laboratory and surrounding areas, a habitat evaluation survey (Level 2) was conducted. A Level 2 survey is performed when there are areas that are not highly disturbed that potentially support threatened and/or endangered species. Techniques used in a Level 2 survey are designed to gather data on the percentage of cover, density, and frequency of both the understory and overstory components of the plant community.

The habitat information gathered through the field surveys was compared with the habitat requirements for species of concern as identified in the database search. If habitat requirements were not met, no further surveys were conducted. If habitat requirements were met, specific surveys for the species of concern were conducted. The species-specific surveys were done in accordance with pre-established survey protocols.

In each location, all wetlands and floodplains within the survey area were noted using National Wetland Inventory Maps and field checks. Characteristics of wetlands, floodplains, and riparian areas were noted using criteria outlined in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Army Corps of Engineers et al. 1989, 0237).

3.3.1.2 Survey Results

Within OU 1130 there are an estimated 85 species of plants, 70 species of nesting birds, 35 species of mammals (including 13 bat species), and 16 species of reptiles and amphibians.

'The dominant trees within the overstory vegetation of the OU are one-seed juniper (*Juniperus monosperma*) and pinon pine (*Pinus edulis*). In some areas, ponderosa pine (*Pinus ponderosa*) forms nearly uniform stands. The shrub layer is primarily composed of wavyleaf oak (*Quercus undulata*), big sagebrush (*Artemisia tridentata*), squawbush (*Rhus trilobata*), mountain mahogany (*Cercocarpus montanus*), and wax currant (*Ribes cereum*). By far the dominant grass of TA-36 is blue grama (*Bouteloua gracilis*). Other dominant forbs and grasses include bluegrass (*Poa* sp.), wormwood (*Artemisia ludoviciana* and *A. carruthii*), and mountain muhly (*Muhlenbergia montana*). Many open areas completely lack vegetative cover.

The plant and animal species of concern for OU 1130 are

- peregrine falcon (*Falco peregrinus*—federally endangered);
- bald eagle (*Haliaeetus leucocephalus*—federally endangered);
- common black hawk (*Buteogallus anthracinus*—state endangered);
- Mississippi kite (*Ictinia misisippiensis*—state endangered);
- broad-billed hummingbird (*Cynanthus latirostris*—state endangered);
- willow flycatcher (*Empidonax trailii*—state endangered);
- spotted bat (*Euderma maculatum*—state endangered);
- meadow jumping mouse (*Zapus hudsonius*—state endangered and federal candidate);
- Say's pond snail (*Lymnaea captera*—state endangered);
- Wright's fishhook cactus (*Mammillaria wrightii*—state endangered);
- Santa Fe cholla (*Opuntia viridiflora*—state endangered); and
- grama grass cactus (*Pediocactus papyracanthus*—state endangered and federal candidate).

3.3.1.3 Wetlands/Floodplains

Wetlands have been identified in Water Canyon. In addition, wetlands exist in Pajarito Canyon, just north of the OU. Monitoring and delineating of these areas will be required prior to soil sampling in potential wetland areas in the canyon bottoms. Sampling for site characterization in these areas may have to be modified slightly to avoid impact to a wetland. Potential floodplains are found within some of the canyon systems in the OU. These must also be considered when planning soil sampling.

3.3.2 Cultural Resource Evaluation

The archaeological survey for OU 1130 was not completed during the 1992 field survey season. Additional field surveys and final report preparation will be performed in the summer of 1993. The report will document the area surveyed, survey methodology, results, and monitoring recommendations.

3.4 Geology

A detailed discussion of the geology of the entire Los Alamos area can be found in Section 2.6.1 of the IWP (LANL 1992, 0768). A summary of that material, emphasizing conditions expected at OU 1130, is presented below. Because no formal study on the geology of OU 1130 has been conducted, additional detail has been derived from geologic investigations of the Pajarito Plateau conducted in the area surrounding the OU.

3.4.1 Stratigraphy

The generalized stratigraphy of OU 1130 can be inferred from three wells drilled in the immediate vicinity of the OU. Drilling core logs of wells PM-4 (on Mesita del Buey just north of OU 1130) and DT-10 (on Frijoles Mesa just south of the OU) provide an idea of the stratigraphy underlying the OU 1130 mesas (Purtymun et al. 1983, 0712; Weir and Purtymun 1962, 0228). Drilling core logs of well PM-2 (in Pajarito Canyon approximately 0.75 mi south of PM-4) provide an idea of the stratigraphy underlying the OU canyons (Cooper et al. 1965, 0495). The three wells lie on a roughly southwesterly trend, with OU 1130 lying in the area between PM-2 and DT-10 (Figure 3-3).

The major rock groups that are likely to underlie OU 1130 are shown in Figure 3-4. The figure also shows the relative positions of the wells used to construct the stratigraphic columns and a schematic representation of the OU surface topography. Each stratigraphic unit has different properties that will affect the local hydrogeology. The stratigraphic units that are important to OU

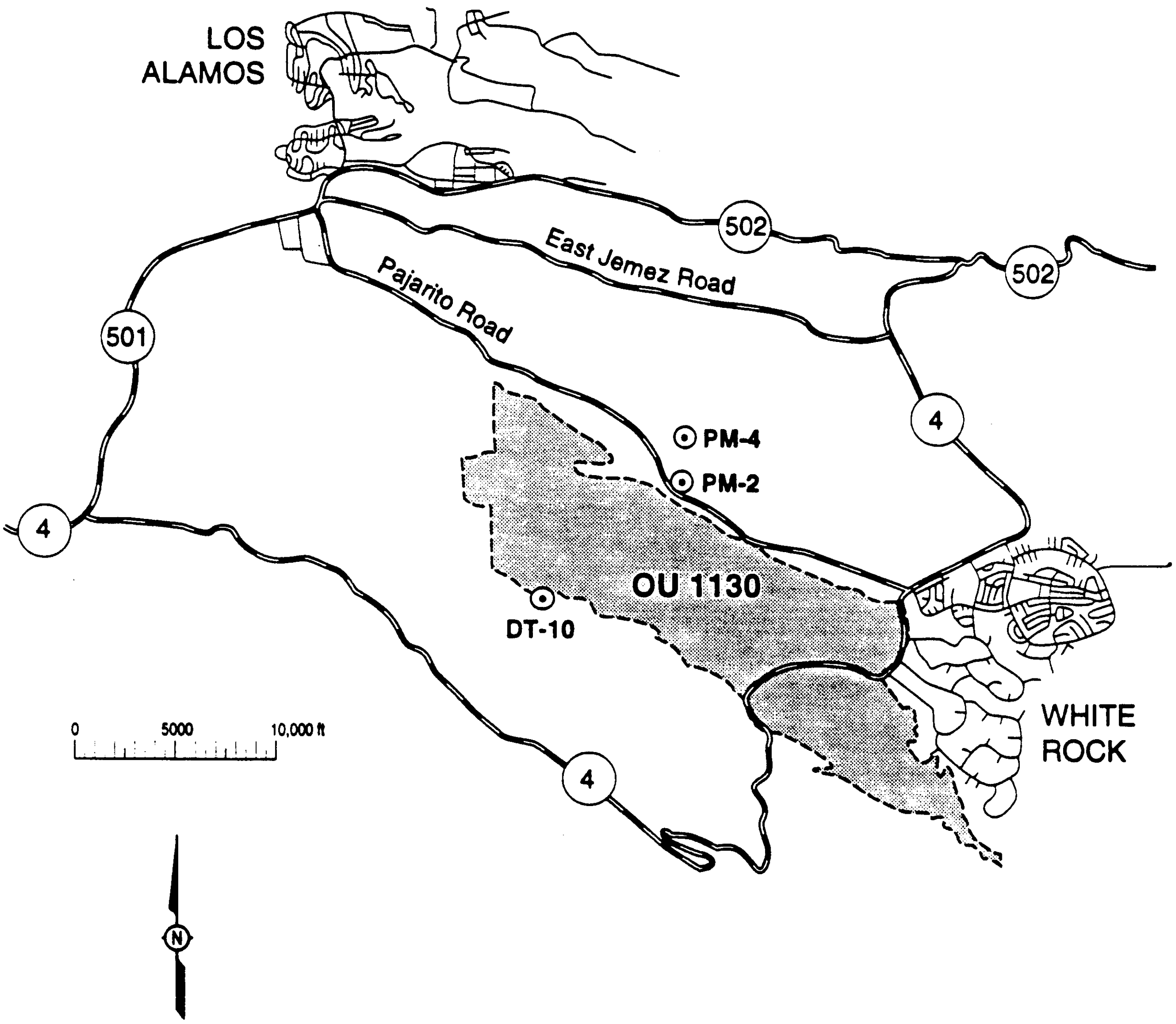

Figure 3-3. Map showing the locations of wells PM-2, PM-4, and DT-10 (from Purtymun, 1984 0196).

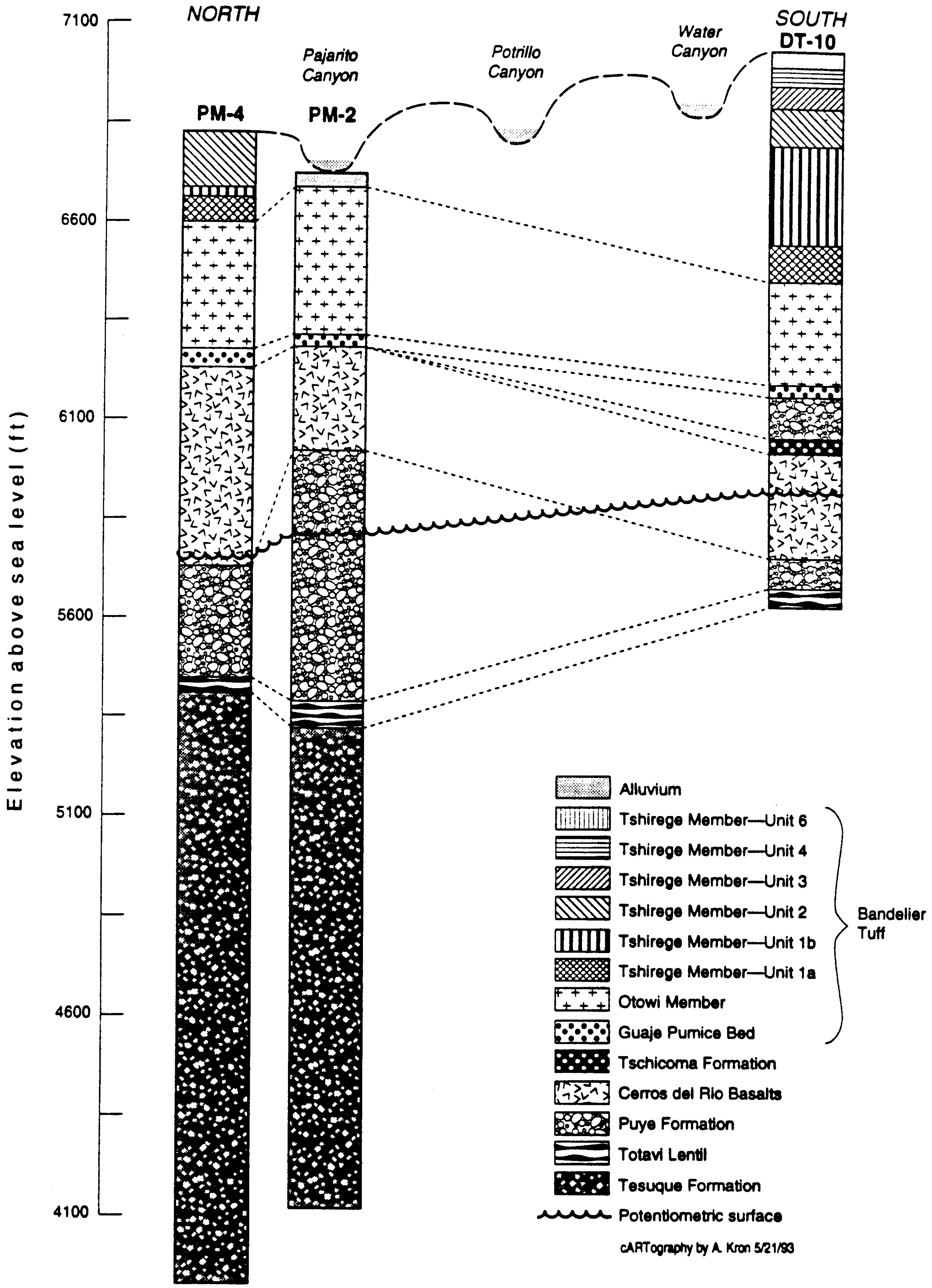

Figure 3-4. Generalized stratigraphy of OU 1130.

1130 are discussed below, beginning with the units highest in the column (i.e., the youngest) and progressing downward. The descriptions incorporate the stratigraphic and lithologic data from the three reports referenced above with the more generalized data found in Section 2.6.1.2 of the IWP (LANL 1992, 0768).

3.4.1.1 Post-Bandelier Alluvium

Alluvial deposits overlie the Bandelier Tuff on canyon bottoms, canyon sides, and mesa tops. These deposits are generally <35 ft thick and consist of volcaniclastic sediments and clay-rich to sandy deposits. In Pajarito Canyon, Cooper et al. (1965, 0495) describe 30 ft of alluvium, the upper 7 ft of which consist of clay and boulders (as large as 1 ft in diameter), and the lower 23 ft of which consist of sand and gravel. Neither PM-4 (Purtymun et al. 1983, 0712) nor DT-10 (Weir and Purtymun 1962, 0228) were described as having alluvium. This is to be expected because alluvium is deposited by fluvial processes and, therefore, is typically not present on mesa tops.

3.4.1.2 Bandelier Tuff: Tshirege Member

The Tshirege Member of the Bandelier Tuff is the uppermost rock unit that underlies the mesa tops over most of OU 1130. It is an ashflow and airfall sequence deposited during an explosive event dated at 1.1 million years ago (Mya). The ash-flow sequence of the Tshirege Member consists of three distinct cooling units across most of the Pajarito Plateau. The member has been further divided into several subunits composed of ash-flow groups or other stratigraphic zones that can be correlated across the entire outcrop area of the Bandelier Tuff (Crowe et al. 1978, 0041).

Purtymun et al. (1983, 0712) report that there is a total of 220 ft of the Tshirege Member in PM-4, including Units 1a, 1b, 2a, and 2b. Weir and Purtymun (1962, 0228) report more than 500 ft of Tshirege Member deposits in DT-10, including Units 3, 4, and 6 as defined by their classification scheme. Cooper et al. (1965, 0495) classify the uppermost units in PM-2 as Otowi Member; however, based on exposures in the neighboring canyon walls, these deposits are more likely the lowest units of the Tshirege. (Note: The naming of units for the Tshirege Member has followed several different conventions; therefore, the unit designations used here may not correlate with those used in other publications.) The Tshirege Member tuff ranges from nonwelded to moderately welded, and contains quartz and sanidine phenocrysts. In particular, Units 1a and 1b are nonwelded to moderately welded and contain quartz, sanidine, and pumice fragments in a yellowish gray (Unit 1b) to gray (Unit 1a) ash matrix (Purtymun et al. 1983, 0712). Units 2a and 2b are moderately welded and have quartz and sanidine in a gray ash matrix. In addition, Units 1b, 2a, and 2b contain fragments of rhyolite. Unit 3 is moderately welded and contains quartz, sanidine, pumice, and rhyolite fragments. Units 5 and 6 have been identified in OU 1130 and Unit 4 is expected to be in the OU, based on its presence in DT-10 (Weir and Purtymun 1962, 0228).

In some localities, the Tsankawi Pumice Bed, which is a fallout unit, forms the basal layer of the Tshirege Member. The Tsankawi has not been identified in PM-2 (Cooper et al. 1965, 0495), PM-4 (Purtymun et al. 1983, 0712), or DT-10 (Weir and Purtymun 1962, 0228); however, the unit is difficult to recognize in core samples and may, in fact, be present in OU 1130.

3.4.1.3 Cerro Toledo Rhyolite

The Cerro Toledo Rhyolite was deposited from a volcanic eruption approximately 1.5 to 1.2 Mya. It occurs between the Otowi and Tshirege Members in some locations in Los Alamos County. Most reported occurrences are north of OU 1130. The Cerro Toledo Rhyolite cannot be distinguished in PM-4 (Purtymun et al. 1983, 0712), DT-10 (Weir and Purtymun 1962, 0228), nor PM-2 (Cooper et al. 1965, 0495), it is frequently difficult to recognize in borehole cuttings; therefore, the Cerro Toledo Rhyolite may be present at OU 1130.

3.4.1.4 Bandelier Tuff: Otowi Member

The Otowi Member disconformably underlies the Tshirege Member. It was deposited during an explosive event dated at 1.45 Mya. The upper section of the Otowi Member consists of nonwelded ashflow deposits containing quartz and sanidine phenocrysts, pumice clasts, and latite and rhyolite fragments. The upper section of the Otowi Member is 320 ft thick in PM-4 (Purtymun et al. 1983, 0712), 375 ft thick in PM-2 (Cooper et al. 1965, 0495), and 257 ft thick in DT-10 (Weir and Purtymun 1962, 0228).

The Guaje Pumice Bed is a fallout unit that forms the base of the Otowi Member. It consists of massive to poorly bedded, unconsolidated lapilli-tuff with pumice clasts averaging 1 to 2 in. The Guaje Pumice Bed is 60 ft thick in PM-4 (Purtymun et al. 1983, 0712), 27 ft thick in PM-2 (Cooper et al. 1965, 0495), and 35 ft thick in DT-10 (Weir and Purtymun 1962, 0228).

3.4.1.5 Tschicoma Formation

The volcanic rocks of the Tschicoma Formation consist of dacites and andesites. The Tschicoma Formation interfingers with the Santa Fe Group and the Puye Formation. Weir and Purtymun (1962, 0228) report a thickness of 40 ft for the Tschicoma Formation in DT-10. This formation pinches out before reaching PM-2 or PM-4. Its thickness under OU 1130 is unknown.

At DT--10, part of the Puye Formation occurs above the Tschicoma Formation (Weir and Purtymun 1962, 0228). The stratigraphic relationship between the Tschicoma Formation, the Chino Mesa Basalts, and the Puye Formation under OU 1130 is unknown.

3.4.1.6 Chino Mesa Basalts (Cerros del Rio Volcanics)

The Cerros del Rio volcanic field consists primarily of basalts (but ranges to latite andesites) deposited between 3.0 and 1.4 Mya. In PM-2 and PM-4, these units are described as basalts with traces of olivine, and vugs lined with calcite (Purtymun et al. 1983, 0712; Cooper et al. 1965, 0495). Interflow breccias containing silts, clays, and gravels are interfingered with the basalts at PM-4 (Purtymun et al. 1983, 0712). This unit is 500 ft thick at PM-4 (Purtymun et al. 1983, 0712), 263 ft thick at PM-2 (Cooper et al. 1965, 0495), and 269 ft thick at DT-10 (Weir and Purtymun 1962, 0228).

In PM-4, according to Purtymun et al. (1983, 0712), the top of the main aquifer is at a depth of 1,060 ft, which occurs within the Chino Mesa Basalts. Weir and Purtymun (1962, 0228) also encountered the top of the water table within these basalts in DT-10 (at an elevation of 5,934 ft). The aquifer was not reported as being in this unit at PM-2 (Cooper et al. 1965, 0495).

3.4.1.7 Puye Formation

The Puye Formation, which dates from 4.0 to 1.7 Mya, was deposited in an alluvial fan that builds out to the east from the Jemez volcanic field. It consists predominantly of volcaniclastic sediments, but its exact lithology depends on proximity to the source.

The Puye Formation at PM-2 and PM-4 is described as a conglomerate with interfingered basalts (Purtymun et al. 1983, 0712; Cooper et al. 1965, 0495). Its total thickness is 280 ft at PM-4 (Purtymun et al. 1983, 0712), and 640 ft at PM-2 (Cooper et al. 1965, 0495). In DT-10, the Puye Formation occurs both above the Tschicoma Formation (108 ft thick) and below the Chino Mesa Basalts (75 ft thick), for a total thickness of 183 ft (Weir and Purtymun 1962, 0228).

The Totavi Lentil, which is a subunit of the Puye Formation, interfingers with other Puye Formation deposits and consists of sediments (ranging from fine-grained sands to gravels from both lacustrine and fluvial sources) and volcanics (both tephra and basaltic lavas). In PM-2 and PM-4, the Totavi Lentil is described as a conglomerate consisting mostly of sands and gravels (Purtymun et al. 1983, 0712; Cooper et al. 1965, 0495). Its total thickness is 40 ft at PM-4 (Purtymun et al. 1983, 0712), 70 ft at PM-2 (Cooper et al. 1965, 0495), and 46 ft at DT-10 (Weir and Purtymun 1962, 0228).

3.4.1.8 Santa Fe Group

The Santa Fe Group dates from about 21 to 4.5 Mya. It is divided into two formations, the Tesuque Formation (which consists of conglomerates, sandstones, mudstones, and limestones), and the Chamita Formation (which consists of conglomerates and sandstones). The maximum total thickness of the Santa Fe Group is approximately 7,710 ft.

At PM-2, the Tesuque Formation ranges from sand to gravel to conglomerates interfingered with basalts (Cooper et al. 1965, 0495). At PM-4, the Tesuque

Formation ranges from silt to clay to sand interfingered with basalts (Purtymun et al. 1983, 0712). The total thickness of the Tesuque Formation cannot be estimated from data from PM-2, PM-4, or DT-10 because these wells were not drilled completely through the Tesuque Formation.

3.4.2 Faults and Fractures

Numerous faults and fractures are present in the Los Alamos area. Both form fissures that can significantly alter the hydrologic properties of the rocks. Faults differ from fractures in that they exhibit displacement of the rocks on either side of the fault and they typically transgress boundaries between rock units.

A fault or fracture has the potential both to retard and to enhance contaminant migration. In some cases, open faults or fractures can serve as conduits that transport contaminants rapidly through a rock body. Conversely, because of secondary mineralization or other processes, fractures can severely impede the movement of contaminants. It is difficult to estimate the effect that a fracture or fault has on hydrologic properties in the absence of data on either fluid flow across the fracture or the physical characteristics (i. e. orientation, aperture, etc.) of the fracture.

Faults in the Los Alamos area are generally associated with one of three subsystems of the Pajarito Fault System. These subsystems are known as the Frijoles Canyon Segment, the Rendija Canyon Segment, and the Guaje Mountain Segment. The Frijoles Canyon and Rendija Canyon Segments lie more than 1 mi west of OU 1130, in what is believed to be the upstream direction of groundwater flow. Consequently, these two segments should not affect the local hydrogeology at OU 1130. Based on extrapolations from exposures to the north, the Guaje Mountain Segment probably lies approximately 0.5 mi west of OU 1130 and also should not directly affect the OU 1130 hydrogeology. However, detailed mapping of faults in the Los Alamos area suggests that many of the faults splay or change direction (Vaniman and Wohletz 1990, 0541). Consequently, it is possible that a fault splay associated with the Guaje Mountain Segment occurs in OU 1130. It is even more likely that other faults not associated with the Guaje Mountain Segment occur within OU 1130.

Numerous faults are inferred to exist in the OU 1130 area. A preliminary geological survey of the OU revealed clear evidence of a fault near the I-J site (referred to as the I-J Fault) (Figure 3-5). Currently, it is unclear whether this fault is related to the Guaje Mountain Segment or to another fault east of the Guaje Mountain Segment. Displacements of the I-J Fault of up to approximately 1 ft have been observed on several fractures exposed in a 300-ft-wide cliff face in the OU. Offsets of this size are larger than are typically observed for faults within the Laboratory boundary.

Additional mapping in the OU 1130 area is needed to identify and characterize potential faults and fractures throughout the unit. Faults, however, are extremely difficult to locate unless well-exposed, fresh road cuts are available; therefore, the exact nature of faulting in OU 1130 may be difficult to ascertain.

3.4.3 Soils

A discussion of the soils in the Los Alamos area can be found in Section 2.6.1.3 of the IWP (LANL 1992, 0768).

OU 1130 contains at least 18 different kinds of soils (Figure 3-6); each is described and mapped by Nyhan et al (1978, 0161). The soil mapping units used by Nyhan et al. are generalizations and may not correlate exactly with soils at specific locations; however, the soils that have been inferred from the existing data to exist under potential release sites or along probable transport pathways are discussed in this section.

3.4.3.1 Carjo Loam

The Carjo loam underlies the mesa top at the I-J site (the western part of Mesita del Potrillo). The Carjo loam is moderately deep (20 to 40 in.) and well drained. The upper 4 in. (the surface layer) consist of a loam or a fine sandy loam. The surface layer is underlain by approximately 15 in. of clay loam and clay (the subsoil), which are underlain by 4 in of very fine sandy loam (the substratum). Permeability of this soil is relatively low, and the ground surface slope generally

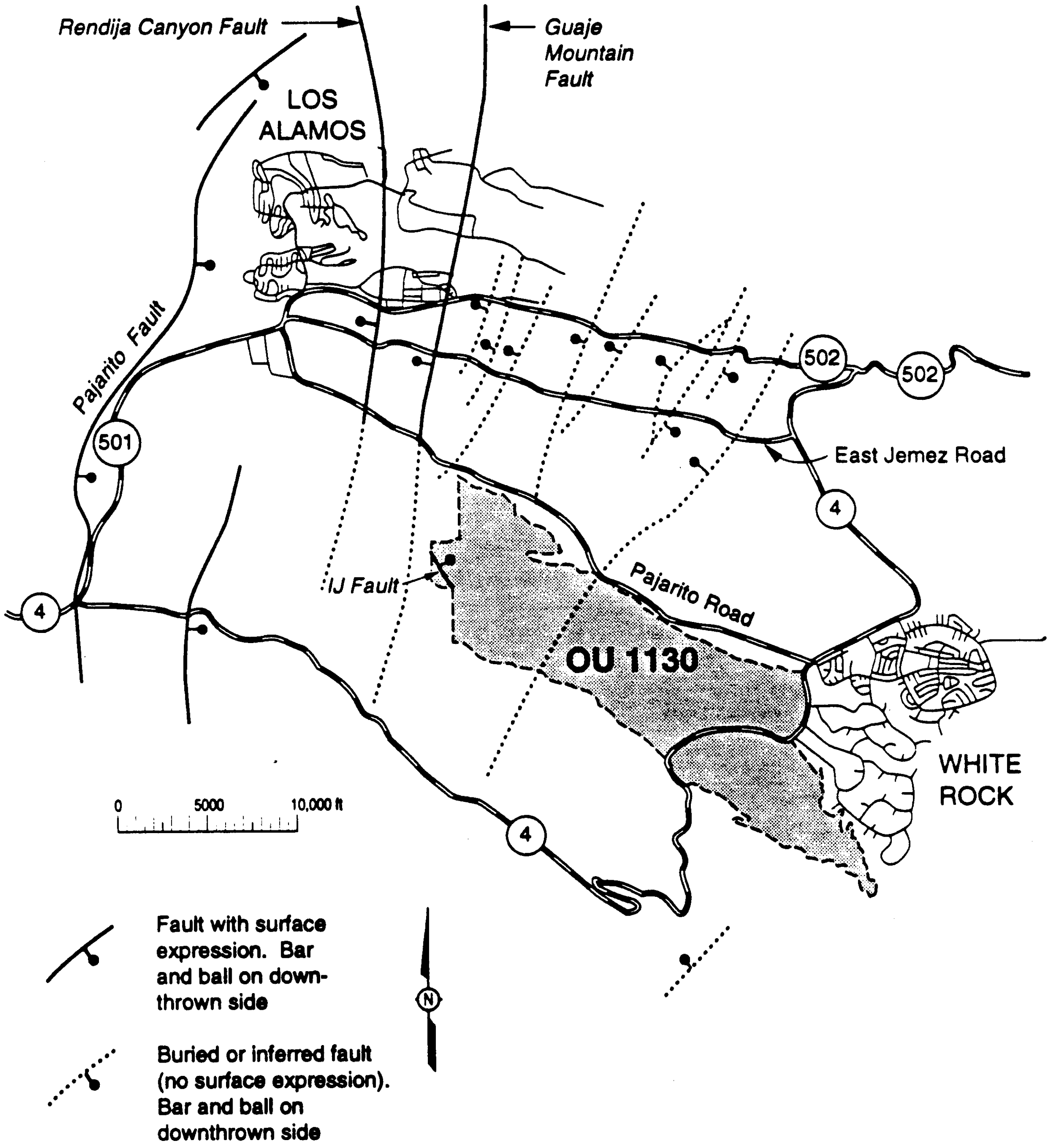

Figure 3-5. Faults in the vicinity of OU 1130.

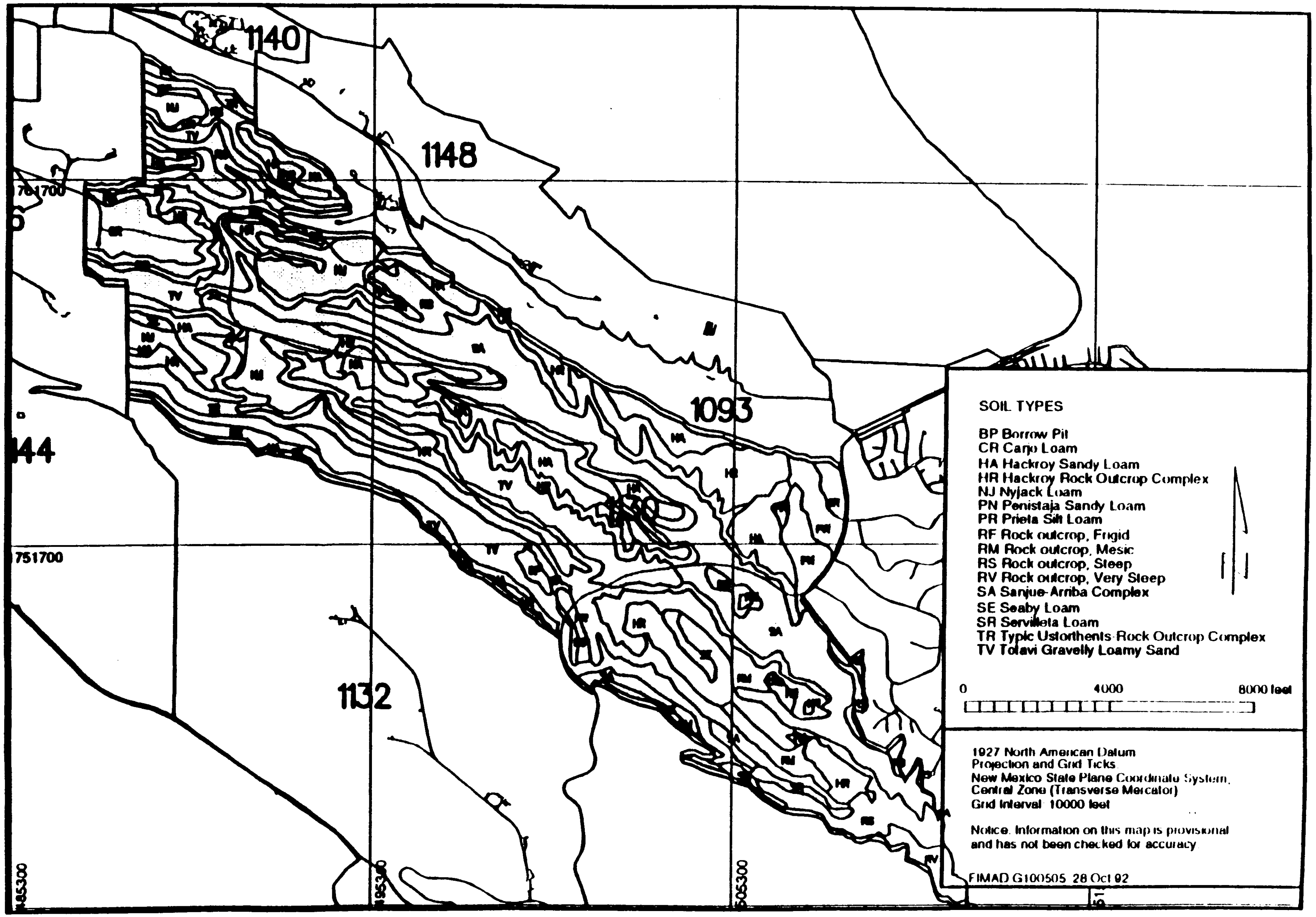

Figure 3-6. Soil distribution in OU 1130, as mapped by Nyhan et al. (1978, 0161).

ranges from 1% to 8%. As a result, surface runoff is moderate (Nyhan et al. 1978, 0161).

3.4.3.2 Nyjack Loam

The Nyjack loam underlies the eastern part of Mesita del Potrillo [i.e., the area below PRSs 36-002, 36-003(a), and 36-003(d)] and PHERMEX Mesa just south of Mesita del Potrillo (i.e., the area under the Eenie, Meenie, and Minie sites, and the boneyard). The Nyjack loam is similar to the Carjo loam in that it is moderately deep (20 to 40 in.) and well drained. The surface layer of the Nyjack loam consists of approximately 2 in. of either a loam, a very fine sandy loam, or a sandy loam. The subsoil is comprised of approximately 20 in. of clay loam, and the substratum is comprised of approximately 16 in. of gravely sandy loam that may contain up to 30% pumice. Permeability of this soil is moderate, with the surface slope generally ranging from 1% to 5%; therefore, surface runoff is slow (Nyhan et al. 1978, 0161).

3.4.3.3 Sanjue-Arriba Complex

The Sanjue-Arriba complex underlies a large part of Potrillo Canyon, including the area around and below Lower Slobbovia. The Sanjue-Arriba complex consists of deep (>60 in.), well-drained soils comprised of material derived from either pumice (Sanjue) or dacites of the Puye Conglomerate (Arriba). The surface layer consists of approximately 8 in. of gravely sandy loam or loamy sand. The substratum consists of approximately 50 in. of gravely sand. Ground surface slope profiles for the complex range from 16% to 40%. Permeability of the Sanjue series soils is medium high to very high, and the erodibility is moderate. Arriba series soils have a moderate to moderately slow permeability and a moderately high erodibility (Nyhan et al. 1978, 0161).

3.4.3.4 Totavi Sand

The Totavi sand underlies the upper sections of Potrillo Canyon (just downslope from the I-J site) and Fence Canyon (just downslope from the Meenie, Minie, and Moe sites). The Totavi sand formed in the alluvium of canyon bottoms is a deep and well-drained soil. The surface (and only) layer is approximately 20 in. of gravely loamy sand or sandy loam, containing 15% to 20% gravel. Permeability of this soil is very high, with the grade generally ranging from 0% to 5%; therefore, surface runoff is very slow (Nyhan et al. 1978, 0161).

3.4.4 Sedimentation and Erosion

Active erosional processes on the Pajarito Plateau are addressed in Section 2.6.1.6 of the IWP. At OU 1130, sediment deposition and erosion by surface water occurs episodically in response to snowmelt and storm-water runoff events. Periods of runoff can produce significant erosion, sediment transport, and deposition. Sediment accumulations >3 ft resulting from a single event have been measured in the active channel in Potrillo Canyon; however, no sediment budget analyses have been performed on the Pajarito Plateau.

Erosion is generally accelerated over areas where the natural soil surface has been disturbed, such as roads, firing site pads, burial pits, boneyards, and open dumps. Disturbed soil can both increase surface runoff and make soil more readily available for erosional processes (Graf 1975, 13-0009; Nyhan and Lane 1986, 0159).

Erosion by surface water can expose and transport contaminants from their original disposal location; sedimentation can then redeposit the contaminant of concern to another location within a watershed, either within or beyond the Laboratory boundary (Becker 1991, 0699).

Uranium, a heavy metal used in dynamic weapons testing at OU 1130, has been found to accumulate in specific geomorphologic deposits (Becker 1991, 0699). Depleted uranium (as distinguished from the naturally occurring uranium in Bandelier Tuff) preferentially accumulates in stream bank deposits, point bars, and alluvial fans in Potrillo Canyon. These deposits can be expected to accumulate other heavy metals, such as mercury, lead, and cadmium, derived from site operations.

Wind-driven erosion, transport, and deposition are also likely to occur at OU 1130; however, wind-driven processes are expected to be much less significant than the processes associated with surface-water-discharge events.

3.5 Hydrology

The hydrology of the Pajarito Plateau is summarized in Sections 2.6.2 through 2.6.6 of the IWP (LANL 1992, 0768). A discussion of surface water, the vadose zone, and groundwater specific to OU 1130 is presented in the following sections.

3.5.1 Surface Water

Precipitation that falls on the ground may go into storage on the surface or into soil and groundwater reservoirs. It may be taken up and then transpired by plants or may evaporate or sublimate back into the atmosphere. Precipitation that becomes overland flow and/or streamflow is the predominant mechanism for transporting and redistributing many of the contaminants at OU 1130. Surface-water discharge may move contaminants in the dissolved, suspended sediment, and bedload phases. Further, surface-water-driven erosion can expose contaminated horizons, thus permitting subsequent contaminant transport. Infiltration of surface water may also cause the migration of contamination deeper into the soil/rock profile.

3.5.1.1 Locations of Surface Water in OU 1130

Three separate watersheds, each with an established stream channel drainage network, exist within OU 1130. These are the Fence Canyon, the Potrillo Canyon, and the Water Canyon watersheds. In addition, part of the Pajarito Canyon watershed lies within the OU. Watershed locations with respect to OU 1130 are shown in Figure 3-1. Fence Canyon waters flow into Potrillo Canyon and then into Water Canyon; Pajarito and Water Canyon waters flow into the Rio Grande. Streamflow in Fence and Potrillo Canyons is ephemeral, with flow occurring only in response to rainfall and snowmelt events. Water Canyon and Pajarito Canyons receive flow from springs upstream from West Jemez Road, from wastewater discharge at TA-49, and from snowmelt and storm-water runoff.

The depth of flow resulting from snowmelt is generally small, usually only a few inches. The depth of flow resulting from rainfall can reach 3 ft or more. Crest stage measurements of flow made in Potrillo Canyon below the E-F firing site (approximately 2,000 ft northwest of I-J site) have recorded a maximum discharge of 30.7 cu ft per second, and flow of up to 57.6 cu ft per second was measured near Lower Slobbovia (Becker 1991, 0699).

3.5.1.2 Infiltration of Surface Water

Infiltration of surface water on the Pajarito Plateau is discussed in Sections 2.6.2 and 2.6.3 of the IWP (LANL 1992, 0768). In general, infiltration rates are highest in areas of disturbed soil and beneath the active stream channels in watersheds. In areas of undisturbed soil, little, if any, infiltration occurs because of the low permeability clay soil cap that forms from the weathering of the underlying tuff. Even in areas of disturbed soil and exposed bedrock, infiltration is expected to be minimal because of the high evapotranspiration rates and low volume of rainfall that occur on the Pajarito Plateau.

Of significant interest is a particular geomorphologic feature termed a discharge sink that has been identified in Potrillo Canyon. The discharge sink has been studied intensively by Becker (1991, 0699). Figure 3-7 shows the approximate location of the discharge sink. There is a strong indication that extremely rapid infiltration rates can occur at the discharge sink. Other characteristics of the discharge sink are greater inflow than outflow (if outflow occurs at all), reduced streamflow velocities, and minimal or no streambed channelization and flow continuity across the formation. Further, the sink is identified by sediment deposition and accumulation. All of these characteristics are primarily related to the high infiltration rates that occur through the discharge sink. It is not known which mechanism permits the observed infiltration rates, nor whether rapid vertical infiltration persists at depth. It has been suggested that the discharge sink allows infiltration to reach the underlying main aquifer much more quickly than may be occurring elsewhere on the Pajarito Plateau, but further investigation is required to determine whether this is occurring or whether infiltration reaches an impermeable boundary and discharges laterally.

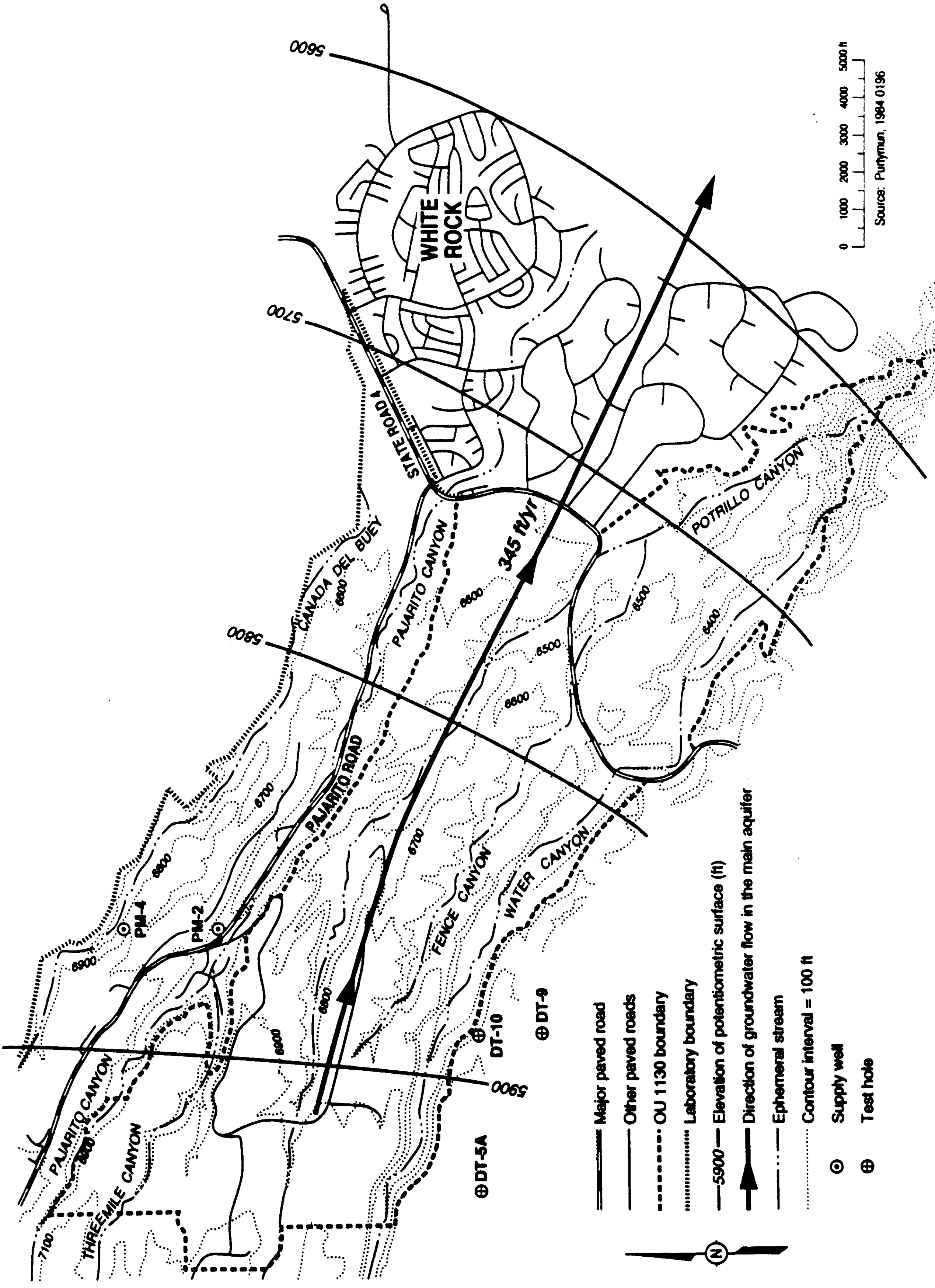

Figure 3-7. Groundwater flow in the main aquifer and water wells in the vicinity of OU 1130.

3.5.1.3 Slope Analyses

Overland flow velocities (discharges) increase proportionally to the square root of the angle of the slope over which the flow occurs. Because of the higher discharge rates (laterally) that occur on steeper slopes, the elevated hydrostatic pressure head that drives vertical infiltration will decline more rapidly, resulting in decreased total infiltration and, therefore, decreased movement of contaminants into the soil profile. Increased flow velocities have a greater capacity to erode sediment and any associated contaminants and to transport contaminated sediment, particulates, and contaminants in the dissolved phase away from their original disposal site. Conversely, overland sediment movement is slower on gentle slopes; however, elevated hydrostatic pressure heads persist longer on shallow slopes (because of the decreased rate of lateral discharge), permitting increased infiltration of surface water and greater vertical migration of contaminants.

There is a wide variation in slope within OU 1130. Slopes on the mesa tops are 2%. Steep-sided canyon walls that form the interface between the mesas and the canyon bottoms range in slope from 30% to 90%. Channel slopes over the whole canyon length range between 3% in Potrillo Canyon, 4% in Pajarito Canyon, 5% in Water Canyon, and 2% in Fence Canyon; however, there may be areas where the local slopes are steeper than these values.

3.5.2 The Vadose Zone

With the exception of those alluvial and perched aquifers in canyon bottoms that receive perennial flow or substantial volumes of wastewater effluent, unsaturated flow conditions predominate throughout the Bandelier Tuff down to the main aquifer. An overview of the vadose zone (unsaturated) hydrogeology of the Pajarito Plateau is presented in Section 2.6.3 of the IWP (LANL 1992, 0768). The IWP summarizes various studies on the movement of fluid through the Bandelier Tuff and provides information on the fundamental hydrogeologic properties of the tuff. Additional information on the vadose zone hydrogeology of the Bandelier Tuff and specific details from the IWP are presented below. Hydrogeologic studies have not been conducted at OU 1130; however, it is assumed that the properties of the tuff underlying OU 1130 are similar to the properties of the tuff determined elsewhere on the Pajarito Plateau.

3.5.2.1 Vadose Zone Soil and Rock Properties

This section summarizes data on the porosity, hydraulic conductivity, and moisture content of the upper 150 ft (approximately) of the Bandelier Tuff collected from several boreholes within the Laboratory boundary. Vadose zone characteristics below 150 ft have not been determined anywhere on the Pajarito Plateau. Two boreholes, MCM 5.1 and MCC 5.9A, were completed below an alluvial aquifer in Mortandad Canyon. Boreholes #6, #7, and SIMO-1 were drilled in Sandia and Mortandad Canyons in areas where no alluvial or perched water is present (Stoker et al. 1991, 0715; Stephens 1991, 13-0010). Additional data have been collected from a borehole in Potrillo Canyon, but the results of the moisture and soil characterizations have not been completed.

Porosity values in samples collected from Unit 1A of the Tshirege Member, the Tsankawi Pumice Bed, and the Otowi Members range from 41% to 62%. Values of porosity as a function of lithology as measured in the SIMO-1 borehole were 44% in the Otowi Member, and ranged from 55% to 56% in Unit 1A and from 41% to 62% in the Tsankawi Pumice Bed. Porosity values from borehole MCM 5.1 varied from 41% to 49% in alluvium, from 29% to 60% in weathered Unit 1A, from 50% to 63% in unweathered Unit 1A, and from 35% to 48% in the Tsankawi Pumice Bed (Stoker et al. 1991, 0715; Stephens 1991, 13-0010).

Unsaturated hydraulic conductivity measurements for Bandelier Tuff from the Mortandad Canyon boreholes range from 10^{-6} to 10^{-11} cm/s (as a function of decreasing moisture content). Upper-end in situ conductivities can increase to between 10^{-3} and 10^{-2} cm/s where the Tsankawi Pumice Bed and the Otowi Member come into contact. Saturated hydraulic conductivity ranges from 5.0×10^{-5} to 2.0×10^{-3} cm/s in areas below the alluvial aquifer in Mortandad Canyon (Stoker et al. 1991, 0715).

Gravimetric moisture measurements were also made in the boreholes in Mortandad and Sandia Canyons. Results indicated that the moisture content below the alluvial aquifer ranged from 10% to 30%. Gravimetric moisture increased to a peak of about 60% in the Tsankawi Pumice Bed just above and at the area of contact with the Otowi Member, then decreased to between 12% and 18% in the Otowi Member. In wells that were completed on mesa tops and did not reach the Otowi Member, the measured moisture content was 32% (Stoker et al. 1991, 0715; Stephens 1991, 13-0010). Other studies indicate that the natural moisture content of the tuff forming the mesas is typically less than 5% at depths greater than a few tens of feet (LANL 1992, 0768).

Laboratory measurements of the specific retention (residual moisture content) for various units of the Bandelier Tuff varied from 8% to 28%, with the majority of samples showing a specific retention of less than 20%.

3.5.2.2 Moisture Movement in the Vadose Zone

Under unsaturated conditions, moisture moves through the Bandelier Tuff by vapor phase diffusion, capillarity, and gravity. At moisture contents between 4% and 8%, gaseous diffusion is the dominant water-moving mechanism. Between 8% and 23%, both gravity and capillarity become significant, and, above 23%, gravity alone becomes the dominant water-moving mechanism (LANL 1992, 0768).

3.5.3 Groundwater

Saturated groundwater occurs in three modes on the Pajarito Plateau: shallow alluvial groundwater bodies in canyon bottoms, isolated perched horizons in conglomerates and basalts at depths between 120 and 200 ft, and the main aquifer underlying the entire plateau. A discussion of groundwater on the Pajarito Plateau is presented in Sections 2.6.4, 2.6.5, and 2.6.6 of the IWP (LANL 1992, 0768).

3.5.3.1 Shallow Alluvial and Perched Groundwater

There has been little drilling to determine the presence of perched or alluvial groundwater in Pajarito, Potrillo, Fence, or Water Canyons. However, the following generalizations can be made, based on the geology and hydrology of these canyons and on hydrogeologic observations made in other canyons of the Pajarito Plateau.

Fence Canyon has a small drainage area that begins on Pajarito Plateau; snowmelt runoff and storms during the spring, summer, and fall induce the ephemeral streamflow in the canyon. It is unlikely that there is perched or alluvial water in this canyon.

Potrillo Canyon begins on Pajarito Plateau at TA-15. Streamflow in the channel results from snowmelt and runoff from storm events in the spring, summer, and fall. The stream channel in the upper reaches of the watershed cuts directly through the Bandelier Tuff. There is little or no alluvial fill in this reach of the watershed; therefore, it is unlikely that an alluvial or perched aquifer has formed in this area. No alluvial or perched aquifers were found in OU 1130, where streamflow discharge is greater because of the larger size of the contributing area.

Water Canyon is a large canyon that begins on the flanks of the Sierra de Los Valles. Discharge from perched groundwater zones within the tuff forms several springs in Upper Water Canyon; the largest of these springs has been used as the water supply for S-Site. Water Canyon also receives wastewater discharge from TA-15 and TA-49. Beta Hole, a now dry well completed 187 ft into the Bandelier Tuff, was drilled a short distance downstream from the confluence of Water Canyon and Cañon de Valle. Two other shallow wells, one within OU 1130 and another just outside OU 1130, were completed into the alluvium in Water Canyon. These wells are also dry. The lack of water in these wells supports the assumption that there is no alluvial groundwater in Water Canyon near OU 1130.

Pajarito Canyon also begins on the flanks of the Sierra de Los Valles. Pajarito Canyon receives flow from storm water runoff and snowmelt as well as from some wastewater effluent discharge at TA-18. Streamflow recharges a shallow alluvial groundwater body near TA-18. This aquifer's size and volume fluctuate in response to recharge from the stream channel and from infiltrating precipitation. Shallow wells east of TA-18 have confirmed that the spatial boundaries are limited to the canyon bottom. The extent of the aquifer within the upstream/downstream axis of the canyon is not well established (Devaurs and Purtymun 1985, 0049).

3.5.3.2 The Main Aquifer

The main aquifer is the only aquifer in the Los Alamos area capable of municipal and industrial water supply. The potentiometric surface of the main aquifer rises to the west from the Rio Grande, passes through the Santa Fe Group, and continues into the lower part of the Puye Conglomerate beneath the central and western parts of the Pajarito Plateau. The water in the aquifer generally moves eastward across the plateau toward the Rio Grande. There is some groundwater discharge into the Rio Grande through seeps and springs (Figure 3-7) (Purtymun 1984, 0196).

No wells are completed into the main aquifer beneath OU 1130; therefore, all inferences regarding the portion of the main aquifer beneath the OU are derived from information on supply wells PM-2 and PM-4, and test wells DT-5A, -9, and -10 (Figure 3-7).

The aquifer beneath TA-36 is stratigraphically within the basaltic rocks of Chino Mesa, the interflow breccia in the Puye Conglomerate, and the Santa Fe Group. Not all of these types of rock transmit water equally well. Thick basalts, siltstones, and fine-grained sandstones will not yield water as readily as coarse-grained conglomerates and sandstones, highly jointed basalts, and interflow breccias. To maximize production, supply and test wells are screened through a thick section of the aquifer to draw from multiple high-permeability layers.

The depth to water varies from about 875 to over 1,100 ft (Purtymun and Stoker 1988, 0205), with depths increasing from east to west as a function of increasing surface elevation. Aquifer hydrologic characteristics vary. Supply well PM-2 is open in the Puye Conglomerate and Santa Fe Group for a total saturated thickness of 1,426 ft. The aquifer in the area of PM-2 has a specific capacity of 23.1 gpm/ft, a transmissivity of 40,000 gpd/ft, and a field coefficient of permeability of 28 gpd/ft^2. Supply well PM-4 is open in the Puye Conglomerate and Santa Fe Group for a total saturated thickness of 1,828 ft. The aquifer in the area of PM-4 has a specific capacity of 36.8 gpm/ft, a transmissivity of 44,000 gpd/ft, and a field coefficient of permeability of 24 gpd/ft^2. Test well DT-5A, open to the Puye Conglomerate and Santa Fe Group, has a total saturated thickness of 643 ft. The specific capacity is 5.7 gpm/ft, the transmissivity is 11,000 gpd/ft, and the field coefficient of permeability is 17 gpd/ft^2. Test well DT-9 is open in the Puye Conglomerate and the Santa Fe group for a total saturated thickness of 498 ft. The specific capacity is 22 gpm/ft, the transmissivity is 61,000 gpd/ft, and the field coefficient of permeability is 122 gpd/ft^2. Test well DT-10, 0.75 mi north of DT-9, is open in the Puye Conglomerate and the Santa Fe Group for a total saturated thickness of 324 ft. The specific capacity is 16 gpm/ft, the transmissivity is 36,100 gpd/ft, and the field coefficient of permeability is 111 gpd/ft^2 (Purtymun 1984, 0196).

The water levels in the main aquifer have declined as a result of pumping. The static water level has declined 25 ft in PM-2 since 1966, and 34 ft in PM-4 since 1984. The static water level in DT-10 has declined about 0.5 ft/yr. The decline in DT-10 results from a decrease in annual recharge to the aquifer and not from pumping of the well. A similar decline was observed in DT-5A (Purtymun 1984, 0196).

The waters from wells PM-2, PM-4, DT-5A, DT-9, and DT-10 are sodium bicarbonate waters of similar quality. Hardness ranges from 35 to 42 ppm; the total dissolved solids range from 124 to 165 ppm; the chlorides are low, ranging from 2 to 9 ppm; and the fluorides range from less than 0.2 to 0.3 ppm (Purtymun 1984, 0196).

Water quality samples from wells DT-5A, -9, and -10 have shown that there has been no significant change in the measured chemical or radiochemical water-quality parameters since the first samples were collected from the wells in 1960 (Purtymun and Stoker 1987, 0204). Since 1964, there has been no significant change in the water collected from springs along White Rock Canyon, which are hydrologically downgradient from the test wells. The chemical and radiochemical qualities of supply and test well waters are presented in the Laboratory's annual surveillance reports.

3.6 Conceptual Hydrogeologic Model of OU 1130

The following section describes and reviews the hydrologic behavior of watersheds in OU 1130.

Precipitation falls on a watershed as either snow or rain. Snowmelt produces low discharge over several months during the spring. Much of the snow sublimates, melts and evaporates, or melts and infiltrates into the soil profile before reaching the main drainage channel of the watershed. Rainfall, primarily during the summer months, accounts for 40% of the annual precipitation and frequently produces high discharges of short duration. As with snowmelt, a significant volume of rainfall evaporates or infiltrates into the soil profile before it reaches the main drainage channel of the watershed. Infiltration losses into the main channel bed also occur.

In the large watersheds, such as Water Canyon and Pajarito Canyon, very large precipitation events or the snowmelt from heavy snowpack can produce channel flow that persists to the Rio Grande. More often, during average-sized rain events, or moderate to light snowpack melts, the channel flow infiltrates into the channel bed and does not produce flow over the entire length of the watershed. This is also a common occurrence in the smaller Fence Canyon watershed.

The presence of the discharge sink in Potrillo Canyon significantly affects the hydrologic behavior of the Potrillo Canyon watershed. The discharge sink absorbs streamflow and traps all of the incoming sediment load to the sink. There is no evidence of streamflow downstream from the discharge sink, and, although there has probably been outflow from the area in the past, the discharge sink has apparently served as a sediment detention area since at least 1968. Therefore, surface waters derived from the upstream portion of the Potrillo Canyon watershed do not contribute to flows that reach the Rio Grande through Water Canyon (Becker 1991, 0699).

The dominant contaminant redistribution processes occurring within OU 1130 are probably surface-water-discharge-driven erosion and sediment/solute transport. Temporary sediment storage features, such as point bars, stream bank deposits, alluvial fans, and the discharge sink in Potrillo Canyon, have been shown to accumulate depleted uranium and are likely to retain other heavy metals as well. Some subsurface transport through the vadose zone driven by surface water infiltration may also occur. The magnitude of unsaturated zone groundwater flow is uncertain, but is expected to be small; however, rapid infiltration rates observed at the discharge sink and the lack of surface water discharge from the sink area indicate that significantly higher rates of subsurface transport may be occurring. Because of the large volume of streamflow that infiltrates into the rather small discharge sink area (less than 1,500,000 sq ft), the sink may be a prime location for significant recharge to the main aquifer to occur on the Pajarito Plateau. The discharge sink in Potrillo Canyon is probably not unique, but similar features have not been identified in OU 1130 (Becker 1991, 0699).

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Executive Summary

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Chapter 4

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4.0 TECHNICAL APPROACH

4.1 Aggregation of PRSs

This section outlines the general approach used to accomplish the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for Operable Unit (OU) 1130. Potential Release Sites (PRSs) with similar characteristics and concerns have been aggregated to reduce redundant discussions of common technical approaches. These aggregated PRSs are septic systems 36-003(a) and 36-003(b) and active firing sites Eenie [36-004(a)], Meenie [36-004(b)], Minie [36-004(c)], Lower Slobbovia [36-004(d)], and I-J [36-004(e)]. In addition, the following PRSs will be investigated individually: material disposal area (MDA) AA (36-001), the sump (36-002), the Boneyard (36-005), surface disposal area (36-006), containment vessel near I-J firing site (C-36-001), photo outfall (C-36-003), and projectile testing area [C-36-006(e)].

4.2 Approaches to Site Characterization

The goal of the RFI described in this work plan is to ensure that human health and environmental impacts associated with past activities at OU 1130 are investigated in compliance with the Laboratory's Hazardous and Solid Waste Amendments (HSWA) permit. This work plan adheres to the Environmental Restoration (ER) Program's technical approach for data collection and evaluation, as documented in Chapter 4 of the Installation Work Plan for Environmental Restoration (IWP) (LANL 1992, 0768). This technical approach adopts the philosophy of the Observational Approach (LANL 1992, 0768), which bases decisions for action (e.g., collecting additional data, versus moving from the facility investigation to the corrective measures study) on definitions for acceptable uncertainties that depend on the current phase of the investigation. Investigations are phased so that decisions remain closely tied to the ultimate goal of selecting an appropriate corrective action, and are formulated in light of what is already known about the site. The phased approach allows intermediate data evaluation in order to develop better focused sampling plans, targeted to collect the data needed to make a decision. The ER Program has adopted a risk-based approach to making corrective action decisions during the RCRA facility investigation/corrective measures study (RFI/CMS) process. In this work plan, the Data Quality Objectives process [Chapter 4 and Appendix H of the IWP (LANL 1992, 0768)] is used to identify site-specific risk-based decisions or risk-related questions, to identify and in some cases quantify risk-based decision errors, and to specify sampling designs to support the risk-based decisions or risk-related questions.

4.2.1 Decision Model

The decision logic for development of this work plan and subsequent RFI/CMS activities is illustrated in Figure 4-1. The first step in the RFI is to evaluate archival information and make field reconnaissance visits to formulate a conceptual model for the site. Archival information includes reports, memoranda, letters, and photographs pertaining to the history of operations associated with each PRS and with the OU in general. These data are used to develop a list of potential contaminants of concern.

As shown in Figure 4-1, no further action (NFA) or deferred investigation may be recommended after the first step of the RFI. Criteria for NFA based on archival information are discussed in Section 4.4.1, and the details are described in Appendix I and Section 4.1 of the IWP (LANL 1992, 0768). The PRSs recommended for NFA or deferred investigation based on archival information are presented in Chapter 6. For active PRSs, full characterization may be deferred if current risks are acceptable.

For most PRSs in OU 1130, archival information indicates that it is highly probable that there are no contaminants of concern at the site, but existing data and archival information are not sufficient to recommend NFA. For these sites, and for sites where virtually no information exists, Phase I investigations will be screening assessments to determine the presence or absence of contaminants of concern. Contaminants of concern are defined as hazardous constituents or radionuclides whose concentrations (adjusted for background) in environmental media or manmade materials are above screening action levels. Screening action levels are media-specific concentration levels for potential contaminants derived using conservative criteria. They are discussed in Section 4.2.2.

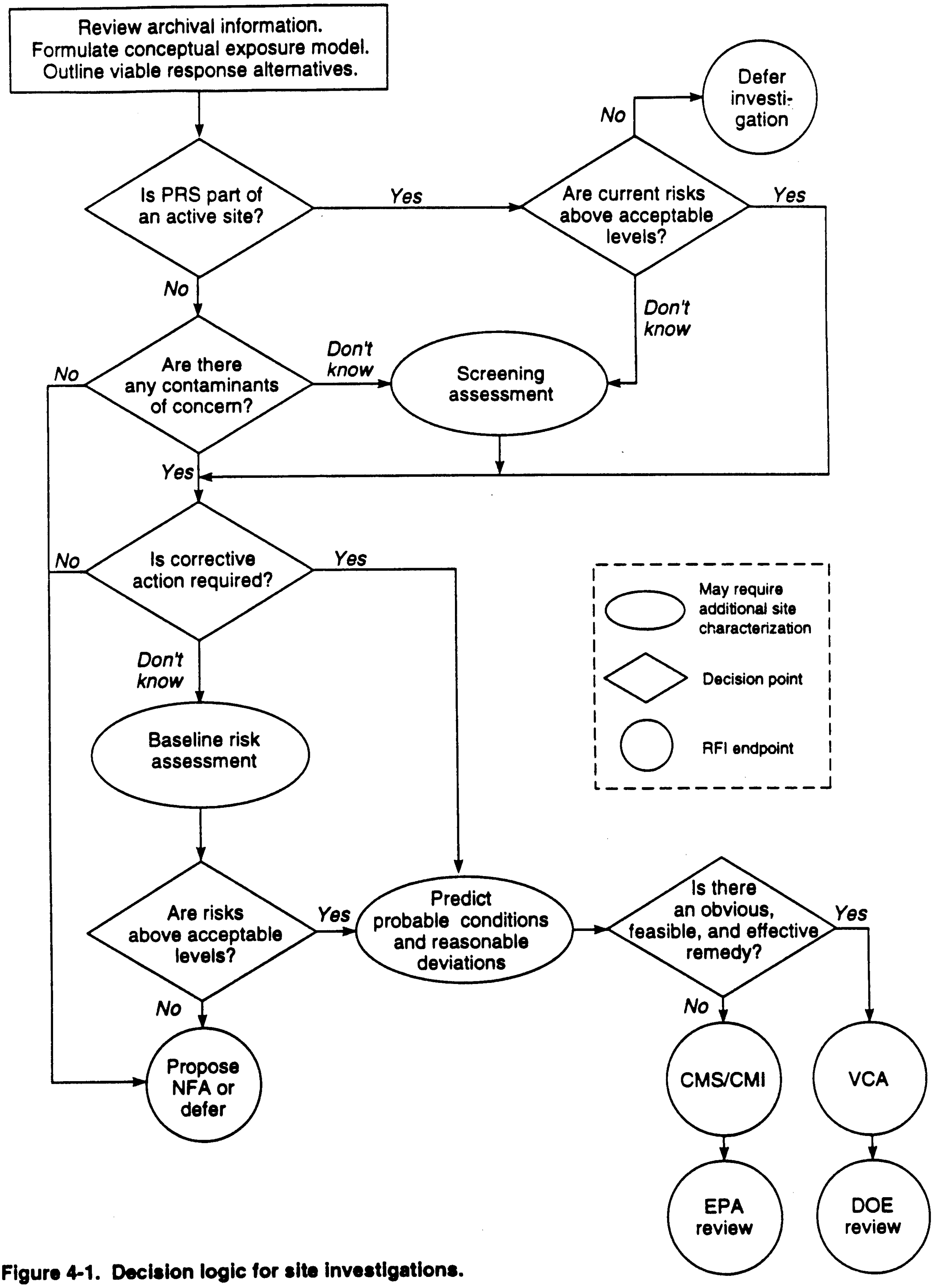

Figure 4-1. Decision logic for site investigations.

A primary goal of screening assessments is to identify PRSs that pose no hazard to human health or the environment, so that they can be recommended for NFA. Eliminating nonproblems through screening assessments allocates resources efficiently and effectively, and allows timely corrective actions to be taken for those PRSs that present the greatest potential hazard. Sampling plans for these screening assessments are given in Chapter 5.

Contaminants of concern can be reasonably expected for some PRSs in OU 1130, but the full extent of their occurrence is unknown. Although corrective action may be required, Phase I investigations are needed to address the nature of that corrective action. For other PRSs, Phase I investigations could identify the need for a corrective action. Whenever corrective action is indicated, if there is an obvious, feasible, and effective remedy, then a voluntary corrective action (VCA) (Section 4.2.3) will be implemented; otherwise, a CMS will be required. Two kinds of sampling strategies are used in a screening assessment, reconnaissance sampling and preliminary baseline risk assessment sampling. The purpose of reconnaissance sampling is to determine whether there are any contaminants of concern at a PRS where there is little or no historical information. The purpose of preliminary baseline risk assessment sampling is to collect data to calculate the upper 95th confidence limit of average concentrations of contaminants of concern, so that a baseline risk assessment may be performed.

If contaminants of concern are detected in the screening assessment, a baseline risk assessment will be performed, and a decision will be made to implement a VCA or perform a CMS. Additional characterization data may be required for the baseline risk assessment. If so, it would be collected as a Phase II investigation.

4.2.2 Screening Action Levels

Screening action levels are media-specific concentration levels for potential contaminants derived using conservative criteria. In most cases, screening action levels for nonradiological potential contaminants are based on the methodology described in Proposed Subpart S to RCRA to calculate action levels (EPA 1990, 0432). Radiological screening action levels are based on a 10-

mrem-per-year dose limit with a residential-use exposure scenario; however, if a regulatory standard exists and is lower than the value derived by these methods, this lower value is used in place of the screening action levels. Derivation of screening action levels is discussed in Chapter 4 of the IWP, and the values are given in Appendix J of the IWP (LANL 1992, 0768).

Screening action levels are tools for efficient discrimination between problem and nonproblem sites, so that resources can be allocated effectively. Screening action levels are not cleanup levels. Therefore, chemical-specific risk-based remediation goals (RGs) will be developed using site-specific exposure conditions and the "as low as reasonably achievable" (ALARA) criteria. In most cases, RGs will be higher than screening action levels. For example, if the site will never be residential-use, the site-specific land-use scenario (e.g., recreational use) could allow higher levels of soil contamination than the conservative residential-use scenario used to calculate screening action levels. Screening action levels for the primary potential contaminants of concern at OU 1130 are given in Table 4-1.

Natural background concentrations for a few inorganic analytes (i.e., barium, beryllium, lead, mercury, silver, and uranium) in soil are provided in Table 4-1. All of the natural background concentrations for these analytes are below the screening action limit. However, should inorganic analytes be present on the site at naturally occurring levels that exceed the screening action level, natural background risk will be calculated separately from site-related risk (EPA 1989, 0305).

4.2.3 Voluntary Corrective Actions

VCAs may be proposed at any stage of the RFI as an expeditious alternative to the complete RCRA program with a formal CMS phase. A VCA may be proposed for a PRS if contaminants of concern have been identified, and if an obvious and effective remedy is available that meets treatment and disposal restrictions and other limiting criteria. Implementing a VCA requires submission of a change control for DOE approval. VCAs on sites that contain mixed or land-

TABLE 4-1

COMPARISON OF SCREENING ACTION LEVELS WITH PRACTICAL QUANTITATION LIMITS FOR AVAILABLE ANALYTICAL METHODS

	SOIL				WATER		
CONTAMINANTS	SAL (mg/kg)	PQL (mg/kg)	Background in Soil (mg/kg)[a]	PQL versus SAL[b]	SAL (ug/L)	PQL (ug/L)	PQL versus SAL[b]
INORGANICS[c]							
Barium	5,600	0.2	120-810		2,400	2	
Beryllium	0.16	0.03	1-3		0.0081	0.3	X
Cadmium	80	0.4			35	4	
Chromium III	80,000	0.7			50	7	
Chromium IV	400	0.7			50	7	
Cyanide	1,600	5			200	10	
Lead	500	4.2	8-98		50	42	X
Mercury	24	0.0002	.007-.029		2	0.02	
Nickel	1,600	1.5			700	15	
Silver	400	0.7	<1.6		50	7	
Uranium	240	0.0005	1.54-6.73		100	2	
Zinc	24,000	0.2			10,000	2	
VOLATILES[d]							
Acetone	8,000	0.1			3,500	100	
Benzene	0.67	0.005	0		1.2	5	X
Carbon tetrachloride	0.21	0.005			0.27	5	X
Chlorobenzene	67	0.005			100	5	
Chloroform	0.21	0.005			5.7	5	X
1,1-Dichloroethane	410	0.005			25	5	
1,1-Dichloroethene	0.59	0.005			0.58	5	X
1,2-Dichloroethane	0.2	0.005			0.38	5	X
Methylene chloride	5.6	0.005			4.7	5	X
1,1,2,2-Tetrachloroethane	3.9	0.005			1.8	5	X
Tetrachloroethene	5.9	0.005			0.67	5	X
Toluene	890	0.005			750	5	
1,1,1-Trichloroethane	1,000	0.005			60	5	
Trichloroethene	3.2	0.005			3.2	5	X
Xylenes (Total)	160,000	0.005			620	5	
SEMIVOLATILES[e]							
Acenaphthene	4,800	0.66			2,100	10	
Acenaphthylene	ND	0.66		?	ND	10	?
Anthracene	24,000	0.66			10,000	10	
Benzo(a)anthracene	ND	0.66		?	ND	10	?
Benzo(k)fluoranthene	ND	0.66		?	ND	10	?
Benzo(ghi)perylene	ND	0.66		?	ND	10	?
Bis-(2-chloroethyl)ether	0.13	0.66		X	0.032	10	X
Bis-(2-ethylhexyl)phthalate	50	0.66			2.5	10	X
Butyl benzyl phthalate	16,000	0.66			7,000	10	
2-Chlorophenol	400	0.66			170	10	
Chrysene	ND	0.66		?	ND	10	?
Dibenz(a,h)anthracene	ND	0.66		?	ND	10	?
Di-n-butylphthalate	8,000	f		?	3,500	10	
2,4-Dichlorophenol	240	0.66			100	10	
Diethylphthalate	64,000	0.66			28,000	10	
2,4-Demethylphenol	1,600	0.66			700	10	

TABLE 4-1 (concluded)

COMPARISON OF SCREENING ACTION LEVELS WITH PRACTICAL QUANTITATION LIMITS FOR AVAILABLE ANALYTICAL METHODS

	SOIL				WATER		
CONTAMINANTS	**SAL** (mg/kg)	**PQL** (mg/kg)	**Back-ground in Soil** (mg/kg)[a]	**PQL versus SAL**[b]	**SAL** (ug/L)	**PQL** (ug/L)	**PQL versus SAL**[b]
Dimethyl phthalate	80,000	0.66			35,000	10	
2,4-Dinitrotoluene	1	0.66		X	0.051	10	X
Fluoranthene	3,200	0.66			1,400	10	
Fluorene	3,200	0.66			1,400	10	
Indeno[1,2,3-cd]pyrene	ND	0.66		?	ND	10	?
Naphthalene	3,200	0.66			30	10	
4-Nirophenol	ND	3.3		?	ND	50	?
N-Nitrosodiphenylamine	140	0.66			7.1	10	X
Pentachlorophenol	5.8	3.3		X	0.29	50	X
Phenanthrene	ND	f		?	ND	f	?
Phenol	48,000	0.66	0		21,000	10	
Pyrene	2,400	0.66			1,000	10	
2,4,6-Trichlorophenol	64	0.66			3.2	10	X
EXPLOSIVES[g]							
Barium nitrate	5,600	f		?	ND	f	
TNT	40/233	f		?	ND	f	
2,4-DNT	160/1	0.42		X	ND	f	
2,6-DNT	4/1	0.4		X	ND	f	
1,3-DNB	8	0.59			ND	f	
2-AMINO-2,6DNT	ND	f		?	ND	f	
RDX	240/64	0.98			ND	f	
PETN	1,600	f		?	700	f	
Tetryl	800	0.25			ND	f	
NC(nitrocellulose)	ND	f		?	ND	f	
RADIONUCLIDES[h]	pCi/g	pCi/g			pCi/L	pCi/L	
Cs-134	1.5	0.1			NA	20	?
Cs-137	3.2	0.1			NA	20	?
Pu-239	20.15	0.005			NA	0.04	?
Sr-90	4.46	2		X	NA	3	?
Th-232	0.72	0.01			NA	0.1	?
U-233	69.9	0.01			NA	0.2	?
U-235	14.75	0.05			NA	0.2	?
U-238	47.81	0.01			NA	0.2	?
Tritium[i]	ND	400		?	NA	400	?

a. Available background levels from Ferenbaugh et al. 1990, 0099 and Longmire, 1993, in preparation.
b. Constituents for which the PQL is higher than 0.1 times the screening action level.
c. EPA Method 1990.
d. EPA Method 8240.
e. EPA Method 8270.
f. PQLs not available.
g. US Army Toxic and Hazardous Materials Agency procedures.
h. Method documented in DOE 1983, except for Pu-239, which uses radiochemical separation and alpha spectrometry.
i. Screening action levels not provided.
NA Not available.
ND Toxicity data not available.

disposal-restricted wastes may not proceed without a plan for storage and/or disposal that has been approved by DOE and the appropriate regulatory agencies. VCAs will be described in technical quarterly reports to EPA, and the public will be informed of VCAs in quarterly public meetings, but the ER Program will not formally solicit EPA approval for VCAs until it requests final approval of the cleanup.

4.2.4 Inactive PRSs

The following inactive PRSs will be investigated: the Boneyard (36-005), the sump (36-002), and septic systems [36-003(a) and 36-003(b)]. The goal of the Phase I investigation in OU 1130 is to determine whether contaminants of concern are present in the PRSs' surface and subsurface soils. Surface soils will be sampled along with most PRSs to ascertain potential current environmental and health risks caused by migration from the source term.

The Boneyard (36-005) is within the hazard range of an active firing site, but it may have received potential contaminants of concern other than those from the firing range; therefore, the Boneyard investigation will not be deferred with that of the firing range.

If the Phase I investigation detects contaminants of concern, a baseline risk assessment will be performed to assess current and future risks. If more data are required for the baseline risk assessment, a Phase II investigation will be conducted. After the risk has been calculated, a decision will be made to propose NFA, implement a VCA, perform a CMS, or defer action. Should a decision be made to implement a VCA or to perform a CMS, chemical-specific risk-based RGs will be developed using site-specific exposure conditions and the "as low as reasonably achievable " (ALARA) criteria.

4.2.5 Active Sites

Many PRSs in OU 1130 are part of active systems. These include firing sites [36-004(a, b, c, d, e)], a surface disposal site (36-006), a contaminated chamber at the I-J site (C-36-001), and projectile testing at the I-J site [C-36-006(e)].

Because of changes in operations at OU 1130, many of the contaminant sources for these PRSs no longer exist; thus, contamination could be present only because of past practices. Active operations could be changing site conditions continually; therefore, it is not appropriate to characterize these areas or to evaluate corrective actions at this time. The inactive surface disposal site, 36-006, is located within the hazard range of firing site Eenie [36-004(a)]. The surface disposal site has received only the potential contaminants of concern that the firing site has received, and, therefore, it will be considered for deferred action along with the firing site. Final investigations and permanent corrective actions (if required) for active PRSs will be addressed when the sites become inactive.

These proposals for deferred investigation, however, must be accompanied by a determination that the PRSs will not pose an unacceptable current risk to human health or the environment. Therefore, the RFI will ascertain whether offsite migration of contaminants from active PRSs in OU 1130 could result in offsite concentrations that exceed screening action levels. If it is ascertained that these levels could be exceeded offsite, a Phase II survey will be conducted or a VCA will be implemented.

4.3 Conceptual Exposure Models for OU 1130

A conceptual exposure model was developed to identify potential contaminant migration pathways and any potential human receptors. This information helps to specify the location and magnitude of sampling and the analytical methods needed to characterize PRSs at OU 1130 accurately. A conceptual model includes identification of chemicals present, characterization of the release of contamination, determination of migratory pathways, and identification of human receptors.

4.3.1 Potential Contaminants of Concern

Table 4-1 lists the regulated substances that have been identified from archival information as potential contaminants of concern for OU 1130. Any chemical or radiological substance considered hazardous to human health will be identified in the RFI work plan for characterization and eventual cleanup. Chemicals that are essential human nutrients at low concentrations and toxic at very high levels (e.g., potassium and magnesium) will not be quantified in a baseline risk assessment.

The fate and transport of potentially hazardous chemicals and radiation are evaluated to predict future exposures and to help link sources with currently contaminated media. This section discusses physical and chemical properties affecting the environmental mobility and degradation of potential contaminants of concern at OU 1130.

The potential contaminants of concern at each PRS or PRS aggregate are summarized in Table 4-2

4.3.1.1 Potential Contaminants from Firing Site Activities

Several types of potential contaminants may be present in the soils, sediments, and/or groundwater at firing sites where explosives were tested and detonated. These include asbestos and inorganic metals (e.g., barium, beryllium, lead, uranium, copper, and iron) from the device that contained the explosive; the residual parent explosive, including production impurities and inorganic metals; products of incomplete detonation; and degradation products.

4.3.1.1.1 Types of Explosives

Explosives can be divided into three classes: primary or initiating, boostering, and secondary (bursting charge) explosives.

Primary explosives are used in squibs, low-energy detonators, fuses, and explosive bolts and fasteners, which are assembled into test devices. Lead azide and lead styphnate are examples of primary explosives. The majority of detonators assembled into test devices are of the exploding bridge wire (EBW) type. These contain boostering explosives such as cyclotetramethylene tetranitramine (HMX), cyclonitrite or cyclotrimethylenetrinitramine (RDX), and tetryl. Examples of secondary explosives include baratol, the cyclotols, trinitrotoluene (TNT), and several plastic-bonded explosives (PBX) and extrudable explosives (XTX).

TABLE 4-2

POTENTIAL CONTAMINANTS OF CONCERN

PRS	Potential Contaminant
MDA AA (36-001)	Uranium, metals, and explosives
Sump (36-002)	Uranium, metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and explosives
Septic System [36-003(a)]	Cyanide, metals, VOCs, and SVOCs
Septic System [36-003(b)]	Uranium, explosives, metals, VOCs, and SVOCs
Active Firing Sites [36-004 (a), (b), (c), (d), (e)]	Asbestos, uranium, metals, VOCs, SVOCs, and explosives
Boneyard (36-005)	Asbestos, uranium, gamma emitters, metals, VOCs, SVOCs, and explosives
Photo Outfall [C-36-006(e)]	Metals, cyanide, and SVOCs

The parent explosive generally consists of the original explosive organic (e.g., HMX, RDX, or TNT) and a bonding material such as a plasticizer, a polystyrene, a wax, etc. These explosives may also contain production impurities and inorganic constituents such as aluminum, boron, barium, copper, iron, lead, and zinc.

4.3.1.1.2 Potential Contaminants of Concern

Several of the constituents and/or degradation products of these explosives and their associated experimental devices are carcinogens and/or systemic toxicants. Explosive constituents (i.e., parent explosives, along with their production impurities and environmental degradation products) that have been detected in the environment (Layton et al. 1987, 13-0085), and that have health criteria values developed by the EPA, have been selected as potential contaminants of concern.

The explosives used at the I-J firing site included boracitol, baritol, TNT, Composition B, cyclotol, PBX-9494, and nitromethane. Liquid explosives included benzene-ring compounds, n-hexane, cyclohexane, nitrogen oxide, and nitroglycerin (Henke and Van Marter 1992, 13-0093; Kelkar 1992, 13-0060). Other explosives included barium nitrate and diphenylamine. The potential contaminants of concern associated with these explosives include the parent explosive, along with any manufacturing impurities, and its environmental degradation products.

The nominal composition of these explosives is contained in Table 4-3.

TABLE 4-3

NOMINAL COMPOSITION OF ESTABLISHED EXPLOSIVES

Explosive	Composition
Baritol	76% barium nitrate, 24% TNT
Barium nitrate	100% barium nitrate
Boracitol	60% boric acid, 40% TNT
Composition B	60% RDX, and 40% TNT
Cyclohexane	100% cyclonexane
Cyclotol	70 - 75% RDX (Cyclonite), 30 - 25% TNT
Diphenylamine	100% diphenylamine
n-Hexane	100% n-hexane
Nitrogen oxide	100% nitrogen oxide
Nitroglycerin	100% nitroglycerin
Nitromethane	100% nitromethane
PBX-9494	3% Chloroethyl phosphate, 3% nitrocellulose, 94% RDX
TNT	100% TNT

Manufacturing impurities and environmental degradation products are associated with these explosives. TNT may contain manufacturing impurities such as 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, 1,3-Dinitrobenzene, and 1,3,5-Trinitrobenzene (Layton et al. 1987, 13-0085). Environmental degradation products that may be associated with TNT include 2-amino-4,6-Dinitrotoluene and 4-amino-2,6-Dinitrotoluene. Manufacturing impurities associated with RDX include HMX (cyclotetramethylenetetranitramine) (Layton et al. 1987, 13-0085.

4.3.1.1.3 Fate and Transport

Equilibrium distributions among eight compartments (i.e., air, air particles, biota, upper soil, lower soil, groundwater, surface water, and sediments) of an environmental landscape in two ecoregions (western and southeastern) demonstrate that organic explosive constituents will reside primarily in the subsurface soil and groundwater.

Metal constituents that may form a portion of the explosive, or the unit that houses the explosive, are expected to be oxidized during detonation. Oxidized metals are not very soluble and may be in surface soils.

Asbestos materials that may have formed the housing unit for some of the explosives are also insoluble, and are expected to be in surface soils.

4.3.1.2 Metal Constituents

In addition to those derived from firing sites, metal constituents may be present in all liquid waste streams discharged at OU 1130. In general, the mobility of metals in the environment is governed primarily by soil pH. Metals tend to be more mobile in an acidic environment; however, other factors may mediate the effects of soil pH on metal mobility. Barium and beryllium are two potential contaminants of concern at processing, assembly, and storage locations. These metals exhibit very low mobility in soils, and their mobility is moderated by factors other than soil pH.

Elemental barium exhibits very low mobility in soil. The primary factors influencing barium mobility are the cation exchange capacity and the calcium carbonate ($CaCO_3$) content of the soil (Clement International Corporation 1990, 0874). Barium mobility is limited by adsorption in soils with high cation exchange capacity (e.g., finely textured mineral soils [clays] or soils with a high organic matter content). High $CaCO_3$ content limits barium mobility by the formation and subsequent precipitation of barium carbonate ($BaCO_3$). In the presence of sulfate ions, barium will also precipitate as barium sulfate. Barium may also react with metal oxides and hydroxides that are subsequently absorbed onto soil particulates; it may adsorb onto soil and subsoil through electrostatic interactions; or it may undergo ionic substitution. In its typical valence state under natural conditions (i.e., Ba^{+2}), the ionic radius of the barium ion is similar to that of strontium, making isomorphous substitution possible. Under typical environmental conditions, barium will also displace other adsorbed alkaline earth metals (i.e., calcium and strontium oxides) from manganese, silicon, and titanium dioxides (MnO_2, SiO_2, and TiO_2, respectively). The mobility of barium in soils increases with the formation of water-soluble salts (e.g., barium acetate, nitrate, chloride, and hydroxide). However, under typical environmental conditions, barium may be expected to be near the soil surface (Clement International Corporation 1990, 0874).

Beryllium is expected to have limited mobility in most soil types. Beryllium tightly adsorbs to soils by displacing divalent cations that share common sorption sites (Clement International Corporation 1990, 0872). It is also geochemically similar to aluminum, and may be expected to adsorb onto clay surfaces at low pH. Thus, in most soils, beryllium may be expected to be near the surface.

4.3.1.3 Polycyclic Aromatic Hydrocarbons

The manner in which individual polycyclic aromatic hydrocarbons behave in the environment is linked to the molecular weight of each potential contaminant. For example, low-molecular-weight polycyclic aromatic hydrocarbons (e.g., acenaphthene, acenaphthylene, anthracene, fluorine, and phenanthrene) are associated with significant volatilization, compared with carcinogenic high-molecular-weight polycyclic aromatic hydrocarbons (e.g., benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, chrysene, dibenzo[a,h]anthracene, and indeno[1,2,3-c,d]pyrene) (Clement International

Corporation 1990, 0873). Thus it is more likely that high-molecular-weight polycyclic aromatic hydrocarbons will be found in soils and sediments. In addition, sorption of polycyclic aromatic hydrocarbons to soil and sediments increases with increasing soil organic carbon content. The high-molecular-weight polycyclic aromatic hydrocarbons have organic carbon partition coefficient (K_{OC}) values in the range of 10^{+5} to 10^{+6}, indicating a stronger tendency to adsorb to organic carbon (ATSDR 1990, 13-0014). This tendency for sorption also governs the manner in which individual polycyclic aromatic hydrocarbons will move in surface or groundwater. The high-molecular-weight polycyclic aromatic hydrocarbons will tend to be transported in water adsorbed to particulates, whereas the low-molecular-weight polycyclic aromatic hydrocarbons will tend to volatilize. Microbial metabolism is the major process for degradation of polycyclic aromatic hydrocarbons in the soil. Photo-oxidation and chemical oxidation are degradation processes of lesser importance, except in aquatic environments. Hydrolysis is not considered to be an important degradation process for polycyclic aromatic hydrocarbons (ATSDR 1990, 13-0014).

4.3.1.4 Volatile Organic Compounds

Volatilization from solution, soils, and/or sediments will generally be a significant transport mechanism. In general, potential contaminants that have high water solubility are less likely to vaporize than those with lower water solubility.

Leaching is a significant transport mechanism for potential contaminants with high water solubility. The ability of a potential contaminant to bind with organic matter (K_{OC} value) may mitigate its tendency to leach to lower soil horizons. Thus volatile organic compounds with a high K_{OC} value will tend to remain in soils or sediments with significant organic matter.

Media conditions also affect the relative tendency of potential contaminants to volatilize or remain in solution, soil, or sediments. Volatility occurs more readily in dry soils than in soils with a higher moisture content. Increased soil porosity increases the relative volatility of a potential contaminant from soils. Volatility from solution is expedited under increased flow rate, turbulence, and temperature. The depth of incorporation of a potential contaminant also affects its relative rate of volatilization. Potential contaminants at greater depth will take longer to volatilize from the media of concern.

The volatile organic compounds identified in Table 4-1 are soluble in water and have low K_{OC} values. Thus they will tend to volatilize, and to leach to lower soil horizons and to groundwater.

4.3.1.5 Cyanide

The fate of cyanide in soils and/or sediments is pH-dependent. Although adsorption is probably insignificant when compared to volatilization, soluble metal cyanides may adsorb to suspended solids and sediments. As the flow of the stream decreases, these compounds may settle out of the water column. As with other metal compounds, the adsorption of metal cyanides increases with increasing iron oxide, clay, and organic material in the soil. However, metal cyanide adsorption increases with increasing acidity, instead of being more mobile in an acidic environment like other metal compounds (ATSDR 1991, 13-0017).

In the soil, cyanide may be present as hydrogen cyanide, soluble alkali metal salts, or as immobile metallocyanide complexes. Under aerobic conditions, low concentrations of cyanide undergo biodegradation, with the formation of ammonia followed by nitrate. Under anaerobic conditions in the subsurface environment, cyanides denitrify to gaseous nitrogen (ATSDR 1991, 13-0017).

4.3.1.6 Radionuclides

Radioactive decay is the process whereby a radionuclide is converted to some other radioactive or stable element. Radioactive decay results in the release of radioactive particles (alpha, beta, or gamma radiation). The half-life of a radionuclide is the length of time required for one-half of a given quantity of a radionuclide to be converted to the next lowest material in the radioactive decay chain (daughter product); the half-life is thus a measure of how rapidly a radionuclide disappears and how rapidly a daughter product is created. Some daughter products are of more concern than the parent radionuclide. The half-life is different for every radionuclide, but it is an immutable quantity. The half-lives for radioactive elements that are suspected contaminants within OU 1130 are presented in Table 4-4. The quantity of a radionuclide, Q_n, remaining after "n" years can be computed by:

$$Q_n = Q_o \exp[-0.69n/t_{1/2}]$$

where $t_{1/2}$ is the half-life, and
Q_o is the original quantity

Thus, for a radionuclide such as polonium, with a half-life of 140 days, the original quantity will be reduced by a factor of 5×10^{-32} after 40 years. Any uranium, thorium, or plutonium used in operations was in relatively pure form isotopically. Although radioactive decay will lead to ingrowth of daughter products, the long half-lives of these isotopes result in the presence of only very small quantities of daughter products.

4.3.2 Potential Environmental Pathways

Potential contaminants may have been released to the environment from outfalls, sumps, landfills, and firing areas; from spills, leaks, or spattering to surface or subsurface soil; or from residual burned material.

TABLE 4-4

DECAY CHARACTERISTICS OF RADIONUCLIDES IN OU 1130

Radionuclide Products	Half-Life
Polonium-210	140 days
Uranium-233	1.6×10^5 years
Uranium-234	2.5×10^5 years
Uranium-235	7.1×10^8 years
Uranium-238	4.5×10^9 years
Thorium-230	8.0×10^4 years
Plutonium-238	86.4 years
Plutonium-239	2.4×10^4 years

After chemicals have been released from OU 1130 into the environment, they can potentially migrate via the following pathways:

(1) liquid infiltration into near-surface or subsurface soils;
(2) volatilization into ambient air;
(3) wind entrainment of contaminated dust and deposition onto surface soils; and
(4) surface water overflow and subsequent runoff, resulting in contamination of sediments in drainage channels (refer to Chapter 3).

The major migration pathways and relevant environmental media through which human exposure to residual contaminants could occur are summarized in Table 4-5.

Section 3.6 states that it is not known whether or how saturated or vapor-phase flows infiltrate through hundreds of feet of unsaturated tuff to recharge the main aquifer. The discharge sink in Potrillo Canyon may have the potential to recharge the main aquifer. Refer to Sections 3.5 and 3.6 for a discussion of the hydrology of the main aquifer and the discharge sink beneath OU 1130. Potential contaminant movement into perched water and through fractures or faults in the subsurface is possible, subsequent to infiltration or leaching into the vadose zone. Currently, no onsite wells are used as a source of drinking water.

4.3.3 Potential Human Impacts

This section discusses how people could be potentially exposed to site-related potential contaminants of concern in the absence of site remediation, and presents the conceptual site model. Currently the land is used for Laboratory operations; therefore, workers represent the only potentially exposed population on site. The permanent residents nearest OU 1130 are to the northeast in the town of White Rock. The nearest PRS is 1.75 miles from White Rock. Offsite migration of potential contaminants of concern will be investigated to determine whether it presents a health risk or safety hazard to the public or damage to the

TABLE 4-5

SUMMARY OF MIGRATION PATHWAYS, POTENTIAL RELEASE MECHANISMS, AND EXPOSURE ROUTES

Pathways/Mechanism	Concept/Hypotheses
HISTORICAL SOURCES	Operations/processes that contributed to the creation of the PRS (e.g., storage areas).
PRS RELEASE MECHANISM	Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, leaching, dumping, or disposing into the environment.
MIGRATION PATHWAY/ CONVERSION MECHANISM	
Atmospheric particulate dispersion	Entrainment is limited to contaminants in surface soils. Entrainment and deposition are controlled by soil properties, surface roughness, vegetative cover and terrain, and atmospheric conditions.
Volatilization	Volatilization occurs to volatile organic compounds in surface soils, subsurface soils, subsurface water, perched water, or groundwater.
Surface water runoff/Surface water	Precipitation that does not infiltrate or evaporate will become surface runoff. Surface runoff may carry contaminants beyond the OU boundary. Surface runoff may resuspend contaminants. Contaminated surface runoff may infiltrate the canyon-bottom alluvium. Contaminated surface runoff may infiltrate shallow groundwater and/or surface water.
Sediments	Chemical transport by surface runoff can occur in solution, as sorbed to suspended sediments, or as mass movement of heavier bed sediments. Surface soil erosion and sediment transport are a function of runoff intensity and soil properties. Contaminants dispersed on the soil surface can be collected by surface water runoff and concentrated in sedimentation areas in drainages. Erosion of drainage channels can extend the area of contaminant dispersal in the drainage. Surface runoff discharged to the canyons may infiltrate into sediments of channel alluvium.
Discharge Sink	The sinkhole may provide potential recharge of the main aquifer.
Infiltration (Percolation)	Infiltration into surface soils depends on the rate of precipitation or snowmelt, antecedent soil water status, depth of soil, and soil hydraulic properties. Infiltration into the tuff depends on the unsaturated flow properties of the tuff. Joints and fractures in the tuff may provide additional pathways for infiltration to enter the subsurface regime.
POTENTIAL RELEASE MECHANISM	
Leaching	Storm water/snowmelt can dissolve contaminants from soil or other solid media, making them available for contact. Water solubility of contaminants and their relative affinity for soil or other solid media affect the ability of leaching to cause a release. Leaching and subsequent resorption can extend the area of contamination.

TABLE 4-5 (concluded)

SUMMARY OF MIGRATION PATHWAYS, POTENTIAL RELEASE MECHANISMS, AND EXPOSURE ROUTES

Pathways/Mechanism	Concept/Hypotheses
POTENTIAL RELEASE MECHANISM	
Soil erosion	The erosion of surface soils is dependent on soil properties, vegetative cover, slope and aspect, exposure to the force of the wind, and precipitation intensity and frequency. Depositional areas and erosional areas exist, and erosive loss of soil may not occur in all locations. Storm water runoff can mobilize soils and sediments, making them available for contact. Storm intensity and frequency, physical properties of soils, topography, and ground cover determine the effectiveness of erosion as a release mechanism. Erosion may also enlarge the contaminated area.
Mass wasting	The loss of rock from the canyon walls is a discontinuous, observable process. The rate of the process is extremely slow.
Resuspension (wind suspension)	Wind suspension of contaminated soil/sediment as dust makes contaminants available for contact through inhalation and ingestion. Physical properties of soil (e.g., silt and moisture content), wind speed, and size of exposed ground surface determine effectiveness of wind suspension as a release mechanism. Wind suspension can enlarge the area of contamination and create additional exposure pathways, such as deposition on plants followed by plant consumption by humans and animals. Manual or mechanical movement of contaminated soil during construction or other activities makes contaminated soil available for dermal contact, ingestion, and inhalation as dust.
Excavation	The method of excavation (i.e., type of equipment), physical properties of soil, weather conditions, and magnitude of excavation activity (i.e., depth and total area of excavation) influence the effectiveness of excavation as a release mechanism. Excavation can increase or decrease the size of the contaminated area, depending on how the excavated material is handled. Excavation activities may move subsurface contamination to the surface and generate dust. Excavation activities may liberate volatile organic compounds in subsurface soils.
EXPOSURE ROUTE	
Inhalation	Vapors, aerosols, and particulates (including dust) can be inhaled. Physical, chemical, and/or radioactive properties of airborne contaminants influence the degree of retention in the body after being inhaled.
Ingestion	Ingestion of soil, water, food, and dust can lead to chemical intake.
Direct contact	Some contaminants will absorb through the skin when in contact with contaminated surfaces of soil, tuff, or rubble. Matrix effect: the type of media in which the contaminant is located may affect its bioavailability.
External penetrating radiation	External or whole body radiation can occur through exposure to gamma-ray-emitting radionuclides that may be present in soil, either directly through the soil or re-entrained as dusts. Exposure to penetrating radiation can also occur through inhalation or ingestion when radionuclide-contaminated soil or tuff surfaces erode and/or dusts become re-entrained.

environment. Future land use at OU 1130 could encompass recreational users (i.e., campers and hikers), and continued Laboratory operations.

4.3.3.1 Conceptual Exposure Models

The conceptual models identify historical sources of potential contamination, historical migration and conversion, potential current sources of contamination, release mechanisms, contact media, and exposure routes for each PRS or aggregate. Conceptual exposure models are used to illustrate how contaminants can move in the environment from potential release sites to human receptors.

The models are used to help identify appropriate media and locations for sampling, and to determine whether the PRS poses a threat to human health or the environment. Elements of the conceptual models are presented in Table 4-5. The PRS- or PRS-aggregate-specific conceptual models are presented in Chapter 5.

The conceptual models for OU 1130 are formulated on available PRS information only. Further refinement of the conceptual models or development of separate models may be necessary, based on data gathered through the RFI.

Site-specific information on PRS aggregates, such as potential contaminants of concern and migration pathways, is presented in Chapter 5.

4.3.3.2 Potential Human Exposure

All the sampling plans considered for OU 1130 compare soil or water samples to screening action levels in order to identify the presence of contaminants of concern. As mentioned in Section 4.2.2, screening action levels are based on a conservative, residential-exposure scenario. If measured concentrations exceed screening action levels, or if several contaminants come close to screening action levels (i.e., if the sum of the ratios of the measured constituent concentrations to their screening action levels exceeds one), then a Phase II investigation, VCA, or CMS will be initiated. A Phase II investigation may consist of a baseline risk assessment or additional sampling. If soil or water is found to be contaminated (concentrations of potential contaminants of concern above screening action levels) in Phase I or Phase II, the human exposure to these contaminants will be quantified in a baseline risk assessment. Human exposure is estimated through a model of the Reasonably Maximum Exposed individual, defined through assumptions of current and future land use (EPA 1989, 0305). Two exposure scenarios will be evaluated in baseline risk assessments for OU 1130: continued Laboratory operations (current and future), and recreational use (future only). The residential exposure scenario is not applicable for baseline risk assessments at OU 1130 because, after decommissioning, the land at OU 1130 is not expected to be used for residential purposes. Future residential use is unlikely because OU 1130 is located in a rural area with low population density and a projected low growth rate. Currently the community of White Rock has a population of approximately 8,000 people, the majority of whom support the Laboratory.

Refer to Section 4.3 of the IWP for ER programmatic guidance on probable land-use scenarios (LANL 1992, 0768). Depending on site-specific parameters (e.g., types of contaminants present or migration potential), the worst-case exposure scenario may vary. For PRSs where multiple scenarios may be applicable, each will be evaluated in the baseline risk assessment to determine the more conservative exposure scenario. For any baseline risk assessment, the 95 percent upper confidence limit on the arithmetic average concentration of contaminants of concern in exposure areas, in either surface or subsurface soils, is sufficient to determine receptor exposures. Data are averaged over an exposure unit, the definition of which is determined by the land-use scenario. The recreational exposure unit is assumed to be one acre (43,560 sq ft). Other recreational exposure unit areas may be acceptable if a rationale is provided (e.g., in drainages). The construction worker exposure unit is the PRS volume to the final depth. Exposure units for the office worker have not been determined. Assumptions made for continued Laboratory operations and recreational scenarios are developed below.

4.3.3.2.1 Continued Laboratory Operations

Land use in the foreseeable future is likely to continue to be similar to that of current Laboratory operations. Land use for continued Laboratory operations involves populations of office workers (individuals who work on or near the site) and construction workers (individuals who would be exposed to subsurface soils during excavation). Office workers and construction workers are estimated to be the most likely Reasonably Maximum Exposed individuals; therefore, these exposure scenarios will be evaluated under the land-use scenario of continued Laboratory operations.

Office workers are expected to be exposed routinely to contaminated surface media on the mesa top (8 hours a day for 25 years). Surface contamination (0 to 6 in.) above screening action levels will be evaluated in a baseline risk assessment using the office-worker scenario. Both current and future risks can be evaluated using this scenario. The PRSs that include potential surface contamination of the mesa top are the firing sites (Section 5.4), the Boneyard (Section 5.5), and the photo outfall (Section 5.7).

The construction-worker scenario is considered to be the most conservative exposure scenario for PRSs in OU 1130 that consist of subsurface contamination. PRSs in OU 1130 with subsurface contamination above screening action levels will be evaluated in a baseline risk assessment using the construction-worker scenario. This scenario models potential exposures during excavation activities to a depth of 12 ft over a relatively short time. (If contamination is found at depths greater than 12 ft, a groundwater scenario will be considered.) Exposure is limited to the duration of the construction, which, conservatively, is assumed to be 8 hours a day for 2 years. Therefore, it is expected that the construction worker will receive the highest dose from subsurface contamination. PRSs with potential subsurface contamination include MDA AA (Section 5.1), the sump (Section 5.2), and the septic tanks (Section 5.3).

Exposure pathways relevant for office workers include: inhalation of dust and volatile compounds in the workplace, incidental ingestion of soil and dust, and whole-body radiation. Exposure pathways relevant to workers engaged in construction activities that disturb the soil include: (1) inhalation of fugitive dust or volatile compounds, (2) incidental ingestion of contaminated soils, (3) whole-body radiation, (4) direct dermal contact with contaminated soils, and (5) contact with explosives (Table 4-6)

4.3.3.2.2 Future Recreational

When this site is decommissioned in the future, OU 1130 could be released for recreational use. The recreational scenario excludes agriculture, but considers camping, hiking, hunting, and possibly limited construction. Any PRS in OU 1130 with surface contamination (0 to 6 in.) on canyon walls and/or canyon bottoms above screening action levels will be evaluated in a baseline risk assessment

TABLE 4-6

SUMMARY OF EXPOSURE ROUTES IN THE CONTINUED-LABORATORY-OPERATIONS SCENARIO

Exposure Route	Assumptions
1. Inhalation of ambient air (fugitive dust or volatiles)	Fugitive dust is generated by soil disturbances (i.e., bulldozers, trucks, and other earth-moving equipment) and during construction activities. Construction activities may expose subsurface chemicals. Volatile contaminants in near-surface and subsurface soils may contribute to the inhalation exposure.
2. Incidental ingestion of soil	Incidental ingestion of surface or subsurface soils may occur as a result of construction activities.
3. Whole-body radiation	Irradiation may occur from radionuclides on the ground.
4. Dermal contact with soil	Skin surface area available for contact with soil includes arms, hands, face, and head.
5. Contact with explosives	Large chunks of explosives pose a safety hazard. If explosives are present in a finely divided form at low concentrations, the hazard is mainly through exposure by inhalation and dermal contact.

using the recreational scenario. Those PRSs include the Boneyard (Section 5.5), MDA AA (Section 5.1), the firing sites (Section 5.4), and any outfalls or drainages that are associated with PRSs (e.g., the photo outfall [Section 5.7] and the septic tanks [Section 5.3]).

Recreational users of the area could come into contact with contaminants through ambient air, surface soil, sediments in drainage channels, and pooled surface water. The recreational scenario is the most probable worst-case exposure scenario for PRSs that consist primarily of surface contamination located on canyon walls or on canyon bottoms. The construction or office worker is not expected to come into direct contact with contaminated media on the canyon walls or canyon bottoms because of limited access to these areas.

Exposure pathways associated with recreational activities include: (1) inhalation of fugitive dust, (2) incidental soil ingestion, (3) dermal contact with soil, (4) whole-body radiation, (5) dermal contact with surface water, (6) ingestion of surface water, and (7) contact with explosives (Table 4-7).

Campers are assumed to carry in food; therefore, exposure through consumption of contaminated edible plants (pinon nuts, berries, etc.) is an insignificant pathway in the recreational scenario. The contribution of this exposure pathway is likely to be minor in comparison with pathways listed in Table 4-7. No body of water large enough to support a consistent supply of game fish exists at OU 1130.

4.3.3.4 Ecological Assessment

The ecological risk assessment methodology (end points and spatial scales) is currently under development, and guidance will be available in the next IWP. Ecological risk assessments will be based on spatial boundaries that are appropriate for the ecological end points, not necessarily on PRS, PRS-aggregate, or OU boundaries. Although an evaluation of ecological risk for residual contamination may be appropriate for some sites (e.g., canyons), the ER Program Office believes that the most important role for ecological risk assessments will be in evaluating remediation alternatives. The current ER

TABLE 4-7

SUMMARY OF EXPOSURE ROUTES IN THE RECREATIONAL SCENARIO

Exposure Route	Assumptions
1. Inhalation of ambient air (fugitive dust or volatiles)	Fugitive dust is generated by the wind and during recreational activities (e.g., dirt biking). Volatile contaminants on site may contribute to inhalation exposure.
2. Incidental ingestion of soil	Incidental ingestion of surface soil or sediments may occur as a result of recreational activities. Standard daily soil ingestion rates for adults and children are used.
3. Dermal contact with soil	Skin surface area available for contact with soil includes arms, hands, face, legs, upper body, and head. (Camping takes place in warm weather.)
4. Whole-body radiation	Irradiation from radionuclides on the ground surface may occur.
5. Dermal contact with surface water	Ephemeral streams may be present as a result of snowmelt and summer rainfall. Rainfall events result in pooled water 3 to 11 times per year (data from TA-36 [Lower Slobbovia] area). Standing water occurs in the pool for 2 hours after rainfall before it seeps into the ground.
6. Ingestion of surface water	Same as in 5 (dermal contact with surface water).
7. Contact with explosives	This uses a safety model rather than a toxicology model.

Program guidance is that PRS or PRS-aggregate NFA decisions will not require an ecological risk assessment. These decisions will be based on comparisons of residual contamination levels to screening action levels as defined in the current IWP, or by a baseline human health risk assessment. This approach follows guidance given in the proposed Subpart S of the RCRA guidance (EPA 1990, 0432). If the ecological risk assessment later indicates that specific PRSs or PRS aggregates contribute to an adverse ecological effect, the NFA decisions will be reevaluated.

Chapter 3 of this work plan describes relevant features of the receiving environment that can later be used in an ecological risk assessment:

- State or federal sensitive, threatened, or endangered plant or animal species potentially occurring within the OU boundaries;
- Presence of sensitive areas, such as flood plains and wetlands; and
- Additional plant and wildlife data concerning the habitat types within the OU.

4.4 Potential Response Actions and Evaluation Criteria

Remediation alternatives must achieve acceptable risk levels. Choices among alternatives that meet the human health risk requirements will be based upon additional factors such as ecological impact, cost, regulatory concerns (in addition to risk), and impact on Laboratory operations [Appendix I, IWP, (LANL 1992, 0768)]. Because OU 1130 is remote and potential contamination is not likely to impact the public, it is unlikely that socioeconomic impacts or public concern will be major decision factors. Note that all actions refer to potential or known surface-soil problems. There is no indication that other media are contaminated, which would require other technologies (e.g., steam injection for vadose-zone contaminants).

4.4.1 Criteria for Recommending NFA

PRSs proposed for NFA are addressed in Chapter 6 of this work plan. Consistent with the decision logic presented in Figure 4-1, some sites are proposed for NFA on the basis of information obtained from the archival data search; other sites may be proposed for NFA at the end of Phase I or Phase II investigations or CMS. The following criteria are used in making these recommendations:

Criterion 1: Based on documented historical data, it is established that no contaminants of concern were ever present at the PRS.

Criterion 2: Based on Phase I data or other reliable data that may be available. it is established that the concentrations of potential contaminants of concern are below screening action levels. NFA recommendations based on screening assessments will include an evaluation of the combined effects of multiple contaminants, and ALARA criteria for radioactive contaminants.

Criterion 3: The risk, as determined by a baseline risk assessment, is less than 10^{-4} to 10^{-6} for carcinogens, and the hazard index is less than 1 for noncarcinogens. These NFA recommendations will also consider ALARA criteria for radioactive contaminants.

Criterion 4: The PRS is unlikely to release contaminants to the environment, and receptors are unlikely to be exposed to any contaminants.

Criterion 5: The PRS is and historically always has been part of an active process that operates under the current RCRA operating permit, National Pollutant Discharge Elimination System (NPDES) permit, or other applicable regulations.

4.4.2 Soil Removal and Treatment and/or Disposal

This alternative is applicable to areas of limited soil contamination, such as firing sites or contaminated sediments in surface drainage-ways. It involves excavation of soil contaminated above screening action levels. If hazardous constituents are present, the soil could be treated to eliminate the contaminants, or to reduce the concentration of constituents to acceptable levels for disposal at an RCRA-permitted treatment, storage, and disposal facility. Land disposal restrictions (EPA 1990, 0093) may need to be addressed as part of determining the acceptable concentration level. If radionuclides are present, the excavated soil would be disposed of in a radioactive or mixed-waste facility.

If Phase I investigations establish that contaminants of concern are present in subsurface or surface soils at concentrations above screening action levels, and there is insufficient data to conduct a baseline risk assessment, a Phase II investigation would be conducted. A Phase II investigation would establish the full extent of contamination within the vadose zone and any underlying saturated zones. Phase I investigations should, therefore, provide data on the constituents present in the subsurface and surface soil, and the approximate physical extent of the contamination.

4.4.3 Excavation of Buried Wastes

Buried waste materials or contaminated subsurface structures (such as septic tanks) and any surrounding contaminated soil would be excavated, containerized, and treated or disposed of as appropriate. Treatment and disposal alternatives would be similar to those described in Section 4.4.2.

Data requirements for designing Phase II investigations are similar to those required in Section 4.4.2. For buried waste, the physical location of the buried material needs to be established, as well as the approximate boundaries of the excavation. Contaminated structures would generally be located by a continuing excavation. Before sampling of waste materials and potentially contaminated soil can be initiated, it will be necessary to characterize any safety hazards associated with this sampling.

4.4.4 Conditional Remedies

Conditional remedies are those dependent on Phase I data. The conditional remedies for OU 1130 include capping and monitoring of surface soil, or installation, maintenance, and monitoring of sediment catchments. Conditional remedies may be appropriate for active sites.

4.4.5 Access Restrictions

All PRSs are within a secured portion of the Laboratory, with security fences or no trespassing signs posted. Access restrictions to all PRSs will continue for the foreseeable future.

4.5 Sampling

This section discusses the strategies to be applied during RFI sampling (Section 4.5.1), the sampling methods to be used in the field (Section 4.5.2), and the field quality assessment samples (Section 4.5.3).

4.5.1 Sampling Strategies

Two sampling strategies will be used in the Phase I screening assessment survey: reconnaissance sampling to support a screening assessment, and sampling to support baseline risk assessment. Reconnaissance sampling may be biased, using professional judgment or field screening results, toward collecting material that is representative of the maximum contaminant concentration in a PRS. Sampling to support a baseline risk assessment focusses on collecting material to estimate exposures under one of the scenarios outlined in Section 4.3.

4.5.1.1 Reconnaissance Sampling

The majority of RFI Phase 1 investigations for OU 1130 will need to support screening assessments to identify contaminants of concern, if any, associated with the PRSs. For most PRSs within OU 1130, existing information is not sufficient to positively identify any contaminants of concern, although in many instances the historical information can be used to eliminate some potential contaminants (e.g., polychlorinated biphenyls [PCBs] and asbestos) from consideration. Screening assessments will follow the logic proposed in Section 4.1.4 of the IWP (LANL, 1992, 0768).

The decision whether further consideration of an area is necessary is based on the highest concentration of a particular constituent of concern measured in the collected samples. A single concentration above screening action levels will be taken as sufficient reason to warrant further consideration, perhaps leading to a Phase II sampling program. For some situations, it is reasonable to assume that the presence of constituent concentrations above screening action levels is equally likely at any location within the area. This would include judgmental sampling in a stream channel, within a drain field, or beneath a tank. For such a situation, it is possible to determine the probability that a particular sample will contain constituents above prespecified screening action levels. Figure 4-2 shows the probability of failing to detect a contaminant of concern when one is present as a function of the size of the sample (N) and the fraction of the site that is contaminated (1-f). The figure is based on the relation:

$$P = 1 - (1-f)^N \qquad (4\text{-}1)$$

(Field duplicates should not be counted in applying the equation above, which assumes N independent observations.) Thus five sampling locations can provide at least a 95% probability of detecting contamination that affects at least half of the area, but a lower probability (75%) of detecting contamination that affects only 30% of the area.

Typical sample sizes for screening assessments range from three to fifteen samples. The choice of the sample size reflects prior estimates of the homogeneity of the site, and of the maximum likely extent of the contamination. Large nonhomogeneous sites, such as the Boneyard, require large sample sizes to guarantee that contamination affects, at most, a small area; contamination in small homogeneous volumes, such as septic tanks, can be adequately bounded with a small number of samples.

Results of preliminary field screening and/or mobile laboratory analyses, or knowledge of the physical processes that control the distribution of contamination, can improve the chances of observing contamination if it is present. If sampling locations are biased, the failure rates will be lower than Figure 4-2 indicates, although it is not possible to quantify the improvement statistically.

The selection of an appropriate quantile to bound (that is, the abscissa on Figure 4-2) and an appropriate confidence level (that is, the ordinate on that figure) depends on several site-specific characteristics of the domain of interest, including the toxicity and likely inventory of the potential contaminants of concern, and the heterogeneity of the contamination. For relatively homogeneous domains (e.g., sludge in a sump or septic tank), bounds on a central quantile

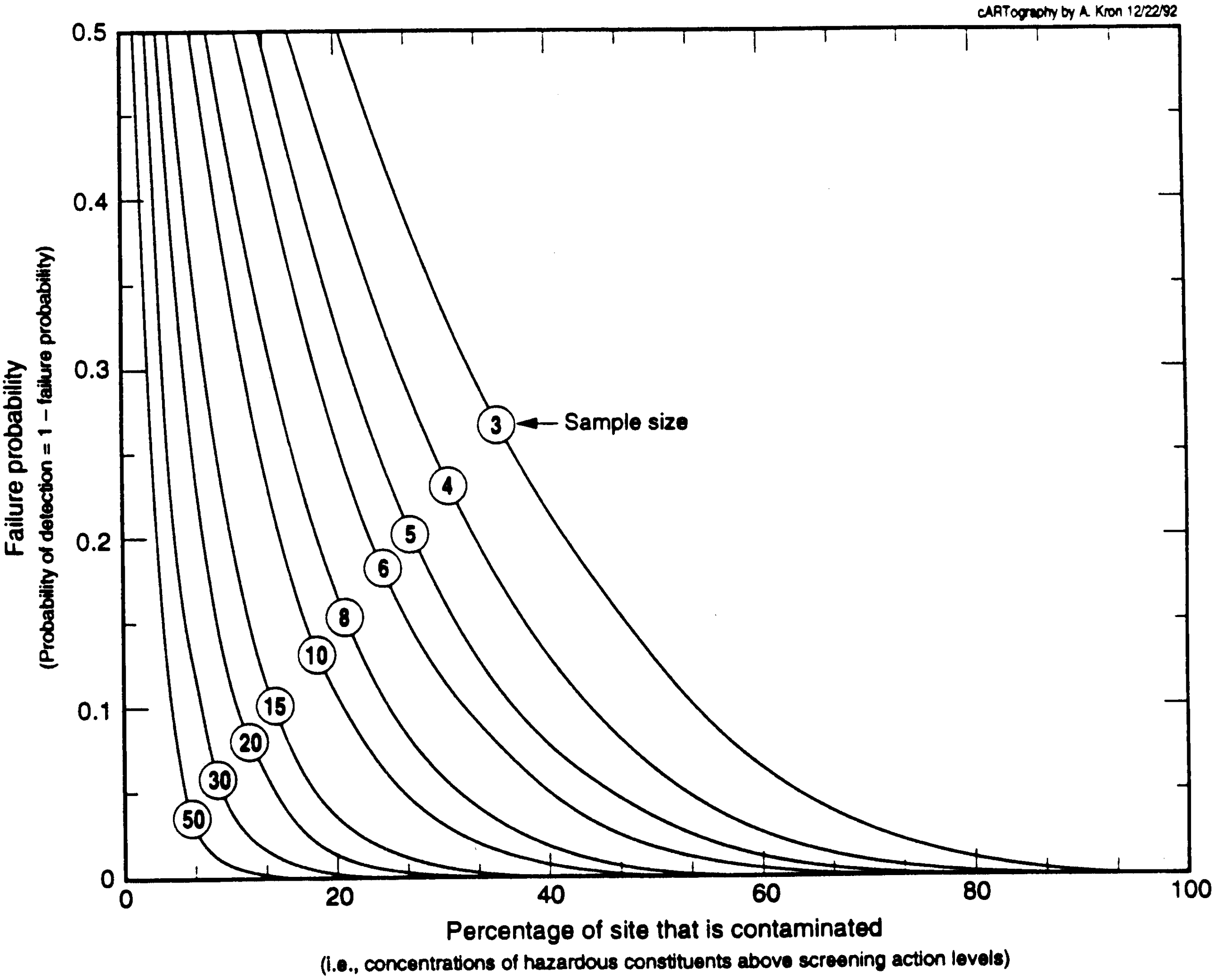

Fig. 4-2. Probability of failing to detect potential contaminants of concern (assuming independent observations).

(e.g., 30 to 50% of the contaminated domain) suffice. For heterogeneous domains, bounds on more extreme percentiles (e.g., 15% or less of the affected domain) are sought. Where the potential problem is not severe, either because the potential contaminants are of low toxicity or because, from the nature of the process generating the site, the total inventory is not large, lower confidence levels (e.g., a failure probability of 20%) can be tolerated. In cases of greater potential impact, greater confidence (e.g., a failure probability of 10% or less) is needed.

Because of the limited data available for OU 1130 PRSs, every PRS to be investigated requires a screening assessment, as described in the preceding section, to determine whether any contaminants of concern are present. Therefore, as much as possible, every Phase I sampling plan is biased to maximize the probability of detecting such contaminants, although, on some sites, the criteria available to bias sampling are very limited. The data from every investigation will be first used to identify contaminants of concern, in general by comparing the maximum observed value with the screening action limit. (For a small number of constituents, such as beryllium, adjustment for natural background concentrations must precede any comparison with screening action levels.)

4.5.1.2 Sampling for Baseline Risk Assessment and Remediation

In a few cases, RFI Phase I data will also support a baseline risk assessment if the screening assessment identifies one or more contaminants of concern. Baseline risk assessments require unbiased and accurate estimates of the mean contamination within exposure units of a size dictated by the appropriate exposure scenario, which is discussed in Section 4.3. (To be conservative, a statistical upper confidence bound on this mean contamination is often used to calculate the associated exposure and risk.) An average based on data from biased Phase I sampling plans will, in general, overestimate the mean contamination; the Phase I designs will also, in general, fail to provide good estimates of the extent of contamination. Thus risk assessment based on Phase I data and conservative bounds on extent may overestimate the associated risks by a significant factor.

At certain sites (particularly PRSs 36-001, discussed in Section 5.1, and 36-005, discussed in Section 5.5), stratification of the sampling design will provide data suitable both for maximizing the probability of identifying contaminants of concern, if present, and for unbiased estimation of area or volume means. This is accomplished by oversampling strata most likely to be contaminated relative to their size, but collecting some data from every stratum to ensure adequate coverage of the site, both across the relevant areas and volumes and across the different media of concern. The relevant volumes and media are determined by the exposure scenario underlying the risk assessment. For example, the construction-worker excavation scenario assumes that exposure is determined by the average concentration between the surface and the depth of a typical building foundation.

For some PRSs, it is anticipated that supplementary data from Phase II investigations will be required to provide additional information concerning the level and extent of contamination for baseline risk assessment, or to support the corrective measures study.

VCAs may be undertaken in some cases on the basis of Phase I results. VCAs will be accompanied by field measurements to determine the extent of the area requiring remediation, and will be followed by confirmatory sampling to verify the attainment of cleanup standards.

4.5.2 Selection of Sampling Locations

Several of the surface sampling plans call for selecting locations on a regular grid with given spacing between the nodes. Sampling locations generated in this way are expected to be "unbiased" with respect to contaminant distributions or any other important feature under study. However, to further guarantee unbiased choice of sampling locations, randomization can be incorporated into these grid sampling plans in two ways, either at the time the field sampling plan is finalized or in the field:

(1) A starting point and an orientation can be selected at random, and the remainder of the grid can be laid out starting from this point, parallel and

perpendicular to the selected direction, using the grid spacing specified in this work plan.

(2) In addition to, or instead of, randomizing the starting point and the orientation of the grid, grid points can be located using a randomization method at each one.

If field randomization is done, it is essential that an explicit protocol be followed in order to avoid the introduction of subtle biasing factors, such as the accessibility of a sampling location, the visual appearance of the soil, etc. The following protocol is taken from an EPA guidance document, "Methods for Evaluating the Attainment of Cleanup Standards, Volume 1, Soils and Solid Media."

> Let M be 1/2 the grid spacing. Choose a random distance between -M to M feet to move away from the reference point parallel to the grid orientation direction, and a second random distance between -M and M feet to move perpendicular to that direction (EPA 1989, 0305).

If the location thus selected is not sampled for some reason, perhaps because it is inside a building or falls in a channel, then the fact of and reason for its elimination should be recorded in the field notebook, and the procedure repeated with a new pair of random numbers to find an alternate sampling location. One of the advantages of this method over prespecified sampling locations, provided that the protocol is followed, is that it allows for the random replacement of sampling locations that turn out to be unusable. Its main disadvantages are the additional surveying time required, and the increased opportunity for recording errors.

A similar form of randomization can be employed in the selection of depths to sample; that is, depths specified in this work plan can be treated as reference depths only, and the actual sample selected a random distance above or below that point. However, where the plan calls for a surface sample (that is, a sample from the top six inches of the core), or a sample from the tuff/fill interface, these instructions should be followed.

Reconnaissance sampling plans specify that the selection of sampling locations should be deliberately biased, using field indications such as anomalous radiation measurements or soil staining. In each of these cases, the statistic of interest is the sample maximum, and the goal in choosing a sample is to mazimize the probability of detecting contamination if it is present.

For these sampling plans, and for several other cases where the target areas require better delineation during preliminary site mapping, exact sampling locations will not be determined before field work commences. If field-determined sampling locations are not warranted, or if no field anomalies are observed, the following protocol may be followed to make a random selection.

> Determine a range of X (Xmin to Xmax) and Y (Ymin to Ymax) coordinates defining a rectangle that circumscribes the target area. To select a sampling location, move a random fraction of the distance from Xmin to Xmax, and another random fraction of the distance from Ymin to Y max. If the resulting location (X,Y) lies inside the target area, sample there. If it lies outside the target area (even though it must be inside the circumscribed rectangle by definition), start over again. Repeat until the required number of samples have been taken. (EPA 1989, 02-041).

All field-determined sampling locations, including field-randomized choices and "neighbors" as well as locations based on field indications, must be accurately recorded in the field notebook.

Field-determined duplicates are important, not only for quality control, but also because they provide data to estimate local sampling variability. Standard operating procedures for sample collection specify the method to be used to select a field duplicate. Note that a field duplicate is a separate sample, collected from a location very near to the first sample, not merely a second measurement on the first sample.

Neighbors of surface soil samples will be selected from a location up to 50 ft away from the first sample, and from the same type of soil. (One satisfactory method for selecting neighbors is a field randomization procedure similar to the one described above for randomizing grid points. Use the location of the first sample as the reference point, and take M to be aproximately one-half of the grid spacing.)

4.5.3 Field Sampling Methods

Table 4-8 provides a complete list of Standard Operating Procedures (SOPs) used in the RFI for OU 1130 (LANL 1993, 0875). Most samples taken at OU 1130 will be surface-soil samples taken with hand augers. Other samples will include borings through soil and bedrock with a drill rig and split-spoon or similar sampler.

Field sample-handling procedures will include collecting material for analyses of volatile organic compounds, metals, radionuclides, semivolatiles, and explosives. Samples will be collected from sampling points defined by a sampling grid or by stratified random sampling. To implement spatially stratified random sampling, the field survey team will be given random x and y offsets from a sampling grid.

4.5.4 Field Quality Assessment Samples

The purpose of field quality assessment samples is to quantify the performance of a sampling technique (surface samples taken by spade, scoop, or hand auger; boreholes taken with a diamond drilll; etc.). Several kinds of quality assurance (QA) samples can be collected. For example, for composite samples of a soil column, the core may be subsampled twice, or a second aliquot of the homogenized sample may be collected. Another kind of field QA sample is a co-located sample (field duplicate).

Investment in these various field QA types will be based on an estimate of the relative magnitudes of the sources of variation in the sampling process. The largest source of variation is often from field sample preparation (homogenizing), which indicates that the best investment in field QA is to collect additional subsamples of the homogenate (splits). At some sites, localized heterogeneity in the sampled population is the major source of variation, from the perspective of the decision-maker; in these cases, field duplicates (co-located samples) are a useful supplement to the routine field samples.

4.5.5 Quality Analysis / Quality Control

Quality Analysis/Quality Control samples will follow the generic quality assurance project plan (QAPjP) for RCRA Facility Investigations (LANL 1991, 91-0843). These samples include field blanks (1 blank per 20 samples), reagent blanks (1 blank per 20 samples), rinsate samples (1 sample per 20 samples for soils and 1 per 10 samples for water), and trip blanks (1 blank per cooler for VOCs only). Duplicate samples (1 duplicate per 20 samples per media) will be collected; the contamination levels' variability as a result of laboratory sampling techniques and controls, and heterogeneity of the sample media, will be estimated.

4.6 Analytical Methods

The analytical methods discussion is presented in two parts: the field surveys and field screening to be performed (Section 4.6.1); and the analytical methods to be used in the field mobile laboratory and offsite analytical laboratories (Sections 4.6.2 and 4.6.3, respectively).

4.6.1 Field Surveys and Field Screening

Field investigations during RFI Phase I have many common elements. All Phase I investigations include screening for health and safety purposes; however, only some investigations include surveys used for data quality purposes. The SOPs for these methods are summarized in Table 4-8.

Field surveys, including geomorphic, land, and geophysical surveys, will be used to locate structures, PRSs, and sampling locations in the field. The land surveys will also be used to define the locations in planar coordinates so that all data may be transferred onto 2-ft contour maps and sent to the Facility for Information Management, Analysis, and Display (FIMAD).

Field screening will be performed to define potential hazards and health and safety conditions for site workers. Field screening for radioactive constituents

TABLE 4-8

LABORATORY STANDARD OPERATING PROCEDURES FOR OU 1130

SOP TITLE	SOP NUMBER
General Instructions for Field Investigations	LANL-ER-SOP-01.01
Sample Containers and Preservation	LANL-ER-SOP-01.02
Handling, Packaging, and Shipping of Samples	LANL-ER-SOP-01.03
Sample Control and Field Documentation	LANL-ER-SOP-01.04
Field Quality Control Samples	LANL-ER-SOP-01.05
Management of RFI-Generated Waste	LANL-ER-SOP-01.06
General Surface Geophysics	LANL-ER-SOP-03.02
Fracture Characterization	LANL-ER-SOP-03.06
Characterization of Lithologic Variation Within the Rock Outcrop of a Volcanic Field	LANL-ER-SOP-03.07
Geomorphic Characterization	LANL-ER-SOP-03.08
Geologic Mapping of Bedrock Units	LANL-ER-SOP-03.09
Drilling Methods and Drill Site Management	LANL-ER-SOP-04.01
Sampling for Volatile Organics	LANL-ER-SOP-06.03
Soil Water Samples	LANL-ER-SOP-06.05
Tensiometer (Soil Suction Monitor) Installation and Measurement	LANL-ER-SOP-06.06
Spade and Scoop Method for Collection of Soil Samples	LANL-ER-SOP-06.09
Hand Auger and Thin-Wall Tube Sampler	LANL-ER-SOP-06.10
Stainless Steel Surface Soil Sampler	LANL-ER-SOP-06.11
Surface Water Sampling	LANL-ER-SOP-06.13
Sediment Material Collection	LANL-ER-SOP-06.14
Coliwasa Sampler for Liquids and Slurries	LANL-ER-SOP-06.15
Thief Sampler for Dry Powders or Granules	LANL-ER-SOP-06.16
Trier Sampler for Sludges and Moist Powders or Granules	LANL-ER-SOP-06.17
Collection of Sand, Packed Powder, or Granule Samples Using the Hand Auger	LANL-ER-SOP-06.18
Weighted Bottle Sampler for Liquids and Slurries in Tanks	LANL-ER-SOP-06.19
Volatile Organic Sampling Train	LANL-ER-SOP-06.21
Canister Sampling for Organics EPA Method T-14	LANL-ER-SOP-06.22
Sample Collection from Split Spoon Samplers & Shelby Tube Samplers	LANL-ER-SOP-06.24
Pressure Transducers	LANL-ER-SOP-07.01
Fluid Level Measurements	LANL-ER-SOP-07.02
Screening of PCBs in Soil	LANL-ER-SOP-10.01
Measurement of Bulk Density, Dry Density, Water Content, and Porosity in Soil	LANL-ER-SOP-11.01
Particle Size Distribution of Soil/Rock Samples	LANL-ER-SOP-11.02
Permeability of Granular Soils	LANL-ER-SOP-11.03
Soil and Core pH	LANL-ER-SOP-11.04
Total Organic Carbon	LANL-ER-SOP-11.05
Cation-Exchange Capacity	LANL-ER-SOP-11.06
Photoionization Detector (PID)	To Be Written
Flame Ionization Detector (FID)	To Be Written
Field Spot-Test for Explosives	To Be Written
Field Gamma Measurements using the FIDLER	To Be Written
Field Gamma Measurements using the PHOSWICH	To Be Written

(alpha, beta, and gamma) and VOCs will be conducted at all sample locations. If any of these constituents is detected in the field where it is not suspected, the samples will be submitted to an offsite analytical laboratory for further analysis. (Note that, where these constituents are suspected to be present, the samples will automatically be submitted to an offsite laboratory for analysis.) Field screening for explosives will be conducted at all locations where explosives are suspected (i.e., at the firing sites), but not at every sample location. In areas within or adjacent to suspected locations (i.e., debris or fill areas within or adjacent to firing sites), where explosives are not expected to be present, screening will be conducted at 50% of the sample locations. If explosives are detected in any of these locations, all sample locations at the given site will be screened for explosives. In areas that are not within or adjacent to a suspected explosive area (e.g., the photo outfall area away from any firing site), no screening will be conducted for explosives. Offsite analysis will be performed on all samples where field screening for explosives indicates their presence.

In addition, field screening will be used to bias sampling points or locations where samples will be collected for offsite laboratory analysis. For example, as cores are recovered from a split spoon (or equivalent) sampler, the screening instruments may detect "hot spots" where samples will then be collected. Field screening will not be conducted for data quality (or data gathering) purposes.

4.6.1.1 Land Surveys

Each PRS aggregate will be field surveyed before sample collection. The survey will consist of site engineering mapping (geodetic) and geomorphologic mapping. Site mapping is required to accurately record the location of PRSs and sampling points. In the field, the engineering survey will locate, stake, and document all PRS locations (that can be ascertained before sampling) and all surface engineering features and structures. These data will be recorded on a base map. If the repositioning of a sample location becomes necessary during sample collection, this new position will be resurveyed and the revised location will be indicated on the base map. The engineering survey will be performed by a licensed professional. A Survey Procedures Manual will be followed, with oversight by the Field Team Leader (LANL 1992, 13-0096).

The geomorphologic survey will consist of mapping the first-order stream channels downslope of any identified drain outfall. This mapping will facilitate the selection of outfall sediment sample-collection points. The surface drainage mapping will include the sediment catchment sites near any identified outfall.

4.6.1.2 Geophysical Surveys

The purpose of geophysical surveys is to locate subsurface objects, such as trenches or pipes, and to determine the distance to bedrock. Engineering as-built diagrams, when available, can be used to locate objects, but not always with the precision needed for sampling. For example, samples taken adjacent to an active septic system drain line must miss the line and collect the material of interest. In other cases, subsurface utility lines may be near the proposed soil cores.

The general location of subsurface components will be determined by examining dated aerial photographs and engineering drawings, and performing land surveys and onsite visual inspections. Geophysical surveys will be conducted, if necessary, to determine precisely the boundaries of subsurface structures. The Geosciences Technical Team will provide guidance about the appropriate geophysical methods, which may include trenching. Once located, the sites will be surveyed and permanently marked in the field, and the data recorded on a base map.

4.6.1.3 Geomorphic Surveys

Geomorphic surveys will be conducted at locations along channels and drainages carrying surface water runoff from PRSs to locate and map sediment catchment areas. Soil and water samples will later be collected from the mapped catchment areas to address concerns of offsite migration. Surveys will consist of walking the sites in their entirety, studying the land forms and surface processes, and mapping tchannels and drainage systems with noted deposition areas. Orthophotographs and 2-ft-contour topographic maps will be used to aid in the surveys. Geomorphic mapping will be conducted using protocols established in LANL-ER-SOP-03.08, Geomorphic Characterization (LANL 1993, in review).

4.6.1.4 Health and Safety Screening

Before any site work can be started, the health and safety team must screen the site for potential worker hazards. In addition, when subsurface samples are taken, the borehole and cores are also sampled for health and safety levels. These health and safety data are also needed to determine storage, handling, and transportation requirements for the samples.

4.6.1.5 Field Screening Methods

Field screening methods include volatile organic methods, metals methods, field spot tests for explosives, and radiation methods. In addition to the specific instruments described below, field alpha and beta detectors will be used.

Photoionization detector: A Model PI 101 photoionization detector, or its equivalent, will be used. This is a general screening instrument capable of detecting real-time concentrations of many complex organic compounds and some inorganic compounds in air. It may be used in the open, but for greater sensitivity its probe may be inserted into a closed container in which a sample has been collected. The instrument is usually not specific for a particular compound, unless the sample contains a limited number of volatile organics. The applicable SOP is Photoionization Detector (to be written).

Flame Ionization detector: A Foxboro Model OVA-128, or its equivalent, will be used. This flame ionization detector can be used as a general screening instrument to detect the presence of many organic vapors. Its response to an unknown sample is relative to the flammability of the calibration gas. The applicable SOP is Flame Ionization Detector (to be written).

Field Spot-Test Kit for Explosives: The spot-test kit was developed to identify the presence of explosives as contaminants on equipment and environmental media. Three reagents in a carrying case with a portable ultraviolet lamp can be used to detect any of the common explosives used at the Laboratory. A suspect area or material is wiped with a clean filter paper. A drop of each of the three reagents, placed on different parts of the sample, will change color when explosives and/or other nitrogen compounds are present. An ultraviolet light (short wavelength, 254 nm) enhances color for RDX/HMX explosives. In checking soil contaminated with TNT, laboratory experiments determined it was possible to detect a content as low as 0.01% (100 ppm).

Low-Energy Gamma Instruments: Two instruments are commonly used for these surveys, the FIDLER and the PHOSWICH. Both are optimized for the detection of low-energy photons, such as the 60 keV gamma emission from Americium^{241}, or the x-rays that accompany the decay of most heavy radionuclides (e.g., uranium, thorium, plutonium, and other transuranic radionuclides). Either instrument may be used for this work plan. Discrete- or continuous-measurement recording options are available. Surveys are conducted by carrying the instrument close to the ground surface and observing the rate meter or scalar. Stationary measurements may also be made at the ground surface to characterize material without collecting a sample.

4.6.2 Mobile Laboratory Methods

The ER Program is developing mobile laboratories for analysis of radiological and nonradiological constituents in environmental samples. To date, the main application of the mobile radiological laboratory has been for screening samples before shipment to a fixed analytical laboratory. Stipulated detection limits for the radiological laboratory are given in Table 4-9. Screening action levels for radiological constituents have not been established, so it is not possible to stipulate the minimum detection limits necessary to compare environmental concentrations with screening action levels. (The nonradiological mobile laboratory is still under development.)

Anticipated detection limits, as given in Table 4-9, are above screening action levels for about half of the nonradiological constitutents (i.e., cadmium, mercury, benzene, carbon tetrachloride, tetrachloroethane, trichloroethane, and vinyl chloride). Half of the nonradiological constituents have anticipated detection limits below the screening action levels (i.e., barium, chromium, silver, uranium, acetone, toluene, and xylenes). In addition, X-Ray Fluorescence (XRF) analyses are not comparable with EPA methods for analysis of metals in soils or sludges.

TABLE 4-9

COMPARISON OF SCREENING ACTIONS LEVELS WITH MOBILE LABORATORY DETECTION LIMITS

Potential Contaminant	Mobile Laboratory Detection Limits (soils)		Screening Action Levels (soils)
Metals	XRF[a] (ppm)		(ppm)
Barium	10		5600
Beryllium	ND[b]		0.16
Cadmium	2		0.4
Chromium	8		400
Mercury	30		24
Silver	17		400
Uranium	10		240
Volatile Organics	GC/HALL/PID[c] (Ppb)		(ppb)
Acetone	50		8000
Benzene	10		0.67
Carbon tetrachloride	10		0.21
Tetrachloroethane	10		5.9
Toluene	10		890
Trichloroethane	10		3.2
Vinyl chloride	10		0.013
Xylenes	10		160000
Radionuclides	**Gross a/b (pCi/g)**	**Gross g (pCi/g)**	(pCi/g)[d]
Cobalt-60		4	0.72
Cesium-137		4	3.2
Plutonium-238	55		22.48
Plutonium-239	55		20.15
Strontium-90	55		4.46
Thorium-232	55		0.72
Uranium-233	55		69.9
Uranium-235	55		14.75
Uranium-238	55		47.81

a. X-ray fluorescence.
b. No detection limits established.
c. Gas chromatography.
d. Screening Action Levels for radionuclides were derived using the RESRAD computer model and LANL-specific data for mesa tops.

XRF provides an analysis of the true or bulk composition of the soil, whereas EPA sample preparation Method 3050 for inorganic analytes uses a hot nitric acid bath which results in an incomplete digestion of the soils. Therefore, it is anticipated that analysis for potential contaminants of concern will need to be performed at an analytical laboratory. For this reason, it was decided to perform all analyses at an analytical laboratory, and not to employ the nonradiological mobile laboratory in Phase I sampling. However, if detection limits are improved to below screening action levels, and if EPA-approved QA/QC is maintained at the field mobile laboratory, then the nonradiological field mobile laboratory may be used for analysis instead of an offsite analytical laboratory. The radiological laboratory will be used for screening samples before transport from the investigation site.

This work plan does not propose to use data from the mobile laboratories for making field decisions regarding sampling or analysis. In particular, no VCAs are planned as part of Phase I investigations. It is anticipated that, by the completion of Phase I sampling, the present shortcomings regarding unavailable screening action levels, detection levels, and quality assurance levels will be resolved. Phase II investigations, or VCAs proposed on the basis of Phase I investigations, will then be able to use the mobile laboratory.

4.6.3 Analytical Laboratory Methods

The QAPjP (LANL 1991, 0843) presents analytical methods and practical quantitation limits for most potential contaminants of concern in OU 1130; however, the present version of the QAPjP does not identify analytical methods of sufficient resolution to allow their application to all potential contaminants of concern at OU 1130. (Some of the identified methods have detection limits significantly in excess of screening action levels, or do not specify detection limits for all media that will be investigated.) The QAPjP is presently under revision, and that revision is expected to contain adequate specification of the required methods. In the event that analytical methods of sufficient resolution are unavailable, quantitation limits for the best available method will be used, and application of the screening action levels will be modified as necessary [see Chapter 4 and Appendix J of the IWP (LANL 1992, 0768)]. For example, risk assessment guidance for Superfund investigations (EPA 1989, 0305) recommends that for constituents present at or below the practical quantitation limit (PQL), half the PQL should be used as a surrogate for the actual concentration in risk assessment calculations. Using this concept, if the screening action level is below the PQL for a particular analyte, but no less then half the PQL, the PQL could be used as a surrogate for the screening action level. Alternatively, it may be necessary to perform a baseline risk assessment for analytes whose screening action level is significantly below the PQL. Results of the risk assessment, probably using half the PQL as a surrogate for the actual value, could establish whether the risk is acceptable or whether improved analytical methods are necessary.

4.7 Mitigation of Impacts on Biological and Cultural Resources

The biological and cultural resource inventory (Sections 3.3 and 3.4) identified critical species and sensitive areas in OU 1130. These impacts will be minimized as discussed below.

4.7.1 Biological Resources

4.7.1.1 Threatened, Endangered, and Sensitive Species

As a result of a habitat evaluation of and previous data from the OU, several species of concern have been located within or have potential for occurrence in the area. These are Wright's fishhook cactus, grama grass cactus, Santa Fe cholla, the spotted bat, the meadow jumping mouse, the Jemez salamander, and various raptorial birds (birds of prey). The Biological Resource Evaluation Team (BRET) of EM-8 should be contacted before any soil sampling is conducted that could disturb or disrupt these species.

Wright's fishhook cactus (*Mammillaria wrightii*) is found on gravelly or sandy hills or plains, in desert grassland to pinon-juniper woodlands. Its elevational range extends from 3,000 to 7,000 ft. Further vegetational sampling is required to determine the presence or absence of Wright's fishhook cactus within OU 1130. Potential habitat site disturbances should be kept to a minimum; if ground disturbance is greater than one-tenth acre, or if machine sampling is required, notify BRET 60 days prior to sampling to evaluate the sample site for Wright's fishhook cactus.

Grama grass cactus (*Toumeya papyrancantha*) is usually found within basalt outcrops on sandy soils. Its elevational range extends from 5,000 to 7,300 ft. Further vegetational sampling is required to determine the presence or absence of grama grass cactus within OU 1130. Sampling of this species must occur while it is in flower, a brief period dependent upon weather conditions and occurring between early April and late June. Potential habitat site disturbances should be kept to a minimum, and motor vehicles should be restricted to established roadways whenever possible. If ground disturbance is greater than one-tenth acre, or if machine sampling is required, notify BRET 60 days prior to sampling to evaluate the sample site for grama grass cactus.

Santa Fe cholla (*Opuntia viridiflora*) occurs on south- and west-facing slopes within pinon-juniper woodlands at elevations of 7,200 to 8,000 ft. Further vegetational sampling is required to determine the presence or absence of Santa Fe cholla within OU 1130. Potential habitat site disturbances should be kept to a minimum; if ground disturbance is greater than one-tenth acre, or if machine sampling is required, notify BRET 60 days prior to sampling to evaluate the sample site for Santa Fe cholla.

The spotted bat (*Euderma maculatum*) is found in pinon-juniper, ponderosa, mixed conifer, and riparian habitats. The two critical requirements for the spotted bat are a source of water and roost sites (caves in cliffs or rock crevices). In the Pajarito wetlands, appropriate roost sites are plentiful and usable water is available. Mist netting for bats in TA-36 was conducted during July of 1992. No spotted bats were captured, and none have been found in similar attempts at TA-2, TA-16, and Bandelier National Monument. No adverse impact will occur to the spotted bat (if present) as long as small caves and rock crevices are not disturbed and the water sources within the canyon are not altered.

The meadow jumping mouse (*Zapus hudsonius*) prefers habitat containing permanent streams, moderate to high soil moisture, and dense and diverse streamside vegetation consisting of grasses, sedges, and forbs. Due to an unnaturally long hibernation period, the meadow jumping mouse is primarily active from June through September in the Jemez Mountains. In 1990 and 1991, small mammal trapping sessions within the Pajarito wetlands captured no meadow jumping mice; however, this area may support a small population, and further trapping is required to verify its presence or absence. These trapping surveys should take place during the meadow jumping mouse active period, from June through September, with July being the optimal time. Until additional survey work is done within Pajarito Canyon, the potential for a meadow jumping mouse population should be included in management plans. Disturbance to the waterway and streamside vegetation should be avoided.

Several species of raptors are known to occur within OU 1130. Nesting sites for the Cooper's hawk (*Accipiter cooperii*), the red-tailed hawk (*Buteo jamaicensis*), the American kestrel (*Falco sparverius*), and the great horned owl (*Bubo virginianus*) have been confirmed within the lower canyons. Zone-tailed hawks (*Buteo albonotatus*) are listed as probable breeders in lower Pajarito Canyon, and flammulated owls (*Otus flammeolus*) are listed as possible breeders in lower Water Canyon in the Atlas of the Breeding Birds of Los Alamos County (October 1992). Both bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) have been recorded roosting in nearby Ancho Canyon. Flooding and subsequent backup of contained waters from Cochiti Dam may displace the eagles farther north and into the OU near the Rio Grande in the future. In addition to species listed as threatened or endangered, all raptors receive some level of protection under New Mexico Statutes Annotated, Chapter 17-2-14. Any disturbance that disrupts nesting raptors must be avoided. To determine the breeding season for a specific raptor, contact BRET.

4.7.1.2 Wetlands/Floodplains

There are wetlands within the OU, including the extensive Pajarito Wetland to the south of Pajarito Road in TA-36. Monitoring and delineating of these areas will be required just prior to soil sampling along Pajarito Road and in the canyon bottoms. Sampling for site characterization in these areas may have to be modified slightly to avoid impact to a wetland. Potential floodplains are found within the Pajarito Wetlands and some of the canyon systems. These must also be considered when planning soil sampling. Contact BRET 60 days prior to sampling in any wetland area.

4.7.1.3 Recommendation

Impacts to nonsensitive plant species should be avoided when possible. Revegetation may be required at some sites. A list of native plants suitable for revegetation for OU 1130 will be included in the final report, "Biological Assessment for Environmental Restoration Program, Operable Unit 1130." Additional mitigation measures include the following:

- Avoid unnecessary disturbance (i.e., parking areas, equipment storage areas, off-road travel) to surrounding vegetation during actual sampling and when traveling into sampling sites.
- Avoid removal of vegetation along water sources, drainage systems, and stream channels.
- Avoid disturbance to vegetation along canyon slopes, and especially to drainages.
- Avoid tree removal. If tree removal is required, contact BRET for an evaluation.

In addition to the previously-mentioned mitigation measures, BRET requests notification of additional disturbances before the work is conducted.

The "Biological Assessment for the Environmental Restoration Program, Operable Unit 1130" will be evaluated by the US Fish and Wildlife Service for compliance with the Endangered Species Act. This federal agency may require additional mitigation measures that are not represented in this summary. BRET will notify the project leader if additional mitigation measures are required.

4.7.2 Cultural Resources

All personnel involved in ER sampling activities must follow all monitoring and avoidance recommendations in the Cultural Resource Survey Report specific to OU 1130 (Larson 1993, 13-0086). EM-8 archaeologists must be contacted 30 days before initiation of any groundbreaking activities so that monitoring and avoidance recommendations can be verified.

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Executive Summary

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5.0 EVALUATION OF POTENTIAL RELEASE SITES

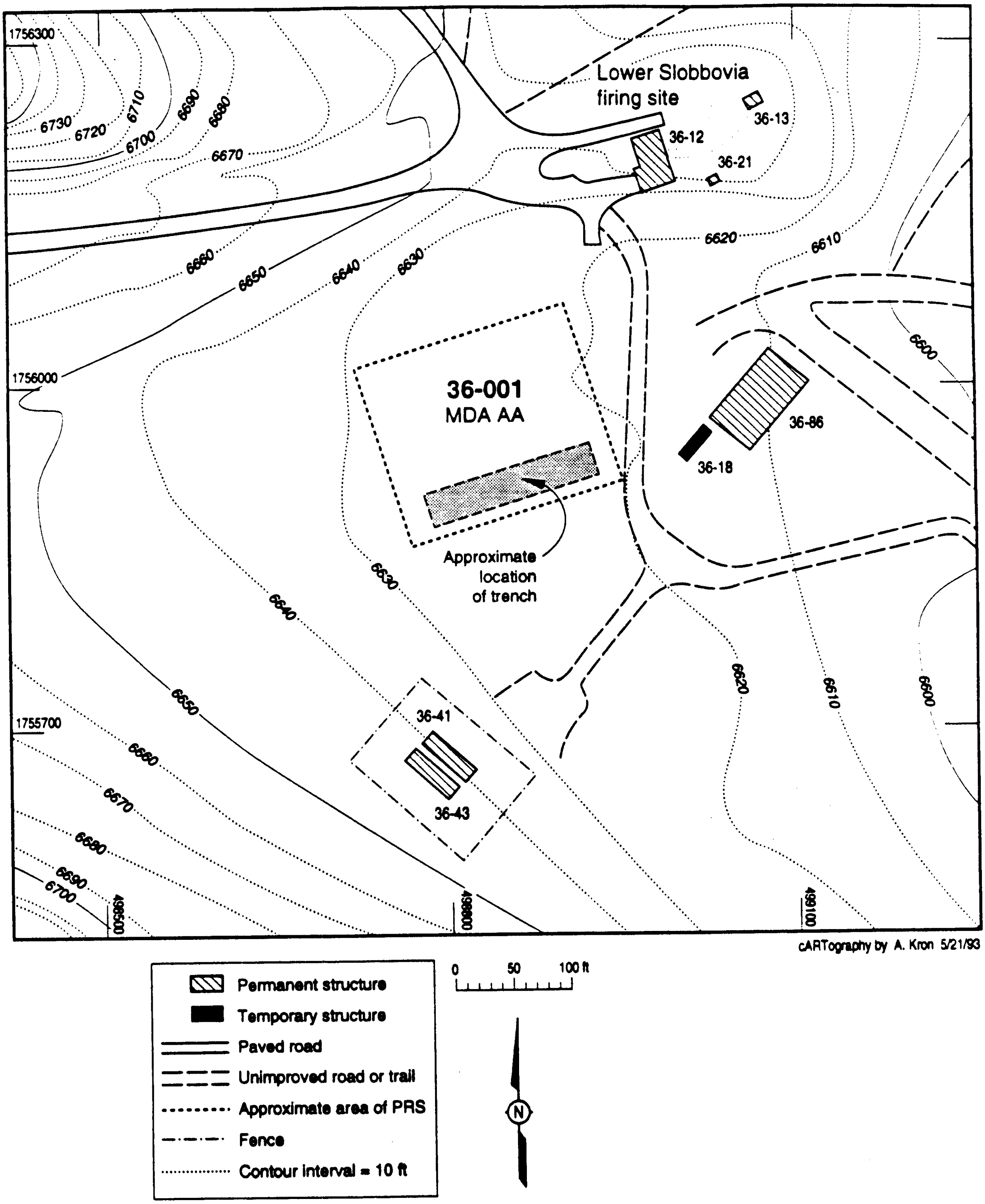
This chapter provides information about the following potential release sites (PRSs): Material Disposal Area (MDA) AA, the sump, the septic system aggregate, the active firing site aggregate, the Boneyard, the surface disposal area, the photo outfall, the portable vessel at I-J site, and the projectile-testing site.

5.1 PRS 36-001: MDA AA

The following sections describe MDA AA and its history, the nature and extent of contamination, potential pathways and exposure routes, remediation decisions and investigation objectives, data needs and data quality objectives, and the sampling and analysis plan.

5.1.1 Description and History

MDA AA (PRS 36-001) is located in a leveled area south of the Lower Slobbovia firing site in Potrillo Canyon. The area is approximately 300 ft southwest of the firing site control bunker [technical area (TA)-36-12], and 150 ft southwest of the x-ray device (TA-36-86) commonly called PIXY (pulse-intense x-ray machine) (Rae 1989, 13-0074; Kelkar 1992, 13-0007). The exact number of trenches is unknown; however, information from two sources indicates that there are from two to four trenches (LANL 1990, 0145). Operations consisted of collecting and loading material remains from the shots into a pickup truck and taking this material to the trench. The material was unloaded by hand into the trench and then burned. When the trench was filled with burned debris, it was covered with approximately 4 ft of soil and a new trench was dug (Henke and Van Marter 1993, 13-0093). The trenches probably contain the burned residue of firing site debris, such as wood, nails, and small amounts of sand contaminated with barium, uranium, other metals, and plastics (EG&G 1989, 13-0044; LANL 1990, 0145). Figure 5-1 identifies the approximate area where MDA AA trenches may be located. The first MDA AA trench was dug in the mid-1960's to burn and dispose of debris and sand from the firing sites (Becker 1991, 0699). The trenches provided safety and administrative controls for explosives and for materials possibly contaminated with explosives; they also provided a way of



cARTography by A. Kron 5/21/93

Figure 5-1. Location of MDA AA (PRS 36-001).

reducing the volume of firing site debris. The last active trench on the south side of MDA AA was closed on May 12, 1989, in accordance with New Mexico solid waste regulations. After the last trench was filled with burned debris and covered with clean soil, the entire MDA AA trench area was graded. Combustible firing site debris, such as wood, is still burned on the surface of a permitted burn area 100 to 300 ft west of MDA AA.

5.1.2 Conceptual Exposure Model

The conceptual exposure model for MDA AA (Figure 5-2) describes both the contamination that might be present in the trenches and the potential future exposure pathways.

5.1.2.1 Nature and Extent of Contamination

The potential contaminants of concern associated with MDA AA are the residues from explosives, natural or depleted uranium, and other metals such as barium, chromium, zinc, and lead. Although there is no indication that undetonated explosives were buried at MDA AA, small amounts of explosives may be present at this site, particularly in the last active trench. It is possible that the last load of material deposited in this trench was never burned (Kelkar 1992, 13-0059). The 1988 Department of Energy (DOE) Environmental Survey (EG&G 1989, 13-0044) collected three grab soil samples from the bottom of the last active trench at depths between 0.0 and 6.0 in. The samples, collected from near each end and from the middle of the trench, were analyzed for volatile organic compounds (VOCs), metals, explosives, uranium and thorium isotopes, and gamma-emitting radionuclides. The analytical results for metals are shown in Table 5-1. Note that the data from this study are provisional because the holding times for samples were exceeded. The inorganic and radionuclide analyses are believed to be more reliable; however, this is not documented (Ferenbaugh et al. 1990, 0099; Purtymun et al. 1987, 0211).

No VOCs or explosives were reported. The levels reported by the DOE Environmental Survey are generally within normal background ranges for soils derived from Bandelier Tuff (Ferenbaugh et al. 1990, 0099; Purtymun et al. 1987, 0211). There is one above-background cadmium measurement, but it is

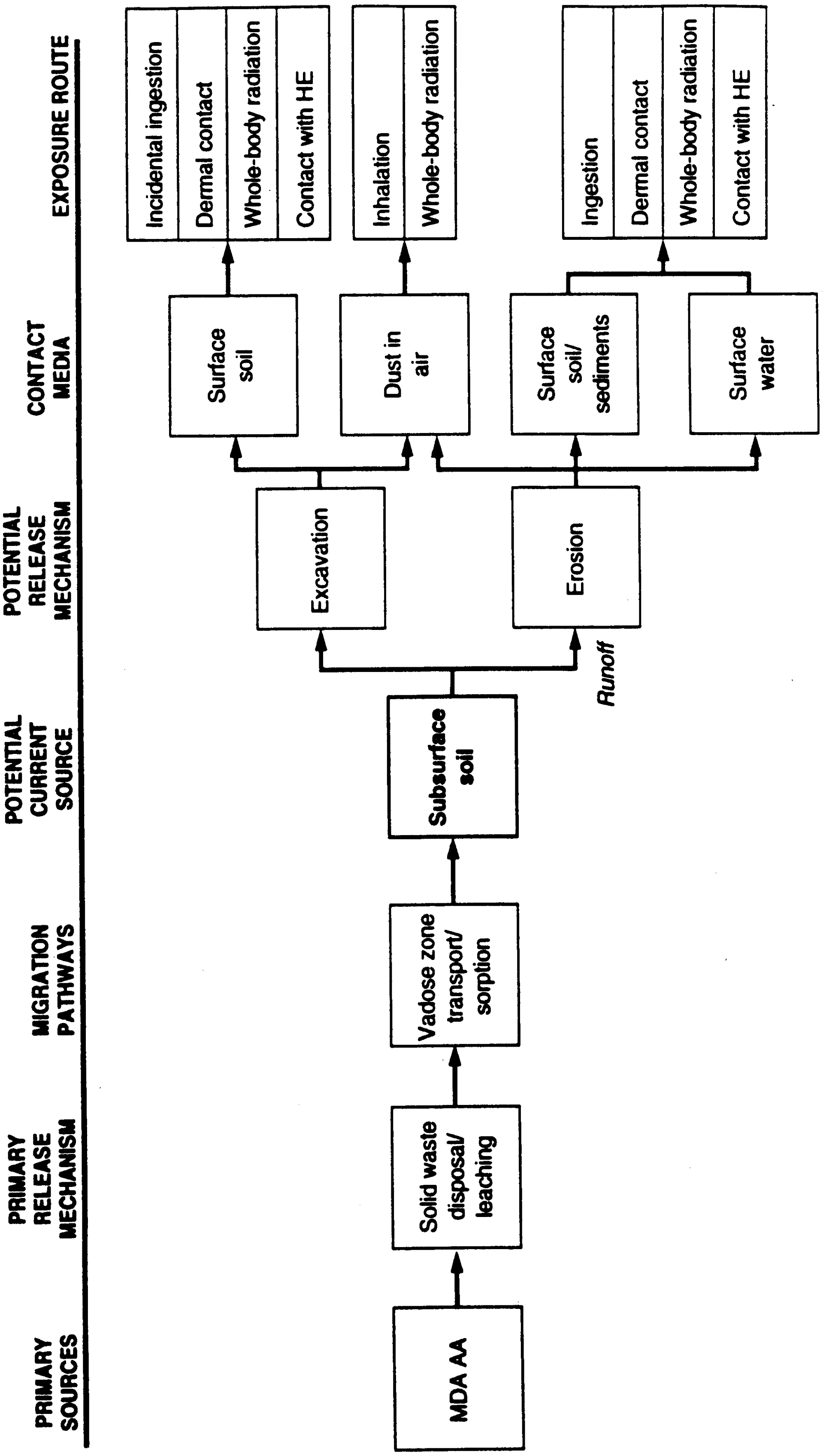


Figure 5-2. Conceptual exposure model for MDA AA.

TABLE 5-1

DOE ANALYSIS OF SAMPLES FROM MDA AA TRENCH

Contaminant Measured	Soil Concentration (ppm)	Background Concentration in Soil (ppm)	Screening Action Level in Soil (ppm)
Barium	89 to 150	120 - 810[a]	5,600
Chromium	3.6 to 8.6	1.6 - 71[b]	400[c]
Zinc	1 to 49	38 - 71[a]	24,000
Cadmium	0 to 4.6	0.03 - 0.52[a]	80
Copper	0 to 9.9	2 -18[a]	3,000
Lead	13 to 19.6	8 - 98[a]	500
Total U	0.3 to 5	1.3 - 3.9[d]	240

[a] (Ferenbaugh et al. 1990, 0099).
[b] (Longmire 1992, in preparation).
[c] Chromium VI.
[d] (Purtymun et al. 1987, 0211).

less than 6% of the screening action level for cadmium in soil [80 parts per million (ppm)]. Depleted uranium isotopes also exist in the same sample at levels suggesting that low concentrations of hazardous and radioactive materials from burning and treatment at this site may be present within this most recent trench. It is likely, but not confirmed, that small volumes of soil, debris, and burned material in the older trenches are similarly contaminated.

In December 1987, Environmental Management (EM)-8 collected six samples from the last open trench and submitted them for the Toxicity Characteristics Leaching Procedure (TCLP) (McInroy 1987, 13-0072). The metal concentrations of these samples reported in Table 5-2, are below the guidelines for maximum concentration of contaminants for the toxicity characteristics established in the Code of Federal Register 1992, 40 CFR 261.24.

5.1.2.2 Potential Pathways and Exposure Routes

In this section, the conceptual model is used to determine the potential for human exposure to contaminants of concern from MDA AA. The possible sources of

TABLE 5-2

EM-8 ANALYSIS OF SAMPLES FROM MDA AA TRENCH

Contaminant Measured	TCLP[a] Concentration	Toxicity Characteristic Value[b]
Lead	0.14 to 1.06 mg/L	5.0 mg/L
Barium	1.4 to 3.4 mg/L	100.0 mg/L
Cadmium	0.02 to 0.14 mg/L	1.0 mg/L

[a] Toxicity Characteristic Leaching Procedure.
[b] 40 CFR 261.24.

subsurface contamination for this site include both the intentional burning of combustible materials (a practice that has been discontinued), and the treatment of solid waste in trenches located in the bottom of Potrillo Canyon. Leaching and downward migration resulting from accumulated snow melt and rainfall may have occurred in the open trenches, but these processes are less likely to have continued after the trenches were filled in and graded to encourage runoff.

Because the trenches are covered with clean fill, buried contaminants could be released only if subsurface soil became exposed through erosion, or if significant moisture infiltration and leaching occurred. Potential contamination is subsurface and the public has no direct exposure to it at present. A conservative baseline risk assessment will be performed using information collected during the Phase 1 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). This assessment will postulate that future erosion may bisect the trenches, uncovering some of the buried ash and debris, and exposing individuals who will use the site for recreational purposes to possible contaminants. Calculation of the associated risk will be based on the assumption that an individual is in direct contact with this once-buried layer throughout a two-week period, twice per year, for a total of twenty years. To ensure that the most conservative scenario has been chosen, a second scenario that includes excavation in the area will also be used in calculations to determine potential risk to construction workers.

Chapter 4 of this work plan contains additional details about migration pathways, conversion mechanisms, human receptors, and exposure routes. It should be noted that this PRS is near the active firing pad at Lower Slobbovia [TA 36-004(d)] and that no recreational access is likely until the firing site is decommissioned.

5.1.3 Remediation Decisions and Investigation Objectives

MDA AA was closed in 1989 in accordance with New Mexico solid waste regulations (Rae 1989, 13-0074). Based on the available data, further corrective actions may not be necessary. However, it should be noted that the available data are questionable because holding times for analyses were exceeded. Also, measurements were from samples obtained only from the most recently used trench, and are perhaps not representative of the older parts of the site (EG&G 1989, 13-0044; Ferenbaugh 1990, 0099; Purtymun 1987, 0211). The Phase I goals of the RFI for this site are to locate all of the trenches at MDA AA, and to collect more representative data for screening and baseline risk assessments.

If these assessments suggest that corrective action may be necessary at this site, additional site studies will evaluate which corrective measures might be performed as Phase II of the RFI. Possible remedial alternatives include site excavation, or erosion control measures to prevent runon to the trenches. To evaluate the long-term effectiveness of erosion control, site-specific hydrological data are needed. To consider the possibility of site excavation, the potential hazards to remediation workers and the potential effects on the environment must be considered. Effective evaluation of these hazards may necessitate additional sampling to improve the characterization of the source term.

5.1.4 Data Needs and Data Quality Objectives

The objectives of the Phase I RFI are to determine the number and the locations of trenches in MDA AA, and to establish the bounds of the level and extent of contamination in these trenches. In addition, if erosion channels caused by runoff from the buried waste are noted during the investigation, these channels will be sampled to determine whether a release from the buried waste has occurred.

The trenches are located within the leveled area southwest of Lower Slobbovia. The two MDA AA trenches that were closed most recently can be located using landmarks shown in aerial photographs. One of these trenches was open in 1979 (LANL 1979, 13-0092), and the other was open in 1986 (LANL 1986, 13-0062). The ends of the trenches are poorly defined and probably can be located to within 10 ft, while the sides, which are more evident, may be able to be located within 2 to 5 ft. The older trenches are thought to be parallel to, and northwest of, these more recent trenches.

Surface geophysics will be used to locate the other trenches, as well as to confirm the locations of the two trenches shown in photographs, if sufficient information cannot be obtained from the photographs.

Sampling will be performed by drilling through the trenches. Safety precautions will be taken to protect equipment and personnel from the slight possibility that undetonated explosives may be encountered.

The populations to be sampled are the layers of fill overlying the ash and debris, the ash and debris at the bottoms of the trenches, and the underlying soil or tuff. Samples of the overlying fill will be collected from only one hole per trench. This layer will be sampled at a lower density than the other layers because contaminants are not suspected to be present here. The layer will also be sampled to rule out contaminants, since the origin of the fill is unknown. Among these three strata, the potential contaminants of concern in the ash and debris layers are expected to be most variable, so these will be sampled at a high density. Both the concentrations of contaminants and the thickness of this layer may vary considerably within each trench, so each should be sampled at several locations. Inspecting each core should make it possible to distinguish among the three strata; the depth range of each layer, as well as the depth of the sampled intervals, will be recorded.

Observed constituent concentrations in the ash and debris layers will be compared with screening action levels for soil, so that potential contaminants of concern can be identified during the initial screening assessment. If unburned debris is retrieved in any of the cores, it may be collected and analyzed. If contaminants of concern are identified (i.e., if concentrations above screening action levels are observed), site evaluation, in the form of a baseline risk assessment, will continue for these contaminants. The baseline risk assessment will use the exposure scenarios described in Section 5.1.2.2 of this work plan. The recreational scenario assumes that individuals will come into direct contact with the most contaminated layers in the trenches, so the average observed contamination level from the ash and debris layer will be used for calculations. Under the construction scenario, workers would be exposed to a cross-section of all strata to a depth of approximately 8 to 14 ft; an estimate of the average contamination in MDA AA is therefore a more relevant figure to use in calculations for this scenario. The contamination levels in the ash and debris layer do, however, provide a useful upper bound. To evaluate the downward migration of contamination, the maximum observed levels of contaminants in samples from the underlying material (the undisturbed layer below the excavations) will be compared with screening action levels.

It should be possible to estimate the important variance components based on the information derived from Phase I sampling; an effective Phase II sampling plan can then be designed if necessary. Samples are needed from each trench to determine whether disposal practices have changed significantly between the years when the first MDA AA trenches were used and the years when the last trench was used. Both the contaminant concentrations and the thickness of ash or debris layers may vary significantly at different lateral locations within the trenches; enough holes must be drilled so that this variability can be characterized. If no contamination is observed in the trenches, no further action (NFA) will be proposed.

5.1.5 Sampling and Analysis Plan

The sampling and analysis plan includes information about land and geophysical surveys, field screening, and sampling that will be conducted at MDA AA; the plan also describes offsite laboratory analyses.

5.1.5.1 Geophysical, Land, and Geomorphic Surveys

A geophysical survey using electromagnetic and magnetic methods and ground penetrating radar will be conducted over an approximately 75,000-sq-ft area to locate the trenches, if aerial photographs do not provide enough information. Before conducting the geophysical survey, locations for taking the geophysical measurements will be surveyed and flagged over a 10-ft grid system. Electromagnetic and magnetic geophysical surveys will be carried out in accordance with protocols established in LANL-ER-SOP-03.02, General Surface Geophysics (LANL 1993, in review).

A land survey will be performed in accordance with the LANL Survey Procedures Manual (LANL 1992, 13-0096). This survey will be used to determine sampling locations identified by the geomorphic survey. The surveyed location points and geophysical readings will be logged on 2-ft contour maps and the information will be transferred to the Facility for Information Management, Analysis, and Display (FIMAD).

A geomorphic survey will be used to identify sediment catchment areas and locations where sampling may occur. Geomorphic mapping will be conducted in accordance with protocols established in LANL-ER-SOP-03.08, Geomorphic Characterization (LANL 1993, in review).

5.1.5.2 Field Screening

Determining potential hazards and establishing health and safety conditions for onsite workers will necessitate field screening. All surface and subsurface samples will be screened in the field. A field portable instrument for detecting alpha-emitters will be used to screen for gross alpha, a field portable instrument for detecting beta- and gamma-emitters will be used to screen for gross beta and gamma, and a flame ionization detector (FID) and/or a photo ionization detector (PID) will be used to screen for volatile organic compounds (VOCs). Fifty percent of the ash and debris layer from each core, and each surface sample from the runoff channel (if a channel is observed in the field), will be screened for explosives using a field spot-test kit. Samples to be field screened for explosives will be selected at every other sampling location (i.e., samples will be collected at the 1,3,5,7...n+2 sampling locations). If explosives are detected in any sample, then the rest of the samples from the ash and debris layer will be screened. The overlying fill and underlying soil and tuff are not likely to contain explosives and therefore will not be screened for them.

5.1.5.3 Sampling

The proposed sampling and analysis plan for MDA AA is presented in Table 5-3. The surface and subsurface soil, the tuff, and the ash debris from the trenches will all be sampled. Four holes will be drilled into each of the trenches, one in each quarter of the length of the trench, using a hollow-stem auger drill rig with a core barrel (or possibly another type of rig). Exact locations will be selected randomly within these quarter-sections. If a geophysical anomaly that requires further investigation is identified in the course of the geophysical survey, an additional sample will be taken. Each hole will be drilled to a depth of approximately 2 ft below the bottom of the trench (approximately 12 ft below the ground surface), into the layer of undisturbed soil or tuff. These samples will be used to determine whether potential contaminants of concern are migrating out of the trenches. Holes will be drilled to greater depths if visual inspection (such as indications of staining, wet intervals, change in color or texture, etc.) or field screening measurements indicate that contamination extends deeper. Continuous cores will be taken from the ground surface to the bottom of each hole. The cores will be examined, and such data as depth, thickness, color, and grain size will be logged and recorded for each layer.

Three or four samples from the cores collected from the drilled holes will be submitted for laboratory analysis: one sample will be collected from the overlying fill layer (one hole per trench); two samples will be collected from the ash and debris layer (each hole); and one sample will be collected from the undisturbed soil or tuff (each hole). The coordinates of each sample will be determined and provided to FIMAD.

If runoff erosion channels emanating from the buried waste are observed in the field, sediment soil samples will be collected from sediment traps along these channels. Table 5.3 presents an estimate of the samples that will be collected. Core samples will be collected using protocols established in LANL-ER-SOP-

TABLE 5-3

SUMMARY OF SAMPLING AND ANALYSES FOR PRS 36-001, MDA AA

	Sampled Media				Samples						Field Screening					Laboratory Analyses										
					Structure		Surface		Subsurface																	
Description	soil/tuff	soil	ash/debris	fill	primary	duplicate	primary	duplicate	primary	duplicate	Beta-gamma	Alpha	Organic Vapor	Combustible gas/oxygen	Explosives (Spot Test)	Gross Gamma	Gamma spectroscopy	Total uranium	Isotopic uranium	Plutonium	Metals (SW 6010/7000)*	Mercury	Cyanides	VOCs (SW 8260)*	SVOCs (SW 8270)*	Explosives (SW 8330)*
Trench	x								16	1	x	x	x					x	z		x					x
Trench			x						32	2	x	x	x		y			x	z		x					x
Trench				x			4	1			x	x	x					x	z		x					x
Channel		x					3	1			x	x	x		x			x	z		x					x

x : All samples
y : Selected samples (see text)
z : Samples will be analyzed if total potential contaminants of concern are detected above screening action levels.
Note: The number of samples may vary depending on the number of trenches located during field surveys.
* : Applicable EPA SW 846 methods.

06.10, Hand Auger and Thin-Wall Tube Sampler and/or LANL-ER-SOP-06.24 Sample Collection from Split Spoon Samplers and Shelby Tube Samplers (LANL 1992, 0688). The number of samples indicated in Table 5-3 is based upon the collection of samples from four trenches; the number of samples taken will vary depending on the actual number of trenches observed during the field surveys.

5.1.5.4 Laboratory Analyses

Samples will be analyzed for total uranium, explosives, and heavy metals (silver, barium, beryllium, cadmium, chromium, mercury, nickel, lead, and zinc). If uranium is detected above natural background levels, the sample will be analyzed for isotopic uranium. If a field laboratory is available and meets Quality Analysis/Quality Control (QA/QC) criteria, these samples may be analyzed on site. Otherwise, an offsite analytical laboratory will be used.

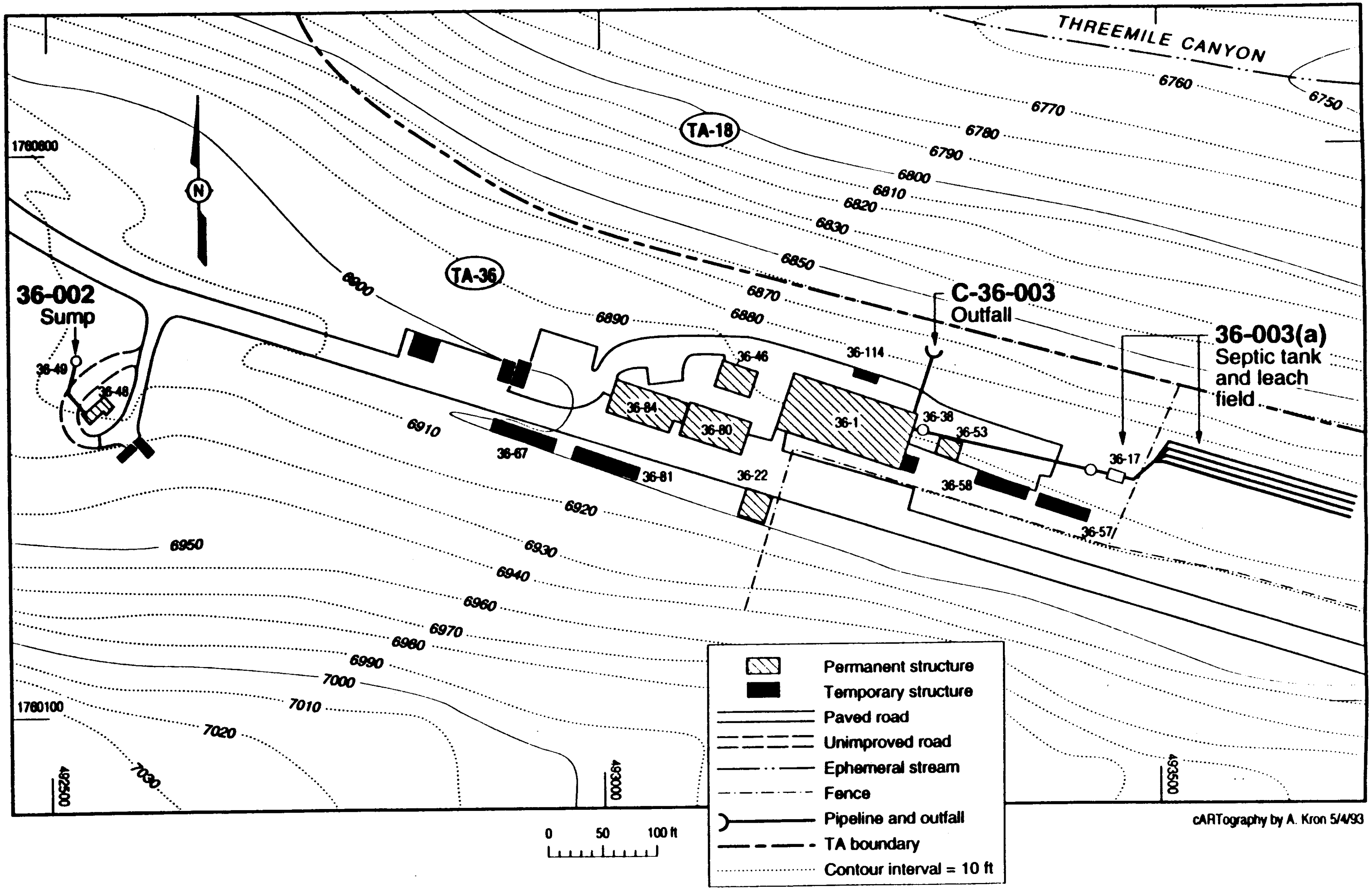
5.2 PRS 36-002: Sump (TA-36-49)

The following sections describe the sump and its history, nature and extent of contamination, potential pathways and exposure routes, remediation decisions and investigation objectives, data needs and data quality objectives, and the sampling and analysis plan.

5.2.1 Description and History

The sump, TA-36-49 (PRS-36-002), is located on a mesa south of Potrillo Drive approximately 655 ft west of the security checkpoint at the entrance to TA-36. The sump, which is approximately 40 ft northwest of building TA-36-48, was constructed in September 1965 (LASL 1965, 13-0069) to receive the drainage from two sinks in that building. A 4-in. vitrified clay pipe connects the sink drains to the sump.

The sump is an unlined pit, 4 ft in diameter by 8 ft deep, that was excavated from soil and tuff. It is filled to a depth of 6 ft with pieces of approximately 3-in.-diam coarse rock. The pit is covered by a 5-ft-diam metal cover. Figure 5-3 shows the location of building TA-36-48 and the sump. TA-36-48, the Controlled Environment Building, comprises two rooms with separate entrances. The two



cARTography by A. Kron 5/4/93

Figure 5-3. Location of PRSs at TA-36 Main Site.

sinks that drain to the sump are located in one room. One of the sinks, which is coated with chemical-resistant enamel, is under a fume hood; the other sink is outside the hood. After the building was constructed in September 1965 (LASL 1965, 13-0069), it was initially used for shot assembly and for temperature-controlled experiments. Depleted uranium was cut, lapped, and polished in the building. Because one sink has the chemical-resistant coating, it is possible that acetone, alcohol, HMX (explosive powder), and nitro-methane were discarded into the sink in the past. However, only small amounts of contaminants are likely to have been discharged into the sump because the building was used infrequently (no more than ten times per year) until recently (Henke and Van Marter 1993, 13-0093).

Shot assembly and preparation of depleted uranium have been discontinued at this site, so no contaminants are being discharged to the sump at the present time. One of the rooms now contains exercise equipment and is used as a workout room. The second room, which houses both sinks, contains vapor deposition equipment for metal plating. This room is also used for assembling shots that do not contain explosives or depleted uranium. Discharge of hazardous or radioactive materials to the sump is now prohibited by Laboratory policy and is controlled by Laboratory administrative policies.

5.2.2 Conceptual Model

The conceptual exposure model (Figure 5-4) indicates both the pathways by which potential contaminants might have been (or are being) released from the sump, and the environmental media that might have been (or are being) contaminated. The potential pathways for human exposure to these media, as depicted in the figure, are addressed in detail in Chapter 4.

5.2.2.1 Nature and Extent of Contamination

There has been no reported sampling of the sump, so it is not known whether it is contaminated. However, contaminants might have been discharged to the sump through the sinks. Materials used in the shot assembly process initially performed in this building included known contaminants, and the fact that the sinks and drains were designed to handle chemicals further supports the idea

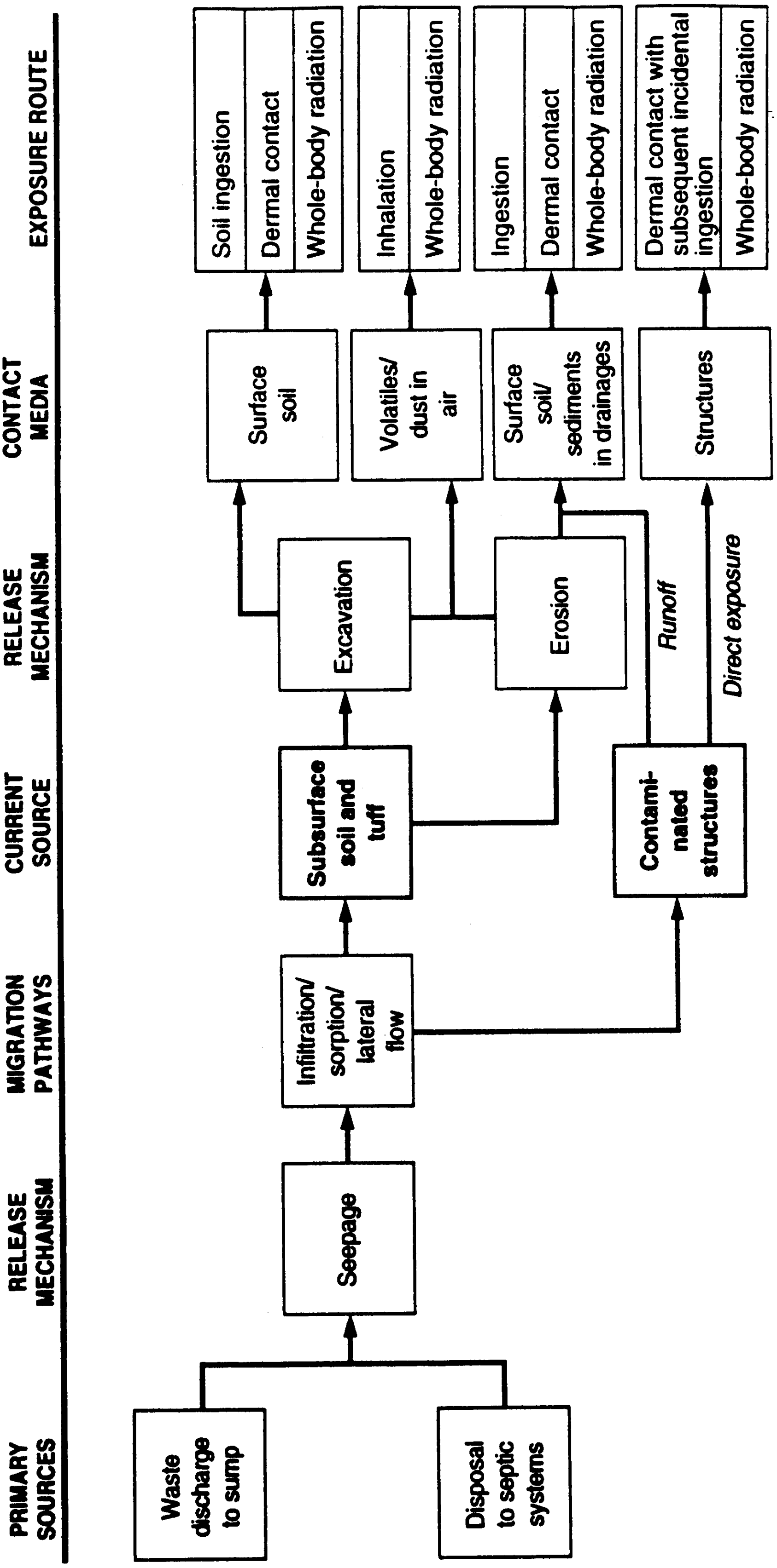


Figure 5-4. Conceptual exposure model for the sump.

that this sump was designed to handle industrial wastes. Undetermined amounts of explosives, acetone, zinc chloride, glue, and acids were probably discharged to the sump (LANL 1990, 0145). Depleted uranium is another potential contaminant of concern (Stauffer 1992, 13-0078). The cumulative discharge of each constituent is unknown, but it is most likely small because the building was used no more than ten times per year (Henke and Van Marter 1993, 13-0093).

The more soluble potential contaminants of concern, if they were present, may have migrated into the soil and tuff underlying and surrounding the sump. The extent of such migration is unknown.

5.2.2.2 Potential Pathways and Exposure Routes

Liquid discharging from the sump bottom and sides could potentially involve the release of chemicals from the sump into subsurface soils. Chemical releases could also result from any pipe leaks that may be present. If potential contaminants of concern were released, the migration pathway would consist of infiltration and lateral and vertical leaching into subsurface soils.

Any existing contamination is currently contained within the sump or the surrounding subsurface material. Future excavation or erosion could bring these subsurface contaminants to the surface. Refer to Chapter 4 of this work plan for a more detailed discussion of migration pathways, conversion mechanisms, human receptors, and exposure routes.

5.2.3 Remediation Decisions and Investigation Objectives

If RFI sampling indicates that concentrations of potential contaminants of concern are below screening action levels, no further action (NFA) will be proposed for this PRS, contingent on the results of an ecological risk assessment (see Section 4.3). If measured concentrations exceed screening action levels, a baseline risk assessment will be conducted to establish appropriate cleanup levels. Additional data collection may be required to perform this assessment. Normally, corrective action would not be initiated until after this risk assessment has been completed.

Because of the relatively large size (3-in-diam cobble) of the fill, it will be necessary to excavate the material in the sump in order to sample it. Therefore, the equivalent of a voluntary corrective action (VCA) will be performed: the sump will be excavated and the excavated fill material will be temporarily stored on site. If analyses indicate that no contaminants are present, the fill can be replaced, and NFA can be proposed. If contaminants are present, and a baseline risk assessment indicates that further corrective action is required, appropriate remediation will be undertaken. This could consist of appropriate treatment of the excavated fill and removal of any additional contaminated soil or tuff from around the sump. If possible, any necessary remediation would be performed as a continuation of the VCA initiated with the sampling program. Selection of appropriate remediation methods would be made on the basis of the types of waste generated (radioactive, hazardous, or mixed) and appropriate treatment or disposal technologies for those wastes.

5.2.4 Data Needs and Data Quality Objectives

The objectives of the Phase 1 RFI are to determine concentrations of potential contaminants in the fill material of the sump; these data will be compared with screening action levels to determine if the contaminants are present at levels of concern. The data will also be used to determine whether contaminants have migrated into the soil or tuff surrounding the sump.

Any existing sludge in the sump will be sampled and analyzed. The contaminants that may be present in the sump are explosives and residues of explosives, acetone and other organic solvents, zinc, and other metals, including depleted uranium. Measured concentrations of these potential contaminants will be compared with screening action levels.

Constituent levels in the soil or tuff immediately below and adjacent to the sump will be measured and compared with the screening action levels to establish whether migration has occurred or whether migration is significant. Determining the extent of migration away from the sump may require further investigation in Phase II of the RFI. The volume of water discharged to this sump has never been large, so observing any existing contamination in the immediately adjacent media should be possible.

5.2.5 Sampling and Analysis Plan

The sampling and analysis plan describes field screening and sampling that will be conducted, as well as laboratory analyses that will be performed off site.

5.2.5.1 Land Survey

A land survey will be performed in accordance with the LANL Survey Manual (LANL 1992, 13-0096). The surveyed location points will be logged on 2-ft-contour maps and the information will be transferred to the FIMAD.

5.2.5.2 Field Screening

Determining potential hazards and establishing health and safety conditions for onsite workers will necessitate field screening. Before any sampling is conducted at the sump, its metal cover will be removed, and the interior space of the sump above the backfill will be screened for VOCs, combustible gases, and gross alpha, beta, and gamma. Portable field instruments for detecting alpha-, beta-, and gamma-emitters will be used to screen for gross alpha, gross beta, and gross gamma, and an FID and/or a PID will be used to screen for VOCs. All field samples will be screened for explosives using a field spot-test kit. The samples to be field screened for explosives will be selected at every other sampling location (i.e., samples will be collected at the 1,3,5,7...n+2 sampling locations).

5.2.5.3 Sampling

The sampling and analysis proposed for the sump is presented in Table 5-4. Throughout the sampling process, the sump will be field screened so that worker safety can be ensured. A backhoe equipped with a clamshell or similar tool will be used to remove the rock fill from the sump. Samples of sludge within the rock fill will be collected at three depths below the discharge point of the pipe entering the sump. As the sump is excavated, the specific sampling intervals will be established on the basis of visual inspection and field screening results of the excavated material. Visual inspection will involve inspection of staining, moisture content, and color or texture changes. Samples will be collected in accordance with protocols established in LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples (LANL 1992, 0688). The excavated rock fill will be placed in a container and stored in the immediate vicinity of the PRS. The hole will be covered and cordoned off to prevent access. Storage will be consistent with Laboratory requirements for materials that are potentially mixed wastes. If liquid is present, two liquid sludge samples will be collected from the near-bottom of the sump. Samples will be collected in accordance with protocols established in LANL-ER-SOP-06.15, Coliwasa Liquid Waste Sampler for Liquids and Slurries (LANL 1992, 0688).

After the excavation is completed and the sludge samples are collected, the samples will be taken to a laboratory and analyzed for potential contaminants of concern. If samples are detected to have potential contaminants of concern above screening action levels, a hollow-stem auger drill rig with a core barrel (or similar rig) will be used to drill three holes inside the excavated 4-ft-diameter sump, and three holes outside the perimeter. The locations of the holes will be selected randomly. The holes will be drilled to depths of approximately 5 ft below the bottom of the sump in order to determine whether potential contaminants of concern are migrating out of the sump. Holes will be drilled to greater depths if visual indicators (such as indications of staining, wet intervals, change in color or texture, etc.) or field screening measurements suggest that contamination extends deeper. Continuous cores will be collected from each hole, and cores will be field screened for VOCs and gross alpha, beta, and gamma. Two samples will be collected from each hole. One sample will be collected from the top 6 in of each hole, and the other sample location will be approximately 2 ft below the bottom of the sump. Core and sample collection will be carried out in a manner consistent with protocols established in LANL-ER-SOP-06.10, Hand Auger and Thin-Wall Tube Sampler and/or LANL-ER-SOP-06.24, Sample Collection from Split Spoon Samplers and Shelby Tube Samplers (LANL 1992, 0688).

TABLE 5-4

SUMMARY OF SAMPLING AND ANALYSES FOR PRS 36-002, SUMP

				Samples						Field Screening					Laboratory Analyses										
	Sampled Media			Structure		Surface		Subsurface																	
Description	soil/tuff	sludge	fill	primary	duplicate	primary	duplicate	primary	duplicate	Beta-gamma	Alpha	Organic Vapor	Combustible gas/oxygen	Explosives (Spot Test)	Gross Gamma	Gamma spectroscopy	Total uranium	Isotopic uranium	Plutonium	Metals (SW 6010/7000)	Mercury	Cyanides	VOCs (SW 8260)	SVOCs (SW 8270)	Explosives (SW 8330)
Sump			x					3	1	x	x	x	x	x			x	*		x			x	x	x
Sump		x						2	1	x	x	x	x	x			x	*		x			x	x	x
Sump	x							12	1	x	x	x		y			x	*		x			x	x	x

x : All samples
y : Selected samples (see text)
* : Samples will be analyzed if total potential contaminants of concern are detected above screening action levels.

5.2.5.4 Laboratory Analyses

Samples will be analyzed for total uranium, heavy metals (silver, barium, beryllium, cadmium, chromium, mercury, nickel, lead, and zinc), explosives, VOCs [as per EPA Method 8260 (EPA 1986, 0291)], semivolatile organic compounds (SVOCs) [as per EPA Method 8270 (EPA 1986, 0291)], and explosives. If uranium is detected in any sample, the sample will be analyzed for isotopic uranium. If a field laboratory is available and meets QA/QC criteria, these samples may be analyzed on site. Otherwise, an offsite analytical laboratory will be used.

5.3 Aggregate Septic Systems

The next sections provide information about the aggregate septic systems in OU 1130, PRS 36-003(a) and PRS 36-003(b). This information includes the description and history of the systems, nature and extent of contamination, potential pathways and exposure routes, remediation decisions and investigation objectives, data needs and data quality objectives, and the sampling and analysis plan.

5.3.1 Description and History

The history and description of each of the two septic systems is provided separately below.

5.3.1.1 PRS 36-003(a): Septic System

Septic system PRS 36-003(a) was originally constructed in 1949 to serve office and laboratory building TA-36-1. The septic system comprises six components: septic tank TA-36-17, manhole TA-36-38, a second manhole, a seepage pit, a distribution box/leach field, and associated drain lines connecting the various parts. Figure 5-3 shows the locations of the components of the septic system.

Septic tank TA-36-17, which is marked by two posts and a sign stating its structure number, is located 115 ft due east from the northeast corner of TA-36-1. Two vent caps that protrude 6 in. above the ground mark the exact location of the tank, and an entrance portal is centered between the vents at 1.5 ft below ground. The septic tank is a single-reinforced concrete chamber with a 1,160 gal. capacity (LASL 1949,13-0066).

Manhole TA-36-38 is located 10 ft from the east wall of TA-36-1. The manhole has a 23-in.-diam opening and an unknown depth (LASL 1949,13-0067).

A second manhole is located approximately 20 ft from TA-36-17. It is positioned on the line between the septic tank and TA-36-38 (LASL 1949, 13-0067).

The distribution box and leach field lie northeast of TA-36-17. The distribution box is a hollow concrete box with outside dimensions of 26 in. long by 20 in. wide by 27 in. deep; it is covered with a concrete lid at ground surface. The leach field comprises four 200-ft-long perforated tile pipes set 10 ft apart; these run west to east with the southernmost one lying 10 ft northeast of TA-36-17 (LASL 1949, 13-0066).

The seepage pit is not shown on engineering drawings. It might be similar to the pit associated with guard station TA-36-70 [Area of Concern (AOC) 36-003(c)], shown on LANL Engineering Drawing ENG-C44534 (LANL 1985, 13-0061), because the pits were built at nearly the same time. If the seepage pit is similar to the one at TA-36-70, it has a diameter of 4 ft and a depth of 50 ft; it is filled with gravel; and it has a 4-in.-diam drain line running to within 2 ft of the bottom of the pit.

The original septic system was built in 1949 to process the liquid waste from building TA-36-1. After the main guard station, TA-36-22, was built, a manhole was installed to connect its sanitary facilities to septic tank TA-36-17. In late 1973 or early 1974, because of increased usage, the leach field was disconnected from the distribution box and a sampling box/seepage pit was installed (LASL 1973, 0493). No records have been found to indicate that the distribution box was removed. In 1988, building TA-36-22 was disconnected from this tank and routed to septic tank TA-36-100. In late 1992, TA-36-1 was disconnected from TA-36-17 and connected to the sanitary waste line.

5.3.1.2 PRS 36-003(b): Septic System

Septic system PRS 36-003(b) was built to handle sanitary waste from a bathroom and an additional sink in building TA-36-55 (LANL 1990, 0145). This bunker houses electronics and instrumentation for the firing site. No explosives assembly is conducted in this bunker. The septic tank, which is located about 100 ft south and east of the control bunker (Figure 5-5), is a 7-ft-long by 3.5-ft-wide by 5.73-ft-deep reinforced-concrete chamber with a 420-gal. capacity; it is connected to TA-36-55 by a 4-in.-diam tile pipe (LANL 1990, 0145).

This tank is a holding tank. It is pumped periodically, and the effluent is taken to the Laboratory sanitary treatment plant. In 1989 a buried overflow pipe (outfall) connected to the tank was capped because of potential direct discharge to the environment (LANL 1990, 0145; Ray 1989, 13-0075; Alexander 1989, 13-0039).

5.3.2 Conceptual Exposure Model for the Aggregate Septic Systems

The conceptual exposure model for septic systems PRS 36-003(a) and PRS 36-003(b) (Figure 5-6) describes the historical sources of contamination, migration pathways and conversion mechanisms, possible current sources and release mechanisms, receptor contact media, and exposure routes for released contaminants. These components of the conceptual exposure model are described in the sections that follow.

5.3.2.1 Nature and Extent of Contamination

The nature and the extent of contamination at PRS 36-003(a) and PRS 36-003(b) are described separately for each system.

5.3.2.1.1 PRS 36-003(a)

Septic system PRS 36-003(a) was designed to handle sanitary wastes from facilities in TA-36-1 and TA-36-22. There are likely to be potential contaminants of concern in this septic system because, for many years, spent photochemicals from the x-ray-developing process, including thiosulfates, silver cyanides, and organic compounds, were discharged into the system (Santa Fe Engineering,

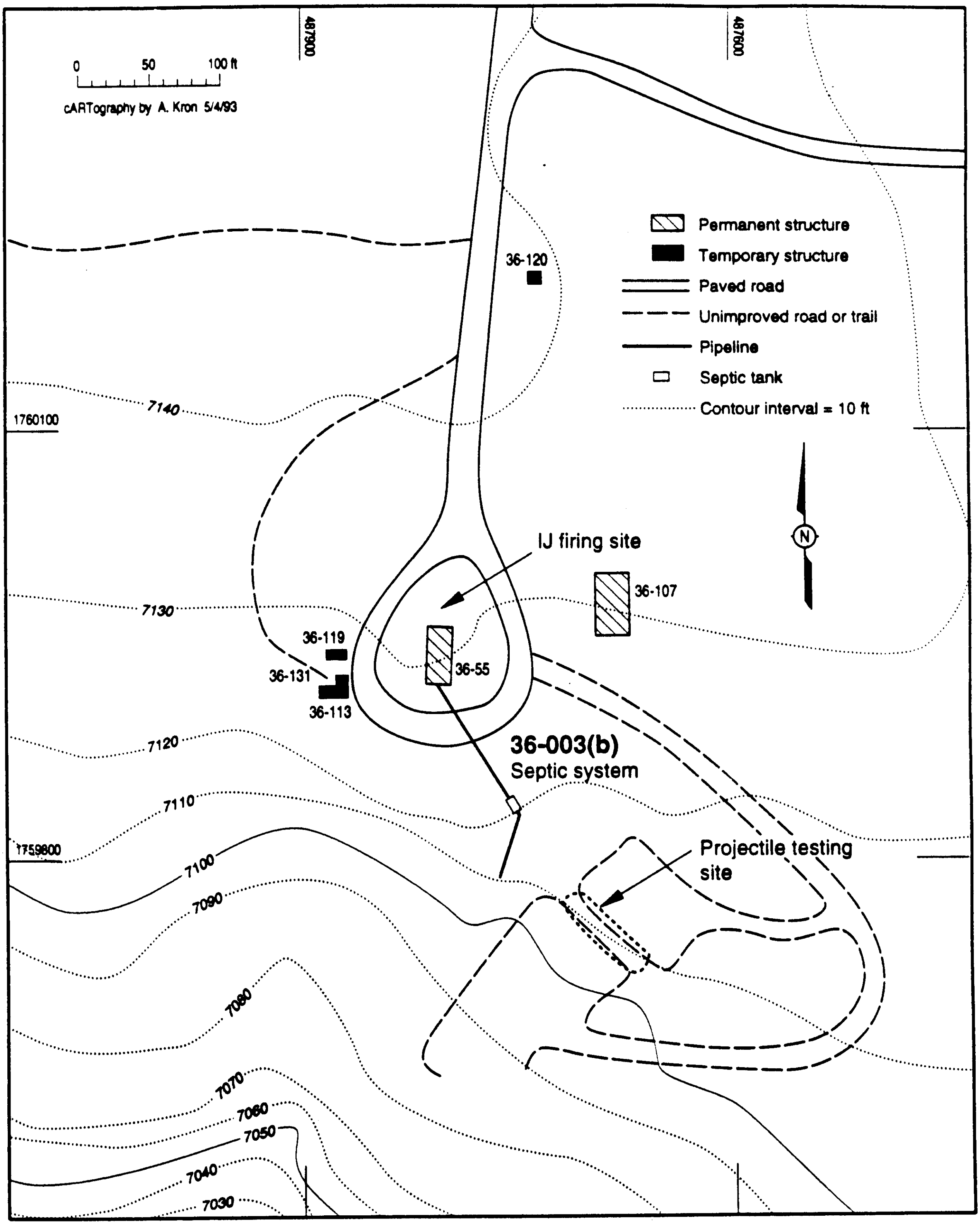


Figure 5-5. Location of septic system PRS 36-003(b).

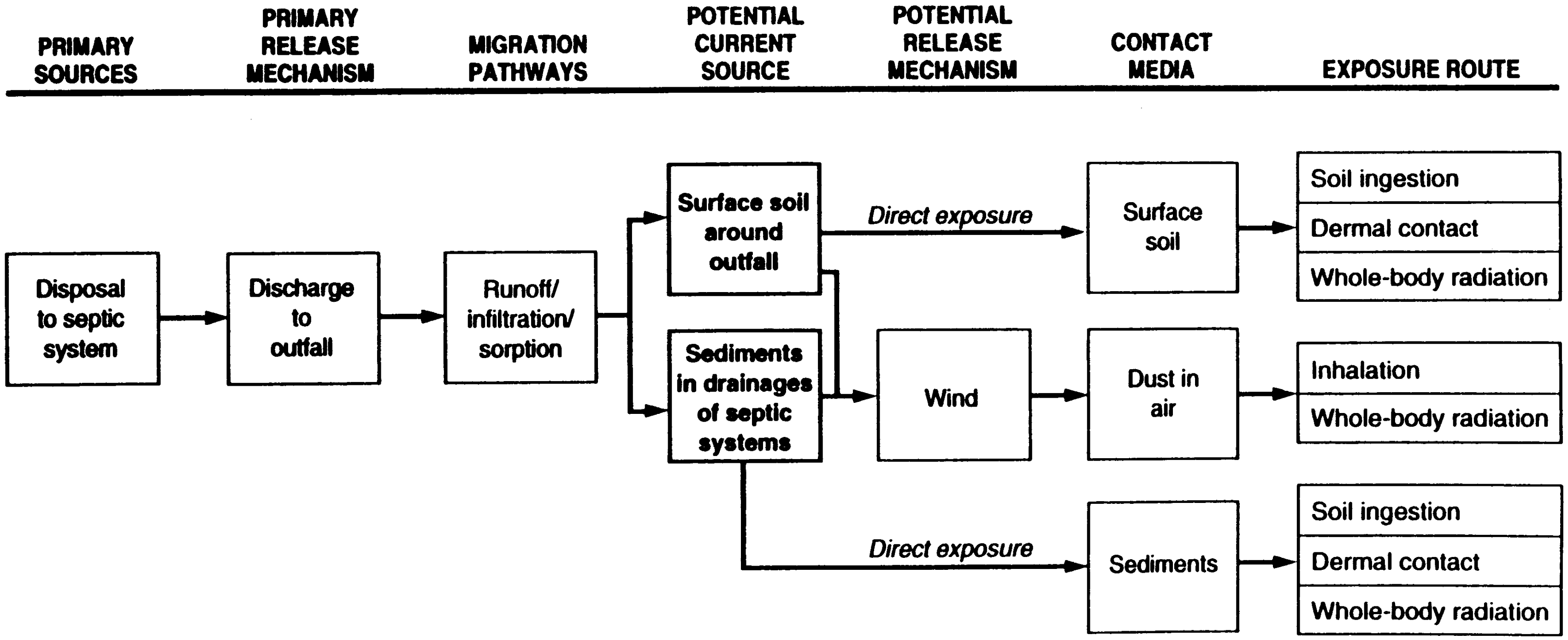


Figure 5-6. Conceptual exposure model for the aggregate septic systems, PRS 36-003(a) and PRS 36-003(b).

Ltd. 1991, 13-0076). In 1990 or 1991, after the operating group was notified that the septic system was to be used only for sanitary waste, the practice of discarding photochemicals in the sink to drain to the septic system was discontinued. The x-ray-processing rinse water continues to go to the sanitary system, but this sanitary system was recently disconnected from the septic system and connected to the Laboratory's sanitary waste line. There is one floor drain in the photo-processing room that connects to the sanitary system; amounts of contaminants discarded into the floor drain are estimated to be small.

The soils in the old leach field are a likely secondary source of contamination associated with PRS 36-003(a). Like some other mesa-top leach fields, this one may have become saturated when use of the septic system increased, perhaps leading to the decision to replace the leach field with a seepage pit. In general, larger volumes of materials were used at TA-36 in the 1950s and 1960s than have been used in recent years. Therefore, if hazardous or radioactive materials were released to the environment through this septic system, residuals are likely to be found in the leach field soils and underlying tuff. Other potentially contaminated media include the tuff surrounding and beneath the seepage pit, and the soil or tuff beneath the drain lines.

5.3.2.1.2 PRS 36-003(b)

Although PRS 36-003(b) is associated with I-J firing site, there is no evidence that hazardous or radioactive materials or other potential contaminants of concern were ever discharged into this septic system; the system handles only sanitary waste and sink drainage. There is little quantitative information about the volume or level of contamination at this site. In 1972, the septic tank was believed to be free of explosives and uranium contamination, but no sampling was done to test this claim (Garde 1972, 13-0048). In early 1981, the system tested negative for trinitrotoluene (TNT), cyclotetramethylene tetranitramine (HMX), and hexanitrosol (RDX), and was judged to have no problems and to require no action (Gonzales 1981, 13-0049).

No testing has ever been performed below the inactive outfall. Although there is a very low probability that contamination is present in the tank or at the outfall, organic solvents, explosives, and metals (including depleted uranium) could be present. Because the flow through this system was never large, it is unlikely that any existing contamination has migrated beyond the immediate vicinity of the outfall.

5.3.2.2 Potential Pathways and Exposure Routes

Subsurface components of the septic systems potentially release contaminants to the subsurface soils through leaks or cracks in the pipes and structures, and through leaching from the seepage pit and leach field. Once contaminants are released into the environment, they potentially can migrate laterally and vertically by liquid infiltration.

The major migration pathway is by excavation and erosion exposing subsurface soil and contaminated structures to the surface. Potential contaminants at the outfall may be transported down the drainage channel and accumulate in sedimentation areas.

If contamination exists, it is suspected to be subsurface. Future excavation and/or erosion could bring subsurface soil to the surface; because the future land use scenario is recreational, the general public could then be exposed to potential contaminants. Chapter 4 contains detailed information about the migratory pathways, human receptors, and exposure routes.

5.3.3 Remediation Decisions and Investigation Objectives

Regarding the aggregate septic systems, the objective of this RFI is to obtain data to determine whether potential contaminants are present at levels above screening action levels within the fluids and sludges in the septic tanks, and in the environmental media surrounding septic systems PRSs 36-003(a) and (b). Phase I of the investigation will concentrate on the septic tank fluids and sludges, and on the potential discharge areas for the septic systems: in the soils and tuffs in the leach field of PRS 36-003(a), and at the outfall of PRS 36-003(b).

If fluid and sludge in the PRS 36-003(a) septic tank are found to be contaminated above screening action levels, consideration will be given to implementing it as a

VCA. This will include removing the inactive tank and connecting lines, and excavating any soil contaminated at levels above cleanup levels. The VCA would also include sampling to verify cleanup of the underlying soil and/or tuff. Unbiased sampling will be done in the leach field for PRS 36-003(a) to determine whether contaminants are present above screening action levels. If contaminants are present above screening action levels, a baseline risk assessment will be performed to determine whether appropriate corrective action measures are needed.

Sampling will be done to determine whether contaminants are present in the active holding tank [PRS 36-003(b)]. If contaminants are present above screening action levels, the tank will be extracted and properly disposed of. A Phase II investigation will be deferred until site decommissioning. Phase II sampling will measure contaminant concentrations in surface soil adjacent to the tank and outfall, and determine the potential for contaminant transport from the PRS. Remediation, if required, will probably consist of removing the tank and contaminated soil for appropriate disposal. The excavation will be sampled to verify that the underlying environmental media are not contaminated.

5.3.4 Data Needs and Data Quality Objectives

The objectives of the Phase I RFI are to determine whether potential contaminants of concern are present at levels above screening action levels at PRSs 36-003(a) and (b), and possibly to conduct a baseline risk assessment. Potential contaminants of concern within the fluids and sludges in the two septic tanks, as well as in the soils and tuffs of the PRS 36-003(a) leach field and below the PRS 36-003(b) outfall, are depleted uranium, lead, mercury, zinc, cadmium, chromium, acetone and ethanol (Henke and Van Marter 1993, 13-0093). Fluid and sludge samples will be collected from the septic tanks. Because of the design of these septic systems, samples will be collected just below the inlet pipe. Most constituents are expected to settle at the location where the velocity of the fluid changes, as is the case where fluid moves from a pipe into a tank.

The tank and leach field of PRS 36-003(a) will be analyzed for cyanide, and the tank and outfall of 36-003(b) will be analyzed for explosives and uranium because of their close proximity to the I-J firing site control bunker.

At PRS 36-003(a), the primary domain of interest comprises the soils surrounding the leach field tiles and the underlying tuff. The soil or fill of the leach field is expected to extend many feet below the tiles. A representative sample of the leach field will include specimens (1) from an interval at approximately the depth of the tiles, (2) from the fill/tuff interface, and (3) from the underlying tuff to a depth of 2 ft below the interface. Six cores will be collected from throughout the leach field. Sample locations will be randomized within the drain field area. The screening assessment will consist of comparing the maximum sample value for each constituent with the screening action level. If contaminants are observed to be present at levels of concern, then a baseline risk assessment will be performed.

At PRS 36-003(b), the end of the outfall pipe will be located. It is believed to be buried on the east side of the drainage immediately south of the old I-J bunker, which is a moderately steep, well-vegetated slope. If the pipe end is buried, the domain of greatest interest will include the surrounding volume of soil extending laterally approximately 1 ft beyond the end of the pipe, and vertically either to a depth of 1 ft below the pipe or to the tuff/soil interface, whichever is shallower. If the pipe discharges to the surface, the domain will include surface soils extending from the end of the pipe down into the gully for a distance of approximately 10 ft.

5.3.5 Aggregate Septic Systems Sampling and Analysis Plans

Sampling and analyses to be conducted at septic systems 36-003(a) and 36-003(b) are discussed separately.

5.3.5.1 Sampling and Analysis Plan for Septic System 36-003(a)

This sampling and analysis plan describes field screening, sampling, and analysis to be conducted for septic system 36-003(a).

5.3.5.1.1 Land Survey

The land survey will be performed in accordance with LANL Survey Procedures Manual (LANL 1992, 13-0096). The surveyed location points will be logged on 2 ft contour maps, and the information will be transferred to the FIMAD.

5.3.5.1.2 Field Screening

Determining potential hazards and establishing health and safety conditions for onsite workers will involve field screening. Portable field instruments that detect alpha-, beta-, and gamma-emitters will be used to screen all subsurface samples for gross alpha, beta, and gamma; an FID and/or a PID will be used to detect any VOCs. Although explosives are unlikely to be present at this site, 50% of the fill sample will be screened for explosive using a field spot-test kit. If explosives are detected in these samples, then the rest of the samples will be field screened for explosives. Before taking any samples from the septic tank, the tank's metal cover will be removed, and the interior space of the sump above the backfill will be screened for VOCs, combustible gases, and gross alpha, beta, and gamma.

5.3.5.1.3 Sampling

Although photo-processing and other chemical constituents are not likely to be present at PRS 36-003(a), sampling and analysis will be conducted to verify that none of the abovementioned chemicals was discarded through this septic system. The proposed sampling and analysis for PRS 36-003(a) is presented in Table 5-5.

Two fluid and two sludge samples will be collected from the interior of the sample tank, using protocols which will be established by LANL ER. (There will be no entry into confined spaces.).

A total of six holes will be drilled at random locations within the leach field using a hollow-stem auger drill rig with core barrel (or similar rig). Continuous cores will be collected from each of the six holes, and three samples will then be taken from each core, so a total of eighteen samples will be collected. One of the three samples will be from the depth of the tiles, one from the fill/tuff interface, and one from the underlying tuff. Core and sample collection will be conducted in accordance with protocols established in LANL-ER-SOP-06.10, Hand Auger and Thin-Wall Tube Sampler and/or LANL-ER-SOP-06.24, Sample Collection from Split Spoon Samplers and Shelby Tube Samplers (LANL 1992, 0688).

5.3.5.1.4 Laboratory Analyses

Samples will be analyzed for heavy metals (silver, arsenic, barium, beryllium, cadmium, chromium, mercury, nickel, lead, and zinc), cyanide, VOCs [in accordance with EPA Method 8260 (EPA 1986, 0291)], and SVOCs [in accordance with EPA Method 8270 (EPA 1986, 0291)]. If a field laboratory is available, and meets QA/QC criteria, these samples may be analyzed on site. Otherwise, an offsite analytical laboratory will be used.

5.3.5.2 Sampling and Analysis Plan for Septic System 36-003(b)

The sampling and analysis plan provides information about field screening and sampling that will be conducted at this site, as well as analyses that will be performed off site.

5.3.5.2.1 Land, Geophysical, and Geomorphic Surveys

A land survey will be performed in accordance with LANL Survey Procedure Manual (LANL 1992, 13-0096). The land survey will be used to determine sampling locations identified by the geomorphic survey. The surveyed location points and geophysical readings will be logged on 2-ft-contour maps, and the information will be transferred to the FIMAD.

A geomorphic survey will be used to identify sediment catchment areas and locations where sediment sampling may occur. Geomorphic mapping will be conducted in accordance with protocols established in LANL-ER-SOP-03.08, Geomorphic Characterization (LANL 1993, in review).

If the buried pipe cannot be located with the help of existing construction maps, ground penetrating radar will be used over a 200- by 200-ft area. (If this area is not large enough to locate the pipe, the survey will be conducted over a larger

TABLE 5-5

SUMMARY OF SAMPLING AND ANALYSES FOR PRSs 36-003(A) and 36-003(B) SEPTIC SYSTEMS

								Samples				Field Screening					Laboratory Analyses						
		Sampled Media						Structure		Subsurface													
Unit	Description	Soil	sludge	fluid	fill	fill/tuff	tuff	primary	duplicate	primary	duplicate	Beta-gamma	Alpha	Organic Vapor	Combustible gas/oxygen	Explosives (Spot Test)	Total uranium	Isotopic uranium	Metals (SW 6010/7000)*	Cyanides	VOCs (SW 8260)*	SVOCs (SW 8270)*	Explosives (SW 8330)*
36-003(a)	Septic Tank		x					2	1				x	x	x				x	x	x	x	
	Septic Tank			x				2	1				x	x	x				x	x	x	x	
	Leach field				x					6	1		x	x		y			x	x	x	x	
	Leach field					x				6	1		x	x					x	x	x	x	
	Leach field						x			6	1		x	x					x	x	x	x	
36-003(b)	Septic Tank		x					2	1			x	x	x	x	x	x	z	x		x	x	x
	Septic Tank			x				2	1			x	x	x	x	x	x	z	x		x	x	x
	Outfall	x								4	1		x	x		x	x	z	x		x	x	x

x : All samples
y : Selected samples (see text)
z : Samples will be analyzed if total potential contaminants of concern are detected above screening action levels.
* : Applicable EPA SW 846 methods.

area). This survey will be carried out in accordance with protocols established in LANL-ER-SOP-03.02, General Surface Geophysics (LANL 1993, in review).

5.3.5.2.2 Field Screening

Field screening will be used to monitor potential hazards and health and safety conditions for onsite workers. A portable field instrument for detecting alpha, beta, and gamma-emitters will be used to screen for gross alpha, beta, and gamma, and an FID or a PID will be used to screen for VOCs. All soil samples from the outfall will be screened for explosives; a field spot-test kit will be used. The samples to be field screened for explosives will be selected at every other sampling location (i.e., samples will be collected at the 1,3,5,7...n+2 sampling locations). Before taking samples from the septic tank, the tank's cover will be removed, and the interior of the tank will be screened for VOCs, combustible gases, and gross alpha, beta, and gamma.

5.3.5.2.3 Sampling

The proposed sampling and analysis for PRS 36-003(b) is presented in Table-5-5. Throughout the sampling process, the septic tank will be field screened to ensure worker safety. Two fluid and two sludge samples will be collected from the interior of the tank in accordance with protocols established in LANL-ER-SOP-06.15, Coliwasa Liquid Waste Sampler for Liquids and Slurries (LANL 1992, 0688).

If the discharge pipe from PRS 36-003(b) is buried, one sample will be taken at the end of the pipe and another approximately 1 ft away and 6 in below the previous sample. The depths at which these soil samples are taken will depend on the depth of the end of the pipe. Samples will be collected in accordance with protocols established in LANL-ER-SOP-06.10, Hand Auger and Thin-Wall Tube Sampler and/or LANL-ER-SOP-06.24, Sample Collection from Split Spoon Samplers and Shelby Tube Samplers (LANL 1992, 0688).

If the pipe discharges to the surface, one sample will be taken near the end of the pipe, and three other samples will be collected along the likely migration pathway. Locations will be determined from a geomorphic survey. Refer to

Section 4.5.1.1 for guidelines on selecting sample sizes. Samples will be collected in accordance with protocols established in LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples (LANL 1992, 0688).

5.3.5.2.4 Laboratory Analyses

Samples will be analyzed for total uranium, heavy metals (silver, barium, beryllium, cadmium, chromium, mercury, nickel, lead, and zinc), VOCs [in accordance with EPA Method 8260 (EPA 1986, 0291)], SVOCs [in accordance with EPA Method 8270 (EPA 1986, 0291)], and explosives. If uranium is detected in any sample, the sample will be analyzed for isotopic uranium. If a field laboratory is available and meets QA/QC criteria, these samples may be analyzed on site. Otherwise, an offsite analytical laboratory will be used.

5.4 PRSs 36-004(a,b,c,d, and e): Aggregate Active Firing Sites

The following sections provide information about the aggregate active firing sites: Eenie, Meenie, Minie, Lower Slobbovia, and I-J. The description and history, nature and extent of contamination, potential pathways and exposure routes, remediation decisions and investigation objectives, data needs and data quality objectives, and the sampling and analysis plan are described for each of the five active firing sites.

5.4.1 Description and History

The history and description of each firing site is provided in the following sections.

5.4.1.1 PRS 36-004(a): Eenie Firing Site

PRS 36-004(a), commonly called Eenie, is an active firing site located on a mesa top overlooking Potrillo Canyon. The only permanent structures at this site are a control bunker, TA-36-3; a make-up building with container storage, TA-36-4; and an impact area. The established hazard radius for Eenie site is 3,000 ft (Kelkar 1992, 13-0057; and LANL 1990, 13-0094). Figure 5-7 shows details of

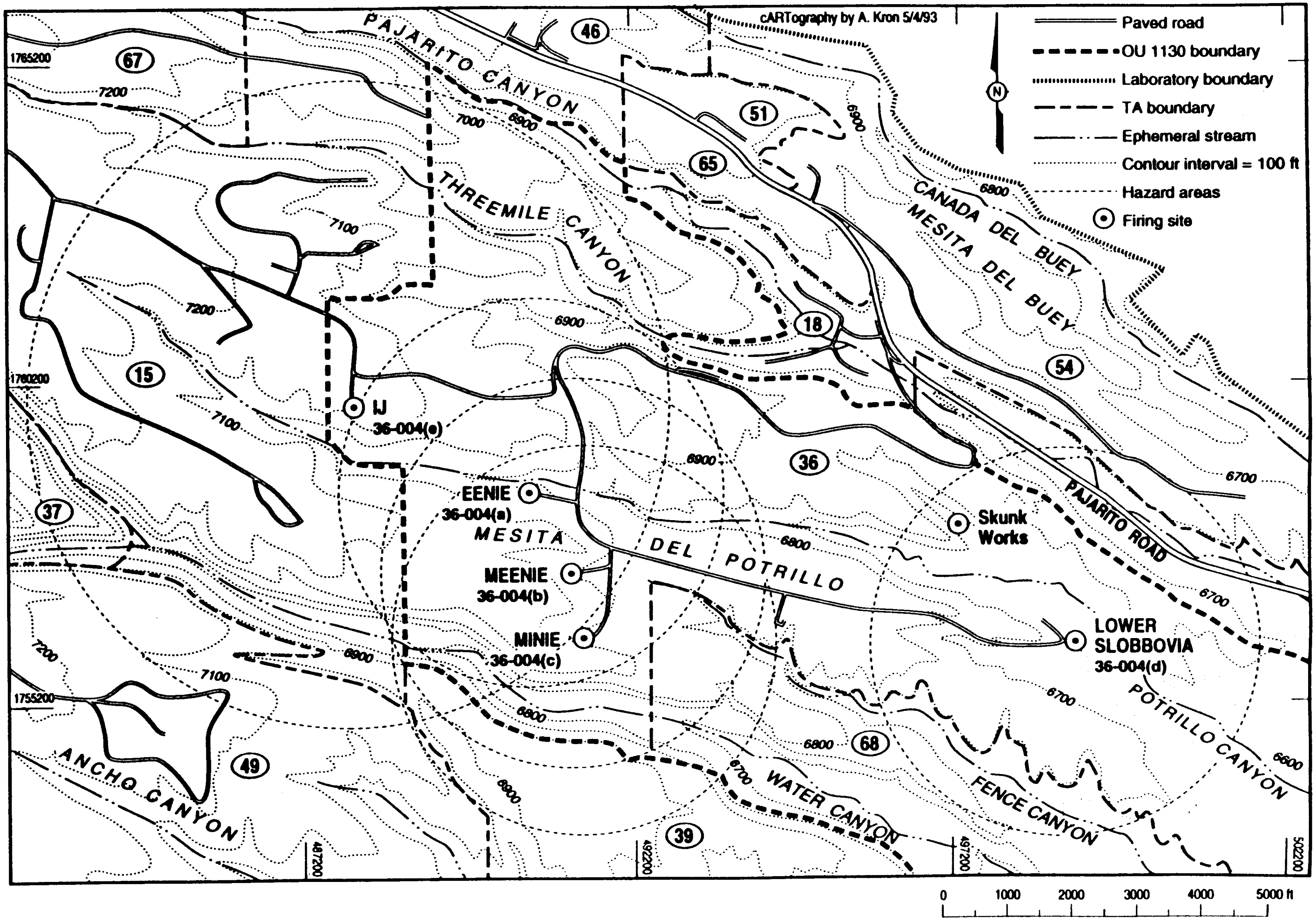


Figure 5-7. Location of the firing sites and associated PRSs and hazard areas for OU 1130.

Eenie and the other active firing sites, their hazard areas, and the topography that indicates the possible flow pattern at each of the sites.

The construction of Eenie was begun in July 1949 and completed in July 1951 (LANL 1992, 13-0065). A few of the shots fired at the site have contained small amounts of lead oxide; mercury, copper, nickel, and brass have been used more frequently. Shots containing depleted uranium have been detonated at this site, and at least two shots fired at Eenie contained nitroglycerine, but most of the shots are believed to have contained relatively small amounts of hazardous substances (Kelkar 1992, 13-0050; Kelkar 1992, 13-0052). In addition to the types of shots usually fired, shoulder-mounted projectiles have been fired into targets south of the firing site (Kelkar 1992, 13-0058).

5.4.1.2 PRS 36-004(b): Meenie Firing Site

PRS 36-004(b), commonly called Meenie, is an active firing site located in the headwaters of Fence Canyon. Meenie comprises a make-up/magazine building, TA-36-5; a control bunker, TA-36-6; and an impact area. The hazard radius for Meenie site is 3,000 ft (Kelkar 1992, 13-0057; LANL 1990, 13-0094). Figure 5-7 shows the details of Meenie firing site, its hazard area, and the topography of the area surrounding the firing site.

The construction of this firing site began in July 1949, and it was completed in June 1950 (LANL 1992, 13-0065). The site has been used for extensive gun work; shots have been fired into the cliff to the north as well as into the embankment south of the firing area (Kelkar 1992, 13-0050). Shots of up to 300 lb have been fired, and at least one shot was detonated that contained 60 gal. of nitromethane sealed in an aluminum cylinder (Kelkar 1992, 13-0058; Stauffer 1992, 13-0078). Until 1971, lead bricks were often used as parts of the shots. Sometimes these bricks were pulverized during detonation (Stauffer 1992, 13-0078).

5.4.1.3 PRS 36-004(c): Minie Firing Site

PRS 36-004(c), commonly called Minie, is an active firing site located on the mesa top in the headwaters of Fence Canyon approximately 800 ft south of

Meenie. Minie consists of an x-ray house; a control bunker, TA-36-8; a firing platform; and a make-up building, TA-36-7. The hazard radius for Minie site is 3,000 ft (Kelkar 1992, 13-0057; LANL 1990, 13-0094). Figure 5-7 shows the details of Minie firing site, its hazard area, and the topography of the area surrounding the firing site.

The construction of this firing site began in July 1949 and was completed in June 1950 (LANL 1992, 13-0065). Many armor-piercing experiments that involve the use of various metal penetrators are conducted at this site. The penetrator jets are directed at the canyon wall to the west; most of the penetrators are stopped by metal plates placed behind the targets (Kelkar 1992, 13-0001). Permitted open burning (detonation) of waste, scrap explosives, and unstable gas cylinders has been conducted at the explosives destruction area within this firing site (LANL 1990, 0145; Kelkar 1992, 13-0050; DOE 1988, 13-0043).

5.4.1.4 PRS 36-004(d): Lower Slobbovia Firing Site

PRS 36-004(d), commonly called Lower Slobbovia, is an active firing site located on a flat area at the eastern end of Potrillo Drive in the bottom of Potrillo Canyon (LANL 1991, 13-0064). The site has two active firing points, both of which are located in an area approximately 655 ft south of the current stream bed and 330 ft west of the discharge sink boundary (Becker 1991, 0699). The first of these active points, the original firing point, is located on top of a pad of dirt and sand approximately 100 ft in radius (LANL 1986, 13-0062). The control building, TA-36-12, is built into the side of the pad. The second firing point is located at the northwest end of a 1,000-ft-long sled track adjacent to PIXY, at TA-36-86. Oil tanks used for PIXY stand approximately 165 ft south of this firing point. In a small side canyon, approximately 2,300 ft upstream and west of Lower Slobbovia, there is an inactive firing point known as Skunk Works (Kelkar 1992, 13-0054). The hazard radius of Lower Slobbovia is 3,000 ft (Kelkar 1992, 13-0057). Figure 5-7 shows the details of Lower Slobbovia firing site, its hazard area, and the topography of the area surrounding the site.

Construction at this firing site was finished in 1950 (LANL 1992, 13-0065). The site has been used for explosives testing since 1951 or 1952 (Kelkar 1992, 13-

0050). Skunk Works was used only in the early to mid-1950s (Kelkar 1992, 13-0054). In 1986 the original firing mount was enlarged to provide a firing point for the newly installed sled track (Kelkar 1992, 13-0053). Shots fired at Lower Slobbovia have contained such materials as explosives, depleted uranium, lead, copper, aluminum, steel, barium, and plastics (LANL 1990, 0145; Kelkar 1992, 13-0050). However, it is estimated that less than 2% of the shots have contained large amounts of metal (Kelkar 1992, 13-0002). Explosives used at this site may have included TNT, baratol, HMX, RDX, and plastic bonded explosives (PBX) (Kelkar 1992, 13-0002). The largest shot fired at Lower Slobbovia was 5,000 to 6,000 lb of explosives containing no metal parts (Kelkar 1992, 13-0051). In 1959, 248 cans of detonators were exploded using nitromethane (Anderson 1959, 13-0040). In addition, several underground tests, buried to a depth of approximately 100 ft, were conducted at this site (Kelkar 1992, 13-0050). A wooden tower, which once stood between PIXY and the original firing point, was used to conduct drop tests (DOE 1986, 13-0042).

Before the first MDA AA trench was dug in the mid-1960s, two contaminated burn pits near TA-36-12 were used to burn firing site debris; these are likely to be still contaminated (Campbell 1956, 13-0041). After MDA AA was opened, these burn pits were no longer used. It is not clear exactly where these pits are located; only an approximation can be given at this time. A 1958 aerial photograph of Lower Slobbovia (LASL 1958, 13-0068) suggests that the pits were a few tens of feet due south of instrument chamber 36-13, on the elevated dirt firing area. Two small blackened spots that appear to be shallow pits can be seen a few feet from one another. They are located a short distance from the large blackened dirt area between 36-13 and control building 36-12, in a convenient location for burn pits—though these could, instead, be firing sites.

5.4.1.5 PRS 36-004(e): I-J Firing Site

PRS 36-004(e), commonly called I-J, is an active firing site located on the north leg of R-Site Mesa overlooking Potrillo Canyon. I-J consists of two active firing points, I and J; two control buildings; a dirt bunker; a covered work area; and an old chamber for enclosed firing (Schlapper 1991, 13-0077). Firing point J is located near control building TA-36-55; firing point I, which has a firing pad radius of 15 ft, is located about 75 ft northeast of the old control building. The hazard radius for I-J site is 5,000 ft (LANL 1990, 13-0094). Figure 5-7 shows the details of I-J firing site, its hazard area, and the topography of the area surrounding the site.

The construction of this firing site began in 1948, and it was ready for use by 1949 or 1950. This firing site was part of TA-15 until about 1981, when TA-36 was enlarged to include I-J (McDougall 1949, 13-0071).

At I-J firing site, shots of up to 500 lb explosives were fired. The explosives used included boracitol, baratol, TNT, Composition B, cyclotol, 9404, and nitromethane. Solid explosives shots were aimed downward, and liquid explosives shots were aimed upward. The liquid explosives included benzene-ring compounds, n-hexane, cyclohexane, nitrogen oxide, nitroglycerin, nitromethane and TNT (Henke and Van Marter 1993, 13-0093; Kelkar 1992, 13-0060). Some shots were fired into iron, copper, and lead targets. Other metals used in shots included aluminum, antimony, various steels, lithium-magnesium alloys, and lithium hydride (Kelkar 1992, 13-0060). In addition, hydrocarbons, argon, benzene, small amounts of mercury, cadmium, and beryllium were used (DOE 1986, 13-0042; Kelkar 1992, 13-0004; Kelkar 1992, 13-0055).

In the early years, depleted uranium was also in heavy use at this site. However, all of the shots fired at this site using radioactive materials were fired in fully containing vessels, with any releases being captured by the environ-efficiency filters. One such vessel, after being decontaminated, was brought back to I-J site, where it still remains (DOE 1986, 13-0042; Martin 1972, 13-0070; Kelkar 1992, 13-0060; Kelkar 1992, 13-0058). This vessel was listed as solid waste management unit (SWMU) C-36-001 in the 1990 SWMU report (LANL 1990, 0145). Section 5.8 of this work plan provides further information on PRS C-36-001. The 1990 SWMU report identified an additional PRS, which it referred to as SWMU 15-006(e), within the bounds of I-J site: in the late 1980s, approximately 138 lb of depleted uranium, in the form of bullets, was used in projectiles that were fired into the cliff face (LANL 1990, 0145; Kelkar 1992, 13-0058; Kelkar 1992, 13-0056). This projectile-testing site, now renamed PRS C-36-006(e) (see Figure 5-5), together with the rest of I-J site, is now part of TA-36.

5.4.2 Conceptual Model

The conceptual exposure model for active firing sites PRSs 36-004 (a, b, c, d, and e) (Figure 5-8) describes historical sources of contamination, migration pathways and conversion mechanisms, potential current sources and release mechanisms, receptor contact media, and exposure routes for released contaminants. These are described for each of the firing sites in the following sections.

5.4.2.1 Nature and Extent of Contamination at the Active Firing Sites

This section describes the nature and extent of contamination at each of the active firing sites.

5.4.2.1.1 Nature and Extent of Contamination at Eenie Firing Site

The amount of contamination present at Eenie firing site is unknown. The potential contaminants of concern include solid explosives and liquid explosive residues, depleted uranium, barium, beryllium, lead, and mercury (Henke and Van Marter 1993, 13-0093; Kelkar 1992, 13-0052; LANL 1990, 0145). Sediment samples from the stream channel that travels from Eenie firing site contained total uranium concentrations ranging from 1.3 to 60.9 ppm, with a mean of 15.1 ppm (Becker 1991, 0699).

5.4.2.1.2 Nature and Extent of Contamination at Meenie Firing Site

The potential contaminants of concern at Meenie firing site are likely to include solid explosives and liquid explosive residues, depleted uranium, barium, beryllium, lead, and mercury (Henke and Van Marter 1993, 13-0093; Kelkar 1992, 13-0052; LANL 1990, 0145).

5.4.2.1.3 Nature and Extent of Contamination at Minie Firing Site

The potential contaminants of concern at Minie firing site are likely to include solid explosives and liquid explosive residues, depleted uranium, barium, beryllium, lead, and mercury (Henke and Van Marter 1993, 13-0093; Kelkar 1992, 13-0052; LANL 1990, 0145).

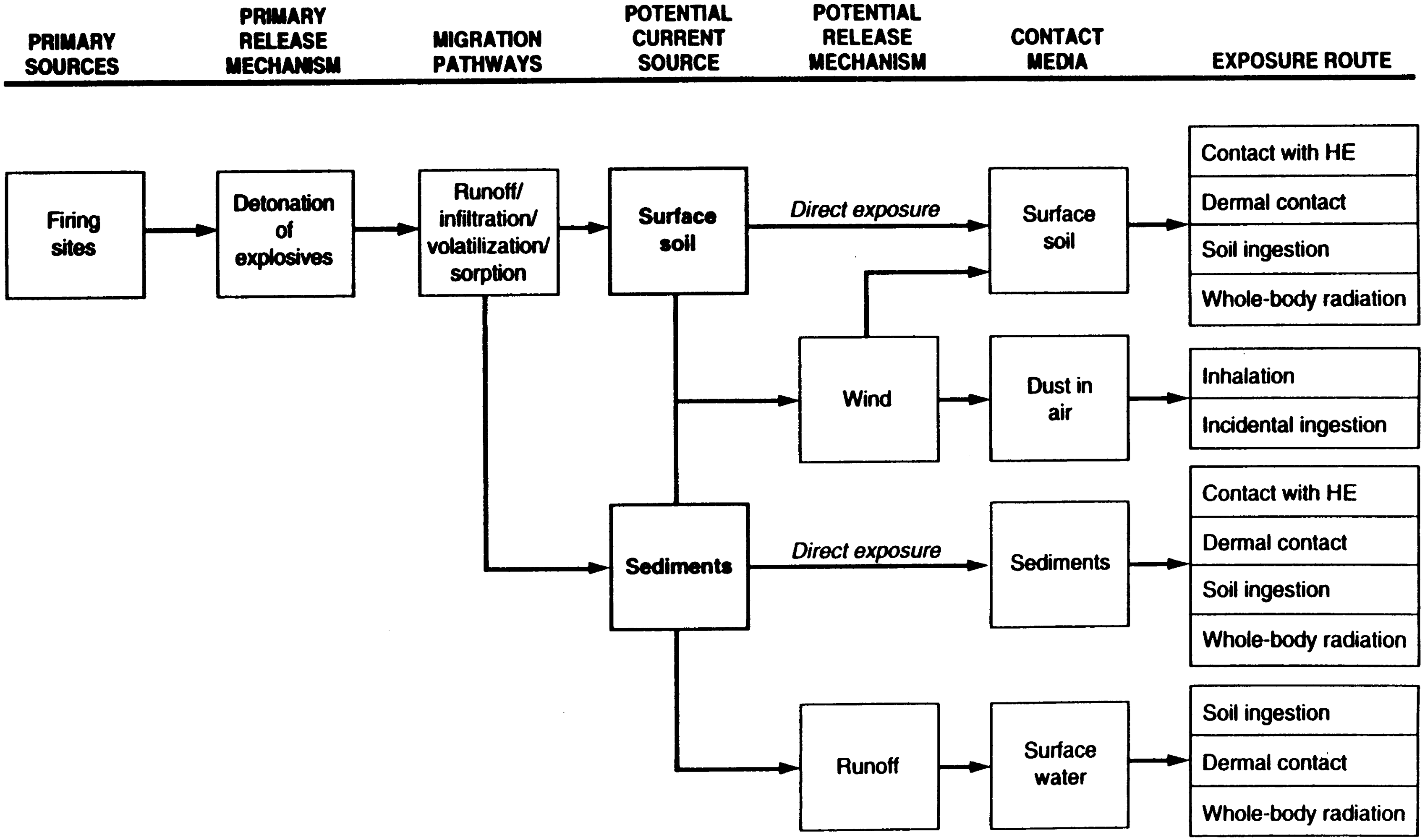


Figure 5-8. Conceptual exposure model for active firing sites.

5.4.2.1.4 Nature and Extent of Contamination at Lower Slobbovia Firing Site

Solid explosives and liquid explosive residues, depleted uranium, barium, beryllium, lead, and mercury may all have been used in explosives shots at Lower Slobbovia firing site (Henke and Van Marter 1993, 13-0093; LANL 1990, 0145;Kelkar 1992, 13-0052). Table 5-6 lists selected data from DOE Environmental Problem 1 (EG&G 1989, 0425). These results are measurements from five samples collected from the top 3 in. of soil at Lower Slobbovia. Each sample was a composite of four grab samples collected at equal distances from the center of the firing site.

5.4.2.1.5 Nature and Extent of Contamination at I-J Firing Site

The potential contaminants of concern at I-J site include solid explosives and liquid explosive residues, depleted uranium, barium, beryllium, lead, and mercury (Henke and Van Marter 1993, 13-0093; LANL 1990, 0145). Although plutonium was used, there have been no documented releases to the atmosphere (Becker 1991, 0699; Martin 1972, 13-0070; Kelkar 1992, 13-0060).

Numerous pieces of depleted uranium and oxidized depleted uranium have been found at and around the firing area, and there is evidence of barium contamination in the Potrillo Canyon watershed near I-J site (Becker 1991, 0699). A surface radiological survey gave contamination results ranging from 40,000 to 255,000 counts per minute (readings are for hot spots) (Schlapper 1991, 13-0077).

5.4.2.2 Potential Pathways and Exposure Routes for the Active Firing Sites

Contamination in the form of fine particles is probably greatest near the firing point, with increasingly smaller amounts at distances farther away from it. Contaminants migrate from the site primarily as a result of explosion-related air dispersion. However, contaminated sediment can also be transported by surface water runoff, and contaminated dust, transported by wind erosion, can play a minor role in the migration of contaminants. The distances to which contaminants have migrated off-site is unknown, with the exception of samples

TABLE 5-6

RESULTS FROM DOE ENVIRONMENTAL PROBLEM 1

Contaminant	Contamination at Selected Distances from the Center of the Firing Site (ppm)					Background Concentration in Soil (ppm)	Screening Action Level in Soil (ppm)
	5 ft	100 ft	250 ft	500 ft	750 ft		
Barium	304	177	101	133	82.2	120–810[a]	5,600
Beryllium	1.0	1.2	---	---		1–3[a]	0.16
Chromium	9.5	4.1	6.2	6.9	4.9	1.6–71[b]	400 (VI)
Copper	145	974	14.5	---	---	2–18[a]	3,000
Lead	16.4	198	14.7	14.4	12.2	8–98[a]	500
Uranium(all isotopes)	91	43	11	13	4	1.3–3.9	240
Zinc	27.9	424	44.7	37.9	39.1	38–71[a]	24,000

[a] (Ferenbaugh et al., 1990, 0099).
[b] (Longmire 1992, in preparation).

Contaminant	Contamination in Picocuries per Gram Deuterium (pCi/gD) at Selected Distances from the Site's Center					Background Concentration in Soil (pCi/g)	Screening Action Level in Soil
	5 ft	100 ft	250 ft	500 ft	750 ft		
Thorium-230	0.7	2.6	1.2	1.5	1.7		b
Thorium-232	<5.59	<10.11	<13.5	<15.5	<14.06		b
Cesium-137	---	0.184	0.42	0.722	0.534	<0.01–0.82[a]	b

[a] (Purtymun et al., 1987, 0211)
[b] To be determined by LANL Risk Assessment Committee.

downstream from Lower Slobbovia. These samples did not contain depleted uranium and all were within background levels of total uranium. This result provides evidence that the discharge sink located at Lower Slobbovia has been effective in trapping sediment and uranium (Becker 1991, 0699).

Several possible current sources of contamination continue to contribute (to an unknown extent) to the contamination at these sites. The firing pads and their immediate vicinities continue to be disturbed extensively by ongoing explosives testing, which generates waste that is deposited in this zone. Shrapnel from the explosives tests lands throughout the sites' hazard areas. Drainage channels carry surface water and any dissolved or entrained contaminants to other parts of the surrounding area, and eventually drain into Potrillo Canyon. (This canyon also drains surface waters from two TA-15 firing points, PHERMEX and E-F.)

Through the years, explosives shots have dispersed fine particles of metals over an area surrounding each firing point. Large metal fragments can travel distances of up to 3,000 ft depending on the nature of the test (Kelkar 1992, 13-0057). Under extreme conditions, shrapnel may travel even farther. Large metal pieces that have landed in the areas immediately surrounding the firing points have routinely been picked up. Explosives are typically consumed in the shot; if any explosives have scattered, the visible pieces have been picked up (Kelkar 1992, 13-0003).

5.4.3 Remediation Decisions and Investigation Objectives for the Active Firing Sites

As discussed in Section 4.2.5 of this work plan, both investigation and remediation of active firing sites at TA-36 will be deferred until the sites are decommissioned. Health and safety risks at these sites risks to onsite workers. Various safe operating procedures, such as a prohibition of eating, smoking, and drinking outside firing site control room bunkers, as well as procedures for handling depleted uranium, are used to control site personnel exposure to the materials. On-site risks to current workers are the responsibility of TA-36 management and, therefore, will not be considered in this RFI. The current charge of the ER Program is limited to ensuring that these sites pose no current risks to the public or the environment.

The current risks posed to off-site receptors by the migration of contamination away from the firing sites will be assessed. The primary concern is that some of the relatively large amounts of material deposited by earlier explosives testing have been transported away from the firing sites by surface water runoff. Recent activities have resulted in far smaller releases of potential contaminants of concern than did tests in the 1950s and 1960s, and current releases are monitored more carefully. Existing data show that surface water runoff constitutes the dominant migration pathway through the environment for these constituents. This RFI will evaluate the transport along this surface water pathway outside the operational boundaries of the active firing sites. Several remediation options are available, including:

- excavating portions of the site to remove contaminated soil,
- implementing measures to reduce erosion,
- deferring corrective action debris removal until adjacent firing sites are decommissioned, or
- taking no further action.

The RFI objective is to determine which of the above remediation alternatives is appropriate.

5.4.4 Data Needs and Data Quality Objectives for the Active Firing Sites

For the active firing sites, the RFI will investigate offsite migration of contaminants. For the purposes of this investigation, "offsite" is defined as the areas outside the hazard radii prescribed for each firing site. Several hazard radii are designated for each site according to the various types of shots carried out there. None of these hazard radii extends outside Laboratory-controlled land. The operational boundary of each of the active firing sites at TA-36 is defined as the boundary of the area encompassed by the combined hazard areas surrounding each site.

Potential contaminants of concern will be evaluated in samples from stream sediments and surface water runoff.

Data from samples collected close to the operational boundaries of the site in Potrillo, Fence, and Water Canyons will be used in estimating the transport of contaminants by the surface water runoff pathway. Water samples will be collected during periods of high runoff. Catchments having substantial accumulations of fine particles will be identified, and sediments from each of these canyons will be analyzed. Analysis will be used to compare the largest observed concentrations of each constituent with its screening action level. If these screening action levels are exceeded, a baseline risk assessment of this site will be performed. If Phase I data are insufficient to conduct a baseline risk assessment, a Phase II investigation will be initiated.

The inactive Skunk Works firing site is located within the hazard area of the active Lower Slobbovia firing site; therefore, an investigation of Skunk Works will be deferred until the Lower Slobbovia firing site is decommissioned.

The potential contaminants of concern are solid explosives and liquid explosive residues, depleted uranium, metals such as barium, beryllium, lead, and mercury, and organic solvents. In addition, plutonium is a potential contaminant of concern at the I-J firing site, even though it is reported that all shots were fired in fully containing vessels with safety environ-efficiency filters.

5.4.5 Sampling and Analysis Plan for the Active Firing Sites

The following sections describe the land and geophysical surveys, field screening, water and sediment sampling, and burn pit sampling that will be conducted at PRSs 36-004(a, b, c, d, and e), and the laboratory analyses that will be conducted.

5.4.5.1 Geomorphic, Geophysical, Radiological, and Land Surveys

A geomorphic survey will be conducted along Water Canyon, Fence Canyon, and Potrillo Canyon to a distance of a quarter mile outside the hazard radii of any active firing sites. This survey will be used to identify sediment catchment areas and locations where sediment sampling will occur. Areas of sediment deposition in the canyons will be shown on a map in order to satisfy concerns about offsite migration by water and sediment. Geomorphic mapping will be conducted in accordance with protocols established in LANL-ER-SOP-03.08, Geomorphic Characterization (LANL 1993, in review).

A geophysical survey will be conducted over a 200- by 200-ft area. Electromagnetic and magnetic methods for locating the burn pits at Lower Slobbovia firing site will follow protocols established in LANL-ER-SOP-03.02, General Surface Geophysics (LANL 1993, in review). Aerial photographs will be used to assist in determining the general area and the dimensions of the pits. If the photographs suggest that the area where burn pits are located is greater than 200- by 200-ft, the survey will be conducted over a larger area. The locations for the geophysical measurements will be surveyed and flagged over a 10- by 10-ft grid, which will be adequate to locate the structures.

The burn pit at Lower Slobbovia will require a radiological survey for gross alpha, gross beta, and gross gamma. This survey will be conducted to locate and map the extent of radiological contamination. Portable field instruments for detecting alpha-, beta-, and gamma-emitters will be used.

The land survey will be conducted in accordance with the LANL Survey Procedure Manual (LANL 1992, 13-0096). This survey will be used to determine sampling locations identified by the geomorphic survey. The locations of the burn pits will be determined by the geophysical survey. The surveyed location points and the geophysical readings will be logged on 2-ft-contour maps, and the information transferred to FIMAD.

5.4.5.2 Field Screening

Field screening will be performed so that potential hazards and health and safety conditions for onsite workers can be defined. Portable field instruments that detect alpha-, beta-, and gamma-emitters will be used to screen all samples for gross alpha, beta, and gamma; a field portable FID and/or PID will be used to screen for VOCs; and a field spot-test kit will be used to screen for explosives.

The samples to be field screened for explosives will be selected at every other sampling location (i.e., samples will be collected at the 1,3,5,7...n+2 sampling locations).

5.4.5.3 Water and Sediment Sampling

Water and sediment samples will be collected from major canyons that drain the firing sites. These samples will be analyzed to determine whether contaminants have been transported by surface water runoff. Surface sediment samples (from depths of 0–6 in.) will be collected from areas in Water Canyon, Fence Canyon, and Potrillo Canyon in which sediments have accumulated as a result of transport, as determined by the geomorphic survey. Water and sediment samples will be collected from the same approximate locations, but not at the same time. Sediment samples will not be collected from under water. A minimum of one water and one sediment sample will be collected from each of four sediment deposition areas in each canyon (as determined by the geomorphic study) (Table 5-7). Sediment samples will be collected in accordance with protocols established in LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples (LANL 1992, 0688). Water samples will be collected in accordance with protocols established in LANL-ER-SOP-06.13, Surface Water Sampling (LANL 1992, 0688).

5.4.5.4 Burn Pit Sampling

At Lower Slobbovia, three holes will be drilled at random locations within each burn pit. The total number of holes drilled will depend on the number of pits that are observed. A hollow-stem auger drill rig with a core barrel (or similar rig) will be used to drill each hole to depths of approximately 2 ft below the bottom of the pits into the undisturbed soil or tuff. The holes will be drilled deeper if there are indications that contamination might extend deeper (based on visual inspection, as described in Section 5.1.5.3, or on field screening measurements).

Continuous cores will be taken from the ground surface to the bottom of each hole. Such data as the depth, thickness, color, and grain size of each layer will be examined and recorded. Two samples will be collected from the cores taken from each hole, one sample will be collected from the ash and debris layer, and

TABLE 5-7

SUMMARY OF SAMPLING AND ANALYSIS FOR PRS 36-004 (A, B, C, D, AND E), ACTIVE FIRING SITES

					Samples						Field Screening					Laboratory Analyses										
	Sampled Media				Structure		Surface		Subsurface																	
Description	soil/sediments	water	ash/debris	soil/tuff	primary	duplicate	primary	duplicate	primary	duplicate	Beta-gamma	Alpha	Organic Vapor	Combustible gas/oxygen	Explosives (Spot Test)	Gross Gamma	Gamma spectroscopy	Total uranium	Isotopic uranium	Plutonium	Metals (SW 6010/7000)*	Mercury	Cyanides	VOCs (SW 8260)*	SVOCs (SW 8270)*	Explosives (SW 8330)*
Canyons	x						12	1			x	x	x		x	x	z	x	z	y	x			x	x	x
Canyons		x					12	1			x	x	x		x	x	z	x	z	y	x			x	x	x
Burn Pits			x						6	1	x	x	x		x	x	z	x	z		x			x	x	x
Burn Pits				x					6	1	x	x	x		x	x	z	x	z		x			x	x	x

x : All samples
y : Selected samples (see text)
z : Samples will be analyzed if total potential contaminants of concern are detected above screening action levels.
Note: Actual number of samples will depend upon how many burn pits are found.
* : Applicable EPA SW 846 methods.

one sample will be collected from the undisturbed soil or tuff. Core and sample collection will be carried out in accordance with protocols established in LANL-ER-SOP-06.10, Hand Auger and Thin-Wall Tube Sampler and/or LANL-ER-SOP-06.24, Sample Collection from Split Spoon Samplers and Shelby Tube Samplers (LANL 1992, 0688).

5.4.5.5 Laboratory Analyses

Samples will be analyzed for gross gamma, total uranium, heavy metals (silver, barium, beryllium, cadmium, chromium, mercury, nickel, lead, antimony, and zinc), VOCs [as per EPA Method 8260 (EPA 1986, 0291)], SVOCs [as per EPA Method 8270 (EPA 1986, 0291)], and explosives. If gamma or uranium is detected in any sample, then the sample will be analyzed by gamma spectroscopy or for isotopic uranium, respectively. In addition to the above sampling, fifty percent of the soil/sediment samples collected from the canyons will be analyzed (on a random basis) for plutonium, because plutonium was used in experiments at the I-J firing site (however, release is not suspected). If a field laboratory is available and meets QA/QC criteria, these samples may be analyzed on site. Otherwise, an offsite analytical laboratory will be used.

5.5 PRS 36-005: Boneyard

In the following sections, the Boneyard and its history are described. The nature and extent of contamination, potential pathways and exposure routes, remediation decisions and investigation objectives, data needs and data quality objectives, and the sampling and analysis plan are also presented.

5.5.1 Description and History

PRS 36-005, known as the Boneyard, is a surface storage area located across the road from building TA-36-7, near Minie (Figure 5-9). It is an undeveloped area, measuring approximately 500 ft by 300 ft, that is largely covered with grass and ponderosa pine. The Boneyard slopes gently into the drainage that enters Fence Canyon from the firing point at Minie. Vehicle tracks are evident throughout the area.

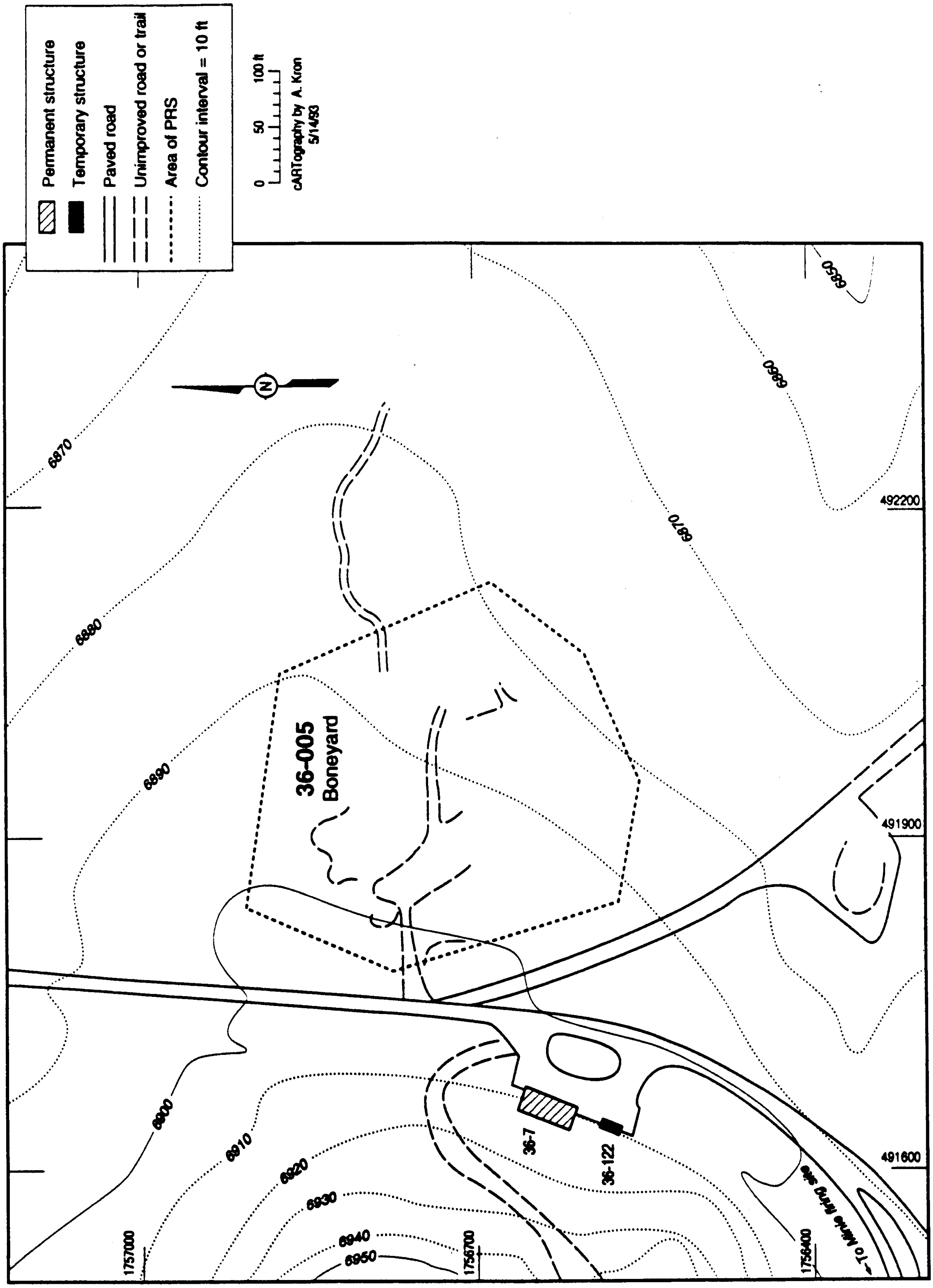


Figure 5-9. Location of the Boneyard (PRS-36-005).

Until the late 1970s, the Boneyard was used as a parking area for trailers and other large non-waste items. From the late 1970s to the late 1980s, the area was used as a surface storage area for large waste items that had been exposed to explosives tests (Kelkar 1992, 13-0058).

Waste items at the Boneyard consisted of such items as metal drums, cans, and cylinders, and scrap metals such as lead sheets, copper, uranium-contaminated steel, and iron. Many of these items were targets for tests (EG&G 1989, 13-0045). As a consequence of the 1986 CEARP report (DOE 1986, 13-0042), the Boneyard underwent a major cleanup. Cans labeled isopentane, uranium-contaminated iron and steel, and unmarked drums and cylinders were removed from the site and disposed of in accordance with established policy (LANL 1990, 0145). The site is currently used for storing usable non-waste items (Kelkar 1992, 13-0058 and 13-0051). Many small fragments of metal, plastic, bolts, etc., lie on the surface or embedded in the ground amid the natural vegetation (Stauffer 1992, 13-0080).

5.5.2 Conceptual Model

The conceptual exposure model for the Boneyard (Figure 5-10) describes the historical sources of contamination, migration pathways and conversion mechanisms, potential current sources and release mechanisms, receptor contact media, and exposure routes for released contaminants.

5.5.2.1 Nature and Extent of Contamination

Any contamination present at the Boneyard might have resulted from releases from hazardous or radioactive materials or contaminated items stored at the site. In addition, because the Boneyard is within the hazard radii of both Meenie and Minie firing sites, it has received, and will continue to receive, shrapnel from both of those sites. However, shrapnel and particulates from firing site activities are not of primary concern in the current investigation. The constituents of potential concern as a result of storage include a number of metals (chromium, silver, zinc, beryllium, copper, lead, and uranium), and explosives and explosives residues. Organic compounds might also be present in soils and sediments.

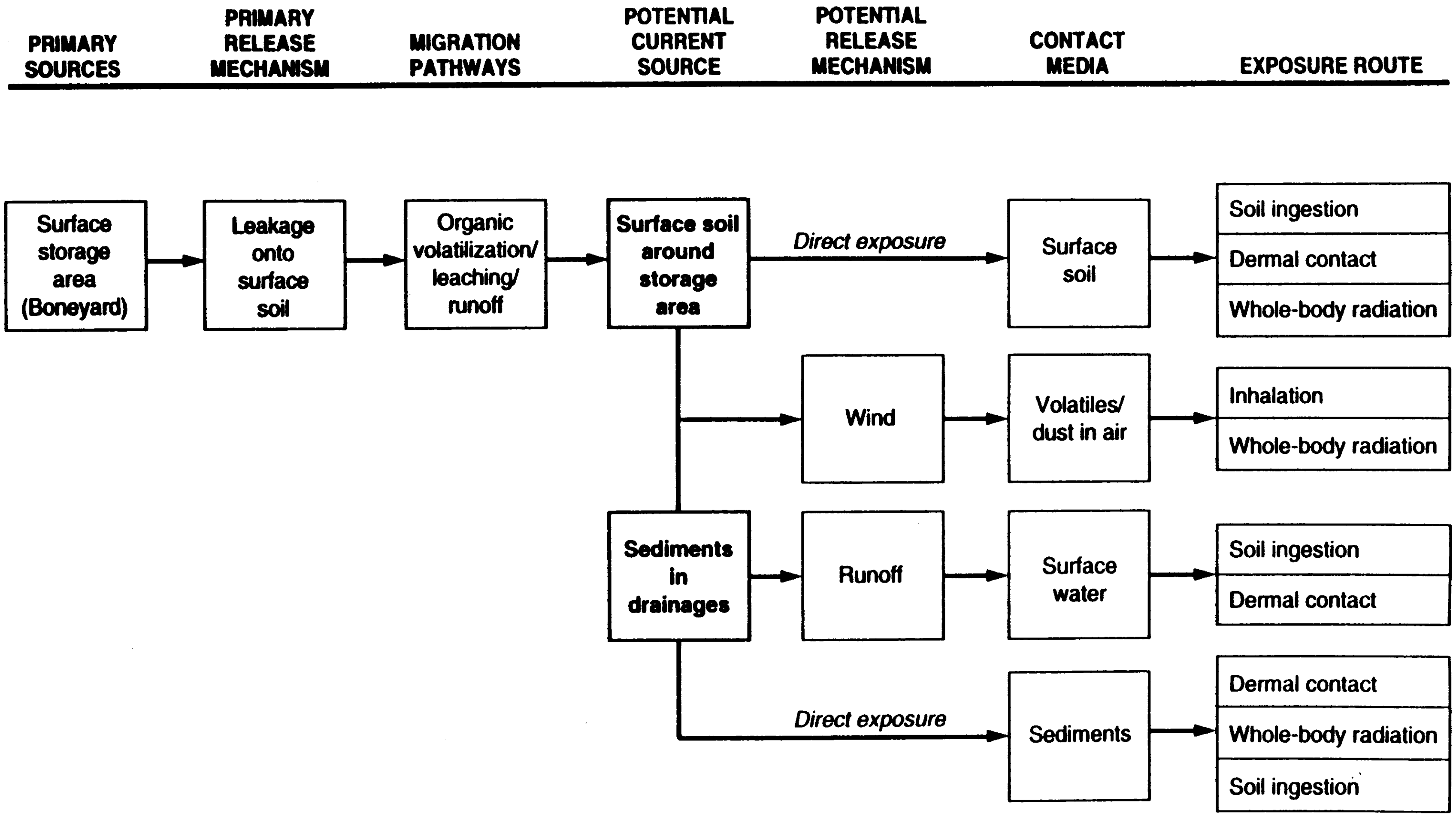


Figure 5-10. Conceptual exposure model of the Boneyard.

These constituents could be present at elevated levels in the surface soils at the site; leaching and infiltration of precipitation might have caused some vertical migration of the contaminants. Because the site was not uniformly used for storage, any existing contamination is likely to be unevenly distributed. The locations of former storage sites, where potential contamination is likely to be localized, are not known; however, they were probably alongside the vehicle tracks that are visible on the site.

The Boneyard was included in Environmental Problem 23 in the survey performed for DOE by INEL in 1988 (EG&G 1989, 13-0045). This radiological survey, Survey 818, identified four locations in the Boneyard that have above-background levels of radioactivity, a range from 31 to 100 mR/h. Six grab samples were collected from these locations. Two of these samples, from one part of the Boneyard, showed uranium at levels above screening action levels, with excess amounts of ^{238}U in evidence (suggesting the presence of depleted uranium). One of these two samples also had elevated concentrations of lead and silver. The results of the survey are shown in Table 5-8.

Six additional surface soil grab samples were collected from visibly stained areas, or from areas downgradient of debris (Survey 852 in Table 5-7). The latter samples were screened using a PID, and, on the basis of the observations made during that screening process, two of the samples were submitted for screening for VOCs. Terpene was tentatively identified (at levels below quantitation limits) in one of these two samples, which was collected next to some empty pentane buckets. All samples were also analyzed for explosives, but none were detected in any of the samples (EG&G 1989, 13-0045).

5.5.2.2 Potential Pathways and Exposure Routes

Erosion caused by surface water runoff is the most likely potential release mechanism of the waste. This potential for migration of contaminants from the Boneyard into Fence Canyon, which merges with Potrillo Canyon, allows for the possibility of future off-site exposure (although the Boneyard's contribution to contamination in this canyon is likely to be minor compared to the contributions

TABLE 5-8

RESULTS FROM ENVIRONMENTAL PROBLEM 23

Contaminant	DOE Environment Survey	Measured Soil Concentration (ppm)	Background Concentration in Soil (ppm)	Screening Action Level in Soil (ppm)
Barium	818	55-100	120-810[a]	5,600
	852	56-139		
Chromium	818	27.4	1.6-71[b]	400[d]
	852	5.2-9.2		
Silver	818	19.7	<1.6[b]	400
Zinc	818	13-52	38-71[a]	24,000
	852	28-48.2		
Beryllium	818?	1.5	1-3[a]	0.16
Copper	818	11.8	2-18[a]	3,000
	852	23.1		
Lead	818	154	8-98[a]	c
Explosives	818	<0.25 detection limit	NA	Available for specific high explosives (i.e., TNT)
	852	<0.25 detection limit		

Contaminant	Measured Activity Concentration	Background Concentration (ppm)	Screening Action Level in Soil (ppm)
Total uranium	870ppm,8,000 ppm	1.54-6.73 [b]	240
Cesium 137	0-1.2pCi/g[b]		

[a] (Ferenbaugh et al., 1990, 0099).

[b] (Longmire 1992, in preparation).

[c] Toxicity data (I.e., reference doses an/or slope factors) not available; therefore, screening action level could not be determined.

[d] Chromium VI

by other PRSs). Such future exposure would likely occur through individuals' direct contact with soil or sediment, or with the intermittent stream that flows through Fence Canyon. Subsurface studies conducted on Mesita del Buey (a typical Pajarito Plateau mesa located approximately 2 km north of the Boneyard [Purtymun and Kennedy 1971, 0200]), suggest that aqueous transport of potential contaminants through the Bandelier Tuff is not a viable migration mechanism on the mesa tops.

A baseline risk assessment will be performed. Data on the contaminant levels at the Boneyard that were collected during Phase I of the RFI will form the basis of the assessment. For this assessment, we postulate future recreational use of the site. In calculating the associated risk, direct contact with potential contaminants of concern throughout a two-week period each year will be assumed. Chapter 4 of this work plan provides a more detailed discussion of migration pathways, conversion mechanisms, human receptors, and exposure routes.

5.5.3 Remediation Decisions and Investigation Objectives

The Boneyard is no longer used for storing hazardous wastes, although it continues to be used for non-waste storage. In addition, the area continues to receive shrapnel and particulates from nearby firing sites. This RFI, together with any resulting corrective measures, addresses only the historical use of the area as a storage site. Several remediation options are available, including:

- excavating portions of the site to remove contaminated soil,
- implementing measures to reduce erosion,
- deferring corrective action debris removal until adjacent firing sites are decommissioned, or
- taking no further action.

The RFI objective is to determine which of the above remediation alternatives is appropriate.

However, these data have not been through a formal QA/QC process. Locations where these samples were taken are indicated on sketches that are not drawn to scale. Phase I of the RFI for the Boneyard will supplement the results reported in the 1988 survey, so that an appropriate remedial action can, if necessary, be designed.

If the results of the Phase I investigation identify contaminants of concern, a baseline risk assessment will be performed for this site. If the data is not sufficient to conduct a baseline risk assessment, or if the design or selection of an appropriate remedial action requires the acquisition of further data, a Phase II investigation might be necessary.

5.5.4 Data Needs and Data Quality Objectives

In response to the proposed RFI Phase I decisions, the following concerns related to the Boneyard must be resolved:

- Are there contaminants of concern, including depleted uranium, associated with the site?
- What are the associated risks to human health and to the environment?

Data necessary to answer these questions are concentrations of metals, including uranium, and concentrations of organic compounds that are present in the soils and sediments at the Boneyard, and in the runoff channels leading away from the area.

Populations to be sampled include surface soils in the 4-acre Boneyard, and the soils or sediments in runoff channels leading to the main drainage from Minie firing site. Disturbed areas, roadways, and current storage locations within the Boneyard will be mapped out in detail on a 2-ft-contour map. A geomorphological survey will also be performed so that potential sampling locations in runoff channels down to the main drainage from Minie firing site can be identified.

Additional sampling locations in different areas or strata may be selected on the basis of survey results or visual evidence of disturbance (caused by use or erosion) as previously mapped.

Results from analysis will be used to compare the largest observed concentration of each constituent with its screening action levels. If these levels are exceeded, a baseline risk assessment of this site will be performed. If Phase I data are insufficient to conduct a baseline risk assessment, a Phase II investigation will be initiated.

5.5.5 Sampling and Analysis Plan

The sections that follow describe the land and radiological surveys, field screening, and sampling that will be conducted at the Boneyard, as well as the laboratory analyses that will be conducted offsite.

5.5.5.1 Geomorphic, Land, and Radiological Surveys

The 4-acre Boneyard site will be mapped at a scale of 1:1,200, or finer. Features to be mapped and flagged include

- current storage locations;
- vegetation disturbances, soil staining, or other possible indicators of former storage locations;
- vehicle tracks;
- structures, fences, and above-ground utilities; and
- the principal rills and channels for surface water runoff.

A land survey will be performed in accordance with the LANL Survey Procedures Manual (LANL 1992, 13-0096). This survey will be used to determine sampling locations identified by the geomorphic survey. The surveyed location points will be transferred to the FIMAD.

locations identified by the geomorphic survey. The surveyed location points will be transferred to the FIMAD.

A radiological field survey for gross alpha, gross beta, and gross gamma will be conducted to locate and map the extent of radiological contamination; portable field instruments for detecting alpha- beta-, and gamma-emitters will be used. The radiological survey will be carried out on a 50-ft grid over the entire site.

A geomorphic survey will be conducted to identify sediment sampling locations in the runoff channels to the main drainage from Minie firing site. Geomorphic characterization will be conducted in accordance with protocols established in LANL-ER-SOP-03.08, Geomorphic Characterization (LANL 1993, in review).

Following the completion of these surveys, the site will be partitioned into the following four strata:

1. Drainage channels that carry surface water runoff during snow melt or heavy rainstorms;
2. Areas with elevated radioactivity (two or more times the background average);
3. Areas currently used for storage or showing signs of recent use, including areas with stained soil; and
4. The remainder of the site.

5.5.5.2 Field Screening

Field screening will be performed to define potential hazards and health and safety conditions for onsite workers. All samples will be screened in the field for gross alpha, beta, and gamma; portable field instruments for detecting alpha-, beta-, and gamma-emitters will be used. An FID and/or a PID will be used to detect VOCs. Fifty percent of the location samples from the five strata will be screened (on a random basis) for explosives; a field spot-test kit will be used to detect any explosives. If explosives are detected in any of the samples, all of the sampling locations within the strata will be screened for explosives.

5.5.5.3 Sampling

The proposed sampling and analysis for the Boneyard is presented in Table 5-9. Eight surface samples (from depths of 0-6 in.) will be collected from each of the four strata described in Section 5.5.5.1. Specific sampling locations will be selected using the randomization techniques described in Section 4.5.2. Additional sample locations may be selected on the basis of survey results and visual inspection (as described in Section 5.2.5.2 of this work plan). Should additional sampling locations be identified by field surveys or visual indications of contamination, additional surface soil samples will be taken. All sampling locations will be surveyed so that the sampling points can be accurately located on the FIMAD map. Soil or sediment samples will be collected in accordance with protocols established in LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples (LANL 1992, 0688).

In addition, two surface samples (from depths of 0–6 in.) will be collected from an area within the hazard radius of Meenie and Minie firing sites, but outside the observed area of contamination at the Boneyard site. Because the Boneyard is within the hazard radius of these active firing sites and continues to receive shrapnel from both of these sites, these samples will be used to evaluate contamination originating from active firing sites. Note that explosives are the only potential contaminants of concern that the active firing sites and the Boneyard have in common.

Samples will be collected in accordance with protocols established in LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples (LANL 1992, 0688)

5.5.5.4 Laboratory Analyses

Samples will be analyzed for gross gamma, total uranium, heavy metals (silver, barium, beryllium, cadmium, chromium, mercury, nickel, lead, and zinc), VOCs [in accordance with EPA Method 8260 (EPA 1986, 0291)], SVOCs [(in accordance with EPA Method 8270 (EPA 1986, 0291)], and explosives. If laboratory analysis indicates the presence of gamma radioactivity and/or uranium for any particular sample, gamma spectroscopy analysis and/or isotopic uranium

TABLE 5-9

SUMMARY OF SAMPLING AND ANALYSES FOR PRS 36-005, FOR PRS 36-005, BONEYARD

Description	Sampled Media	Samples						Field Screening					Laboratory Analyses										
		Structure		Surface		Subsurface																	
	soil/sediments	primary	duplicate	primary	duplicate	primary	duplicate	Beta-gamma	Alpha	Organic Vapor	Combustible gas/oxygen	Explosives (Spot Test)	Gross Gamma	Gamma spectroscopy	Total uranium	sotopic uranium	Plutonium	Metals (SW 6010/7000)*	Mercury	Cyanides	VOCs (SW 8260)*	SVOCs (SW 8270)*	Explosives (SW 8330)*
Drainage channels	x			8	1			x	x	x		y	x	z	x	z		x			x	x	x
Elevated rad	x			8	1			x	x	x		y	x	z	x	z		x			x	x	x
Current/recent storage	x			8	1			x	x	x		y	x	z	x	z		x			x	x	x
Other	x			8	1			x	x	x		y	x	z	x	z		x			x	x	x
Off Boneyard	x			2	1			x	x	x		y	x	z	x	z		x			x	x	x

x : All samples
y : Selected samples (see text)
z : Samples will be analyzed if total potential contaminants of concern are detected above screening action levels.
Note: Additional samples may be taken based on field surveys and observations.
* : Applicable EPA SW 846 methods.

analysis will be performed on the sample. If a field laboratory is available and meets QA/QC criteria, these samples may be analyzed on site. Otherwise, an offsite analytical laboratory will be used.

5.6 PRS 36-006: Surface Disposal Area

The surface disposal area is located within 100 ft of the Eenie firing pad (Figure 5-11). Historically the area was used to dispose of cables and other residuals from explosives tests at the firing pad (LANL 1990, 0145; Kelkar 1992, 13-0058). Because of its proximity to the active Eenie firing pad, debris dispersed from that pad by explosives detonations is routinely deposited over the surface disposal area. Any action to be taken at this PRS will be deferred until decommissioning of Eenie site.

5.7 PRS C-36-003: Photo Outfall

The following sections provide the description and history of the photo outfall. Information about the nature and extent of contamination, the potential pathways and exposure routes, the remediation decisions and investigation objectives, the data needs and data quality objectives, and the sampling and analysis plan for this PRS are also provided.

5.7.1 Description and History

PRS C-36-003 is a permitted outfall (Permit No. EPA 06A106) located north of office and laboratory building TA-36-1. The outfall extends out a few feet over the steeply sloping edge of Threemile Canyon (Figure 5-3). Threemile Canyon eventually joins Pajarito Canyon downstream.

Building TA-36-1 became operational in 1950, and the outfall is thought to have become operational sometime during that same decade. It is believed that at one time spent photo-processing fluids were discharged to this outfall; this is no longer done. Currently the ground beneath the outfall is covered with vegetation, organic matter, rocks, and soil. When the photo-processing unit is in use, a steady stream of water discharges from the outfall; this can be observed as it runs downstream over and through the surface deposits for a distance of at least 35 ft.

5.7.2 Conceptual Exposure Model

The conceptual exposure model for the photo outfall, shown in Figure 5-12, describes the historical sources of contamination, migration pathways and conversion mechanisms, potential current sources and release mechanisms, receptor contact media, and exposure routes for released contaminants. These components of the conceptual exposure model are described in relation to the photo outfall in the sections that follow.

5.7.2.1 Nature and Extent of Contamination

The potential contaminants of concern at the outfall are photo-processing fluids, including silver, thiosulphate, and organic compounds. These contaminants could have been discharged into the surface deposits as a result of historical practices. Water sampling performed in support of the NPDES permit (Bohn 1992, 13-0095) indicated very low levels of cyanide: a sample taken on September 11, 1990, measured 0.125 ppm; one taken on December 13, 1990, measured 0.010 ppm; and the rest of the samples taken measured 0.000 ppm. The screening action level for cyanide in water is 0.2 ppm. The levels of silver in water reported since 1989 have ranged from 0.004 ppm to 0.119 ppm. The screening action level for silver in water is 0.05 ppm.

5.7.2.2 Potential Pathways and Exposure Routes

Downstream migration of contaminants caused by surface water runoff is possible at this site because of the steep slope of the canyon wall. Potential contaminants of concern are likely to accumulate in sedimentation catchment areas within the drainage channels. Vertical migration from leaching and percolation could also occur. Because of the canyon's lush vegetation, there is the potential for uptake by plants and the subsequent ingestion of those plants by animals. Wind dispersion of soil (as dust) is unlikely to be a significant migration pathway.

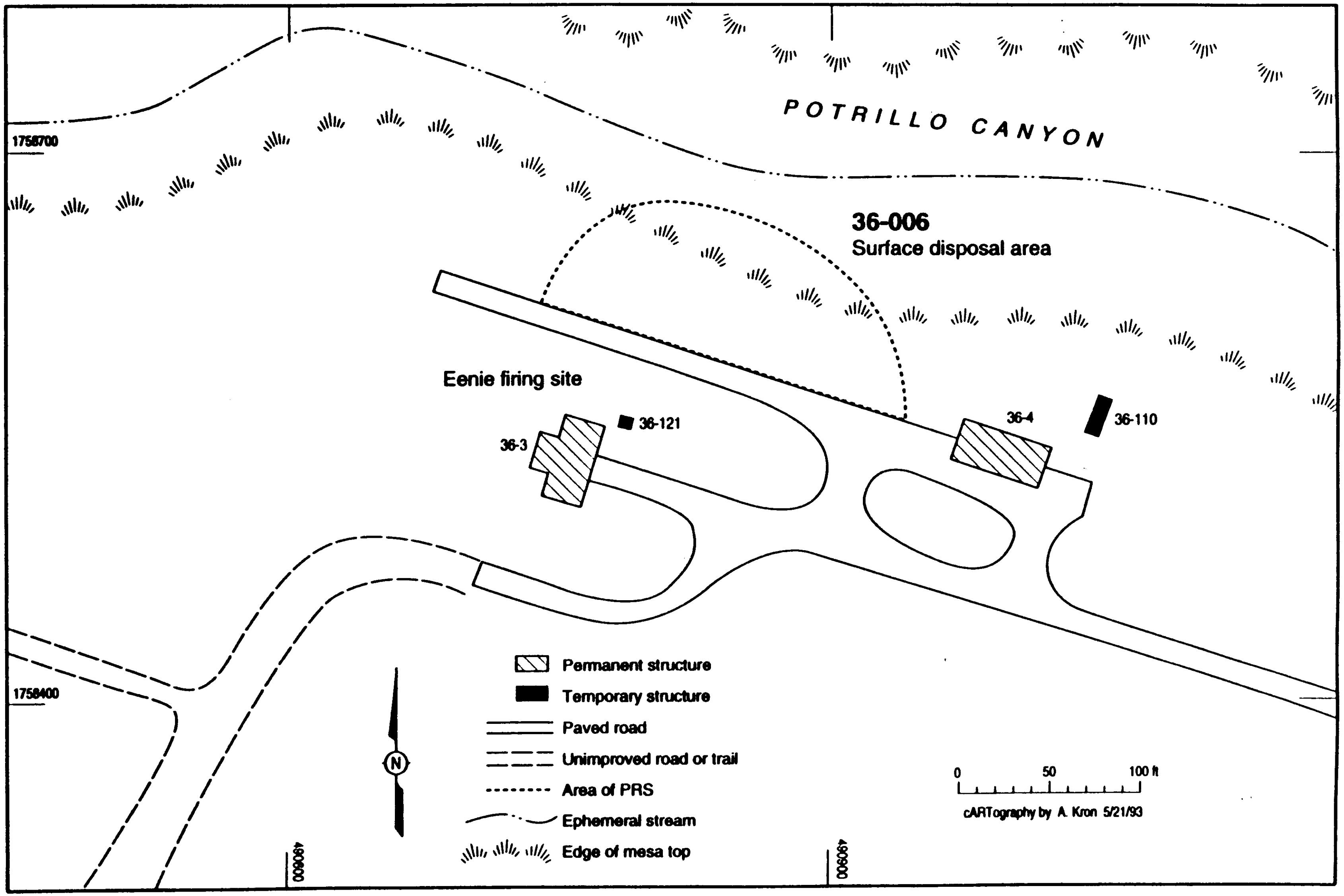


Figure 5-11. Location of the surface disposal area (PRS 36-006).

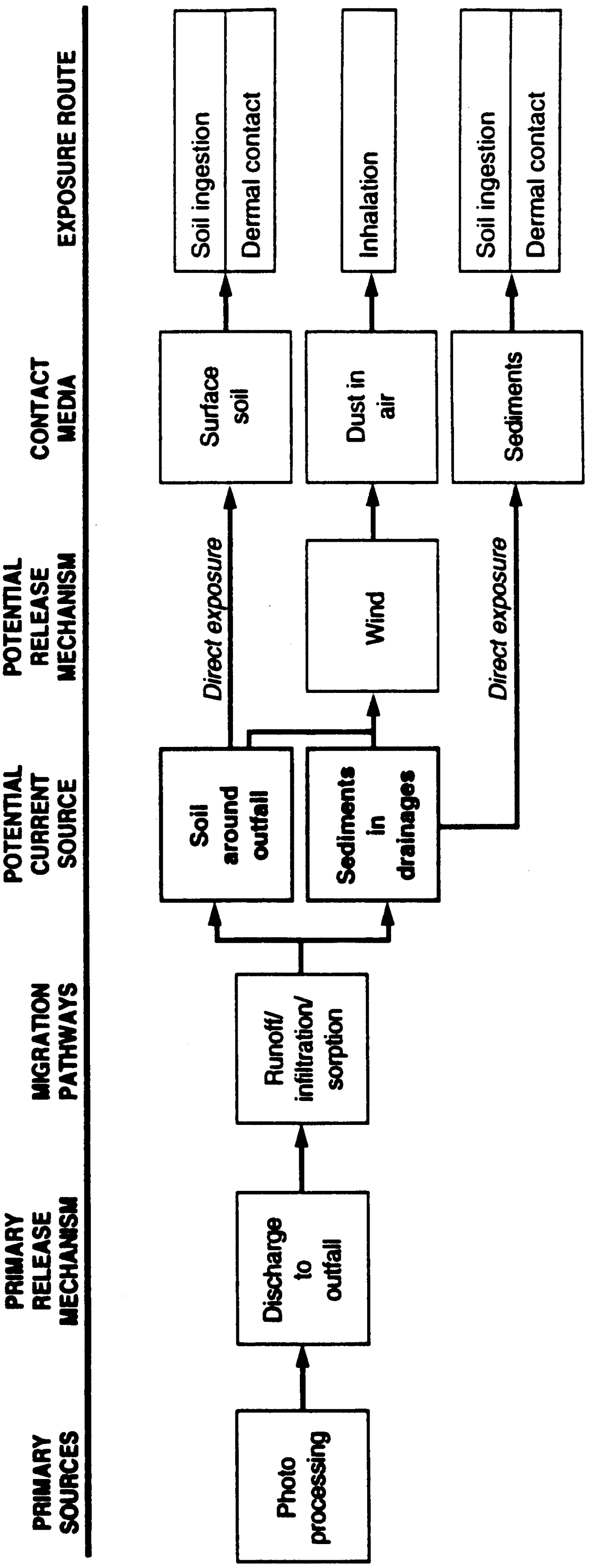


Figure 5-12. Conceptual exposure model for the photo outfall (PRS C-36-003).

Because the outfall is located inside the controlled area of the Laboratory, the pool of human receptors is currently limited to onsite maintenance workers. Possible future receptors of surface contamination are postulated on the basis of the recreational scenario. The steep slope prevents camping at this site, but hikers could come in contact with contaminated media on the slope. If potential contaminants of concern are transported further downstream with the surface water runoff, hikers and campers in downstream areas such as Pajarito Canyon could be exposed to the contaminants.

5.7.3 Remedial Decisions and Investigation Objectives

The objective of this RFI is to determine whether contaminants in surface soils and sediments downstream from the outfall are present at concentrations exceeding screening action levels. If contaminants of concern are identified, further investigations may be needed to assess accurately the extent of contamination. Because this is an active NPDES-permitted outfall, any remediation of this PRS would be postponed until the outfall is made inactive.

5.7.4 Data Needs and Data Quality Objectives

The goal of Phase I of the RFI at this site is to determine if silver, cyanide, and organic solvents contaminants are present in surface soils and sediments on the slope below the outfall at levels exceeding screening action levels. Because the slope of the ground under the outfall is quite steep, there are not many places where soils and sediments, together with potential contaminants, accumulate and remain trapped. Suitable sampling locations may therefore start as far as 170 ft down the slope below the outfall.

5.7.5 Sampling and Analysis Plans

The sampling and analysis plan describes the field screening and sampling that will be conducted at the photo outfall, and the laboratory analyses that will be conducted off site.

5.7.5.1 Land and Geomorphic Survey

The land survey will be performed in accordance with LANL Survey Procedures Manual (LANL 1992, 13-0096). This survey will be used to determine sampling locations identified by geomorphic surveys. The surveyed location points will be logged on 2 ft contour maps and the information will be transferred to the FIMAD. A geomorphic survey will be used to identify sediment catchment areas and locations where sampling may occur. Geomorphic mapping will be conducted in accordance with protocols established in LANL-ER-SOP-03.08, Geomorphic Characterization (LANL 1993, in review).

5.7.5.2 Field Screening

Field screening of all samples will be performed in order to define potential hazards and health and safety conditions for onsite workers. A portable field instrument for detecting alpha-, beta-, and gamma-emitters, and a portable field FID and/or PID for detecting VOCs, will be used.

5.7.5.3 Soil and Sediment Sampling Plan

Proposed samples and analysis for PRS C-36-003 are presented in Table 5-10. Six surface soil and sediment samples (from depths of 0-6 in.) will be collected downstream within approximately 200 ft of the outfall. The exact sampling locations will be determined in the field, based on the results of the geomorphic survey. These six samples should be sufficient to characterize the area accurately, given the expectation that the potential contamination at this site is low and of moderate variability. If visual inspection (as described in Section 5.2.5.2 of this work plan) and field screening measurements indicate the presence of additional areas of potential contamination, more samples may be collected for analysis. Surface samples will be collected in accordance with protocols established in LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples (LANL 1992, 0688).

One sample of the outfall water will be collected if water is found to be flowing at the site. This water sample will be collected in accordance with protocols

TABLE 5-10

SUMMARY OF SAMPLING AND ANALYSES FOR PRS C-36-003, PHOTO OUTFALL

	Sampled Media		Samples						Field Screening					Laboratory Analyses										
			Structure		Surface		Subsurface																	
Description	soil/sediments	water	primary	duplicate	primary	duplicate	primary	duplicate	Beta-gamma	Alpha	Organic Vapor	Combustible gas/oxygen	Explosives (Spot Test)	Gross Gamma	Gamma spectroscopy	Total uranium	Isotopic uranium	Plutonium	Metals (SW 6010/7000)*	Mercury	Cyanides	VOCs (SW 8260)*	SVOCs (SW 8270)*	Explosives (SW 8330)*
Outfall	x		6	1					x	x	x								x		x		x	
Outfall		x	1	1					x	x	x								x		x		x	

x : All samples
y : Selected samples (see text)
* : Applicable EPA SW 846 methods.

established in LANL-ER-SOP-06.13, Surface Water Sampling (LANL 1992, 0688).

5.7.5.4 Laboratory Analyses

Samples will be analyzed for heavy metals (silver, barium, beryllium, cadmium, chromium, mercury, nickel, lead, and zinc), cyanide, and SVOCs [in accordance with EPA Method 8270 (EPA 1986, 0291)]. If a field laboratory is available and meets QA/QC criteria, these samples may be analyzed on site. Otherwise, an offsite analytical laboratory will be used.

5.8 AOC C-36-001

This AOC, which was listed in the 1990 SWMU report (LANL 1990, 0145), is a large portable vessel currently sitting at the I-J firing site. It is considered to be part of active firing site I-J, and has been discussed in Section 5.4.1.5.1 of this work plan. Any action to be taken regarding this PRS will be deferred until the decommissioning of I-J site.

5.9 AOC C-36-006(e)

This AOC, a part of I-J firing site that was once used for projectile testing, was listed in the 1990 SWMU report (LANL 1990, 0145). Refer to Figure 5-5 for location of the projectile testing site. It is considered to be a part of active firing site I-J, and has been discussed in Section 5.4.1.5.1 of this work plan. Any action to be taken regarding this PRS will be deferred until the decommissioning of I-J site.

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Executive Summary

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Chapter 6

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- 36-007(a, b, c, d, e, & f): HE Waste Containers
- 36-004(f): Moe Magazine
- C-36-002

6.0 UNITS PROPOSED FOR NO FURTHER ACTION

No further action (NFA) is proposed for several of the OU 1130 potential release sites (PRSs) that were listed in the 1990 Laboratory Solid Waste Management Unit report (LANL 1990, 0145). These areas should be considered suitable for general Laboratory use, subject to the restrictions imposed during use of the firing sites within Technical Area (TA)-36. Based on the four-step evaluation process described in Appendix J of the 1992 Installation Work Plan (IWP) (LANL 1992, 0768), NFA is proposed for the following units:

• PRS 36-003(c)	septic system
• PRS 36-003(d)	septic system
• PRS 36-007(a)	explosives waste container
• PRS 36-007(b)	explosives waste container
• PRS 36-007(c)	explosives waste container
• PRS 36-007(d)	explosives waste container
• PRS 36-007(e)	explosives waste container
• PRS 36-007(f)	explosives waste container
• PRS 36-004(f)	Moe Magazine
• PRS C-36-002	surface disposal

Archival data regarding these PRSs indicate that they pose no threat to human health or to the environment. It is appropriate, therefore, to propose them for NFA. The basis for this proposal is discussed below for each site.

6.1 PRSs 36-003(c) and (d) - Septic Systems

NFA is recommended for septic systems 36-003(c) and (d) on the basis of Step Four of the IWP evaluation process. Archival information yields no evidence that hazardous or radioactive material, or any material other than sanitary waste, was ever disposed of into these systems. Hence, there is no reasonable basis for continuing the characterization of this PRS. The following points are responses to issues raised in Decision Point 4:

- No credible risk is posed to human health and safety from potential contaminants of concern in these systems because it is highly unlikely that these contaminants exist at concentrations above screening action levels.
- No credible risk is posed to the environment.
- Compliance with regulations does not require additional characterization of these systems.
- Suspending further characterization of these systems will pose no immediate or long-term risk of adversely affecting Laboratory programs and operations.
- Additional characterization of these PRSs will not contribute to the effectiveness, the value, or the expense reduction of other characterizations. Conversely, suspending further characterization of these PRSs at this time would not greatly increase costs, risks, or socioeconomic impacts should such characterization be required at a later date.

6.1.1 PRS 36-003(c)

This septic system was built in 1985 to receive sanitary waste from guard station TA-36-70. The system comprises a 500-gal. reinforced-concrete septic tank (TA-36-69) and a 628-cu-ft seepage pit (LANL 1985, 13-0061; NMED 1989, 13-0088); these and the guard station are connected by pipes (LANL 1990, 0145; NMED 1989, 13-0088).

Environmental monitoring apparently has not been performed on this septic system. However, contaminants of concern are not likely to be present. The guard station is not directly associated with activities that generate hazardous waste, and it has never been used as a laboratory (NMED 1989, 13-0088). There is no evidence that this septic system has ever received anything other than sanitary waste.

6.1.2 PRS 36-003(d)

This septic system was built in 1988 to handle sanitary waste from three buildings in the TA-36 office lab complex: transportable office structures TA-36-81 and TA-36-84, and security structure TA-36-22. This system consists of a 1,000-gal. reinforced-concrete septic tank (TA-36-100), a distribution box, a leach field, and pipes connecting the various parts of the system (LANL 1990, 0145).

Contaminants of concern are not likely to be present, because the system serves office and security structures not directly associated with activities that generate hazardous waste, and there is no evidence that these buildings have ever been used as laboratories. Nor is there evidence that this septic system has ever received anything other than sanitary waste.

6.2 PRSs 36-007(a, b, c, d, e, and f) - Explosives Waste Containers

PRSs 36-007(a, b, c, d, e, and f) are active satellite waste storage containers that are used for short-term storage of small quantities of explosive-contaminated solid waste items. Each container is a small (less than 5 gal.) corrugated cardboard box with a plastic liner. When full, each box is sealed and transported to TA-16 for permitted burning. The boxes are located within Buildings TA-36-4, -5, -7, -8, -11, and a storage area at Minie. All of these buildings are concrete structures with concrete floors and a steel door. There have been no reports of contaminant releases from these waste containers or from the buildings.

These explosive waste containers are all recommended for NFA on the basis of Step Two, Section 3.1.1, Appendix J of the evaluation process described in the IWP (LANL 1992, 0768). That is, these PRSs are all permitted satellite and less-than-ninety-day waste storage areas from which there have been no environmental releases.

6.3 PRS 36-004(f) - Moe Magazine

Moe Magazine is located on a mesa top overlooking Fence Canyon. It comprises three permanent magazines: Big Moe, Little Moe, and Pro Moe (Schlapper 1991, 13-0077). Moe Magazine has never been a firing site and, since its construction in the 1950s, has never been used for any purpose other than storage. There have been no environmental releases of hazardous or radioactive materials from this magazine.

It is thought that, in the 1940s, before the construction of Moe Magazine, two explosives shots may have been detonated in the area where the magazine now stands (Kelkar 1992, 13-0051; Kelkar 1992, 13-0052). These two shots contained only explosives and detonators; no metals or materials other than explosives were involved.

No further action is proposed for this PRS on the basis of Criterion 4 (Section 4.4.1) of the IWP, because there is no reason to believe that hazardous or radioactive constituents have been released from the magazine, and it is unlikely to release any in the future. Further, any organic materials that may have been released by the alleged explosive experience will have volatilized or been degraded in the 50 years since the alleged experiments occurred. Thus potential receptors are unlikely to be exposed to any residual materials.

6.4 PRS C-36-002 - Surface Disposal Area

This site was listed as a suspected waste disposal site in the 1988 SWMU Report (LANL 1990, 0145). Formerly designated as 36-006(b), it is located on the mesa west of Lower Slobbovia near Laboratory coordinates E200+00, S85+00. A field inspection of the site, documented in the 1990 SWMU Report (LANL 1990, 0145), found that it is only a borrow pit from which material was being excavated for use as fill. The site is proposed for NFA on the basis of Criterion 1 (Section 4.4.1), because it has never contained any contaminants of concern.

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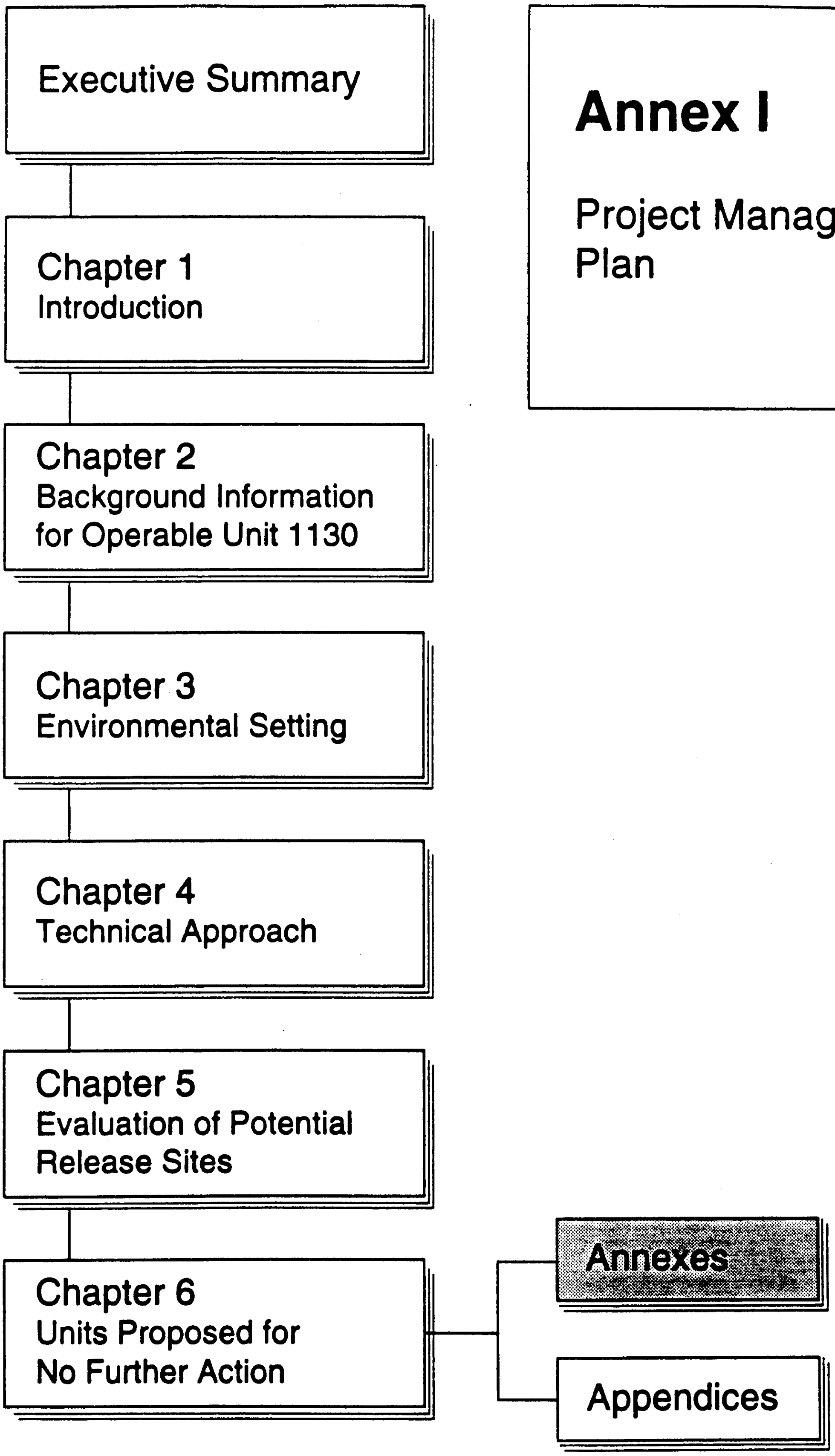
Annex I

Project Management Plan



1.0 PROJECT MANAGEMENT PLAN

This annex provides the technical approach, schedule, reporting requirements, budget, organization, and responsibilities for the implementation of the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) for Operable Unit (OU) 1130. This project management plan (PMP) is an extension of Los Alamos National Laboratory's Program Management Plan described in Annex I of the Installation Work Plan for Environmental Restoration (IWP) (LANL 1992, 0768) and follows the basic Department of Energy (DOE) management philosophy outlined in DOE Order 4700.1, Project Management System (DOE 1992, 0823). This annex discusses the requirements for PMPs set forth in the Laboratory's Hazardous and Solid Waste Amendments (HSWA) Module (Task II, E, p. 39) (EPA 1990, 0306).

1.1 Technical Approach

The technical approach to the RFI for OU 1130 is described in Chapter 4 of this work plan. This approach is based on the Environmental Restoration (ER) Program's overall approach to the RFI/corrective measures study (CMS) process as described in Chapter 4 of the IWP. The following key features characterize the ER Program's approach:

- use of preselected "screening action levels" as criteria to trigger voluntary corrective action (VCA) or Phase II investigations;
- site characterization based on a "sample and analysis" approach;
- use of decision analysis and cost effectiveness studies in selecting remedial corrective measures and their remedial alternatives; and
- the application of an "observational," or "streamlined," approach to the RFI and CMS processes.

The general philosophy of the RFI and CMS processes is to develop and iteratively refine the OU 1130 conceptual exposure model through carefully planned stages of investigation and data interpretation. This will be followed by a study that investigates and proposes various methods for addressing potential release sites (PRSs) that are determined to need remediation. Another objective is to use the minimum data necessary to support either interim corrective measures or the CMS.

1.2 Technical Objectives

The technical objectives of this work plan are to

- locate or confirm the location of each PRS within OU 1130;
- through Phase I investigations, identify contaminants present at each PRS and the concentrations within structures and environmental media;
- conduct VCAs and propose no further action (NFA) or Phase II investigations as appropriate;
- determine the vertical and horizontal extent of the contamination at each PRS during Phase II investigations as appropriate;
- identify contaminant migration pathways during Phase II investigations;
- acquire sufficient information to allow quantitative assessment of migration pathways and the associated risk for all PRSs carried forward to Phase II investigations;
- provide necessary data for the assessment of potential remedial alternatives; and
- provide the basis for planning the detailed CMS.

2.0 SCHEDULE

The plan and schedule for the RFI/CMS process were developed as a joint effort between the operable unit project leader (OUPL) and the management information system staff of the ER Program Office. The initial step was to develop and agree on an ER Program-wide work breakdown structure at the upper levels (i.e., Level 1 down through Level 3, which included all the OUs). Level 3 was expanded for OU 1130, and all the necessary activities were graphically laid out on a detailed logic diagram. All of the activities were related to each other by sequence (i.e., before, after, or parallel with). Duration (in working days) and cost estimates (in dollars) were made for each of the activities. The schedule and cost estimate were calculated as a function of time and were calculated first as a financially unconstrained case and then replanned to account for constrained funding, which was already allocated for fiscal year (FY 92). Key milestones for the RFI are presented in Table 1-1.

Implementation of RFI activities is contingent on regulatory review and approval of this work plan and on available funding. The following assumptions were used to generate this schedule:

- Review and approval of the work plan and supporting project plans by regulatory agencies are scheduled to be completed by September 1, 1993.

- Certain tasks may be initiated before the regulatory agencies grant final approval of the work plan.

- PRSs expected to require subsequent investigations have been scheduled earlier in the RFI to allow time for data assessment and subsequent investigations.

- The schedule assumes that an adequate number of support personnel (e.g., health and safety technicians, trained drilling contractors, etc.) will be available for conducting necessary tasks.

TABLE I-1

SCHEDULE FOR OU 1130 RCRA FACILITY INVESTIGATION AND CORRECTIVE MEASURES STUDY

Milestone	Date
Start RFI Work Plan	10/01/91
DOE Draft RFI Work Plan Completed	02/19/93
Environmental Protection Agency (EPA)/New Mexico Environment Department (NMED) RFI Work Plan Submitted	05/23/93
EPA/NMED Draft of Phase I Report Completed	01/30/95
EPA/NMED Draft of RFI Report Completed	10/10/97
Start Development of CMS Plan	10/14/97
EPA/NMED Draft of CMS Plan Completed	05/08/98
EPA/NMED Draft of CMS Report Completed	08/31/99

- EPA review and comments on phase reports/work plan modifications are assumed to take two months. Another month is allowed for Laboratory revision and EPA final approval.
- Adequate funding is available to accomplish the work shown in the plan and schedule.

3.0 REPORTING

Results of the RFI field work will be presented in four principal documents:

- Quarterly technical progress reports.
- Phase reports/work plan modifications.
- RFI report.
- CMS report (as required).

These reports are summarized in the following sections. A schedule for submission of draft and final reports is presented in Table I-2.

REFERENCES FOR ANNEX I

DOE (US Department of Energy), June 6, 1992. "Project Management System," DOE Order 4700.1, Change 1, Washington, DC. (DOE 1992, 0823)

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TABLE I-2

REPORTS PLANNED FOR THE OU 1130 RFI

Report Type and Subject	Draft Date	Final Date
Quarterly Technical Progress Reports		
• Summary of Technical Activities and Data		02/15 (yearly) 05/15 (yearly) 08/15 (yearly) 11/15 (yearly)
Phase Reports/Work Plan Modifications		
• Phase I Report	03/94	05/94
• Phase II Report	07/95	09/95
RFI Report		
• Final RFI Report	10/10/97	02/24/98
CMS Report		
• Final CMS Report	08/31/99	10/18/99

3.1 Quarterly Technical Progress Reports

As the OU 1130 RFI is implemented, technical progress will be summarized in quarterly technical progress reports submitted by the ER Program, as required by the HSWA Module of the Laboratory's RCRA Part B operating permit (Task V, C, p. 46) (EPA 1990, 0306). Detailed technical assessments will be provided in phase reports/work plan modifications.

3.2 Phase Reports/Work Plan Modifications

Phase reports/work plan modifications will be submitted at the end of each phase for work conducted on PRSs in this operable unit. The first report will summarize Phase I results on initial site characterization and describe the proposed follow-on activities of Phase II, including any modifications to field sampling plans suggested by the Phase I results. This report will also identify any PRSs proposed for NFA. A Phase II report (as distinct from a final RFI report) will be prepared only if Phase III investigations are proposed. The standard outline for a phase report/work plan modification is presented in Section 3.5.1.2 of the IWP (LANL 1992, 0768) and may be modified as needed.

3.3 RFI Report

The RFI report will summarize all field work conducted during the 2.5-year duration of the RFI. The RFI report will describe the procedures, methods, and results of field investigations and will include information on the types and extent of contamination, sources and migration pathways, and actual and potential receptors. The report will also contain adequate information to support the delisting of no further action sites and corrective action decisions.

3.4 CMS Report

The CMS report will propose methods of remediation for selected PRSs listed in the RFI report. Not all PRSs will need remediation because some will have been delisted based on recommendations made in the RFI report. The CMS report will describe the proposed remediation methods, procedures, and expected results, along with a plan, schedule, and cost estimate.

4.0 BUDGET

It is impractical (and almost impossible) to separate schedule and cost because changing one affects the other. For example, the start and end dates for OU 1130 were fixed by regulations and by the ER Program Office. These schedule decisions had an effect on the cost as a function of time.

The detailed planning, scheduling, and cost estimating were done in late FY 91. As stated previously, the schedule and cost estimate were calculated first as financially unconstrained and were then replanned to account for constrained funding that was allocated for FY 92. DOE funding decisions are set two years in advance (in this case, for FYs 92 and 93). Therefore, the first year that the OU 1130 RFI will not be constrained by past budget decisions will be FY 94. Although the FY 93 budget is set by DOE, the allocation has not been made to the Laboratory. Funding requests for FY 94 and beyond will reflect the schedule and cost that are the most efficient (unconstrained) for executing the work plan.

Table I-3 presents project costs for completion of the RFI for OU 1130. Each activity on the logic network was assigned one or more resources (i.e., people, materials, or equipment). Through a rate table, the resources were converted to dollars. The estimated costs are escalated for all years beyond FY 92 and do not contain contingency. To avoid adversely affecting the performance analysis calculations, contingency is held in a management reserve account.

The plan, schedule, and budget (allocation) for FY 92 are now baselined by the DOE's Albuquerque Operating Office. The outyears, FY 93 through FY 98, are not baselined and cannot be baselined until allocations are made by DOE.

5.0 OU 1130 Organization and Responsibilities

The organizational structure for the ER Program is presented in Chapter 3 of the IWP (LANL 1992, 0768). ER Program personnel are identified to the technical team leader (TTL) and OUPL level in Figure 3-2 of the IWP (LANL 1992, 0768), which is reproduced here as Figure I-1. Section 3.3 of the IWP identifies line authority and responsibilities for each position identified in the figure. Records of qualifications and training of all personnel working on the OU 1130 RFI field work will be kept as ER records. Contributors to the work plan are included in Appendix A.

The management organization for this work plan is shown in Figure I-2. The names of all individuals assigned to the positions indicated in the figure have not been determined at this time. The following sections define the responsibilities of the positions identified in Figure I-2.

TABLE I-3

ESTIMATED COST OF COMPLETING
RFI OU 1130

Estimate to Complete	$9,034,000
Escalation	$1,129,000
Prior Years	$ 462,000
Total at Completion	$10,625,000

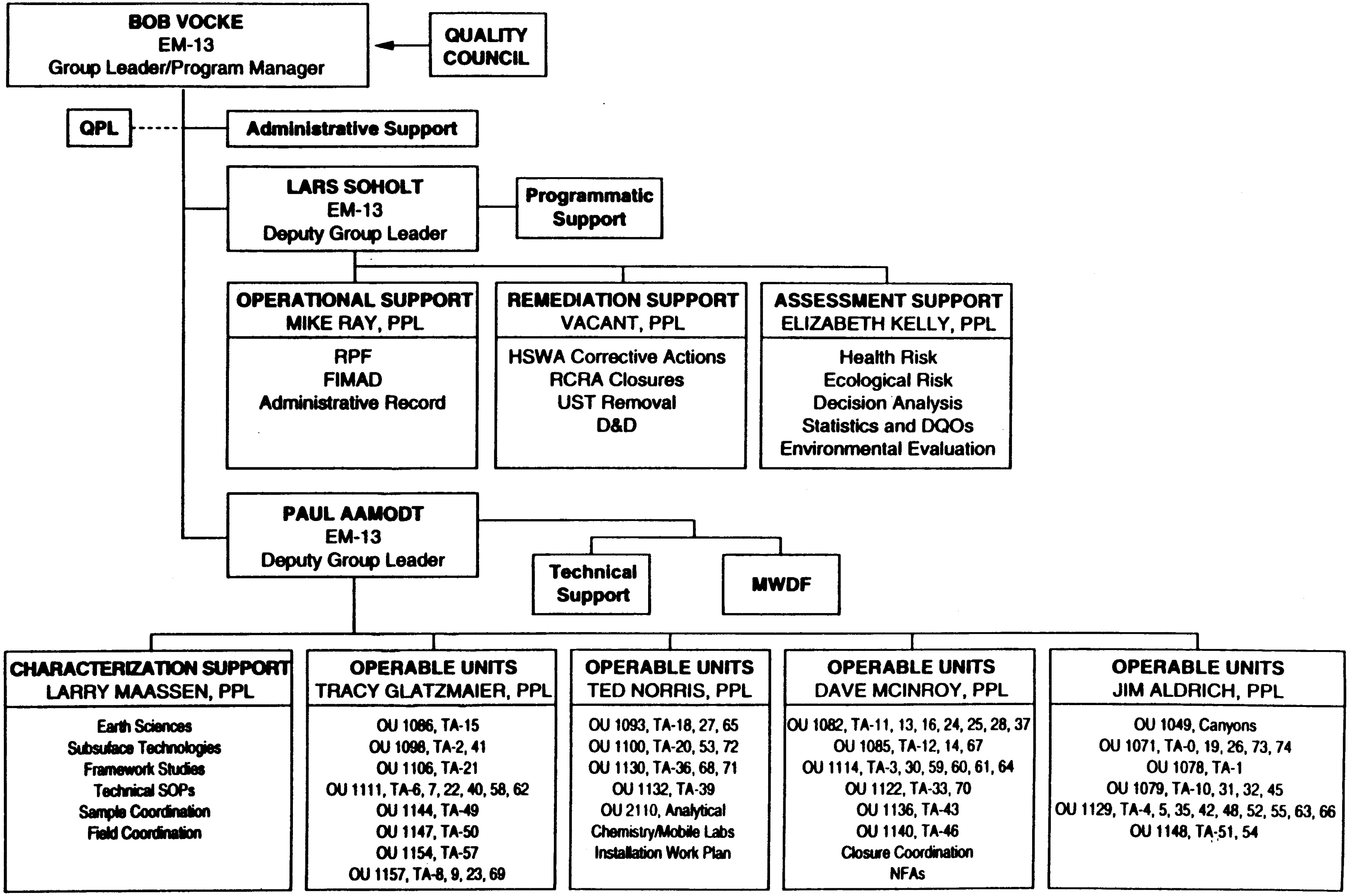

Figure I-1. ER Program organizational structure.

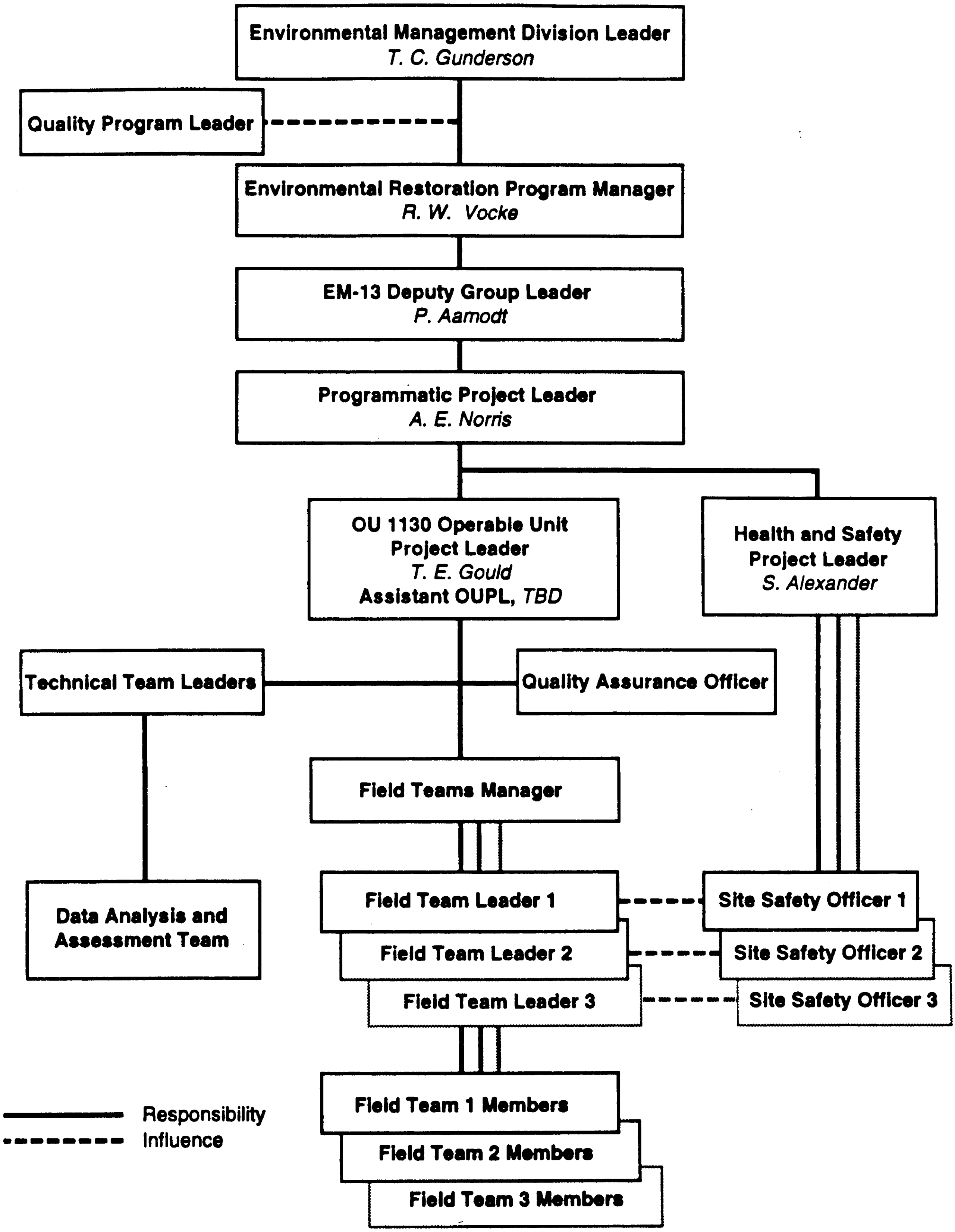

Figure I-2. OU 1130 field organization chart.

5.1 Operable Unit Project Leader

The responsibilities of the OUPL are as follows:

- oversee day-to-day operations, including planning, scheduling, and reporting of technical and administrative activities;
- ensure advance preparation of scientific investigation planning documents and procedures;
- prepare monthly and quarterly reports for the ER Program Manager;
- coordinate with TTLs;
- oversee RFI field work and manage the field teams manager;
- oversee subcontractors, as appropriate;
- conduct technical reviews and direct preparation of final reports;
- comply with the Laboratory's technical requirements for the ER Program;
- interface with the ER quality program project leader to resolve quality concerns and participate with the quality assurance (QA) staff on audits; and
- comply with the ER Program requirements for health and safety, records management, and community relations.

5.2 Assistant to OUPL

The assistant to the OUPL assists the OUPL and acts in the absence of the OUPL.

5.3 Health and Safety Project Leader

The health and safety project leader sets policies and standards of health and safety for the OU 1130 RFI and supervises the site safety officers.

5.4 QA Officer

The QA program that governs the design and implementation of the RFI for OU 1130 is described in Annex II, Quality Assurance Project Plan. The QA officer is responsible for ensuring that these plans are properly incorporated into the implementation of the field investigation, including the selection and location of sampling points, sample collection and processing, data handling, and reporting of results. As shown in the project organization chart, the QA officer reports directly to the OUPL, ensuring the independence of the QA officer from field activities. Although the field team leader has the responsibility of ensuring that all necessary procedures are followed, this independent oversight by the QA officer will provide an extra measure of assurance that the QA program is properly implemented at all stages of the investigation.

5.5 Field Teams Manager

The field teams manager directs day-to-day field operations and conducts planning and scheduling for the implementation of the RFI field activities detailed in Chapter 5.

5.6 Technical Team Leader(s)

TTLs are responsible for providing support in their discipline throughout the RFI/CMS process. During the OU 1130 RFI, the TTLs will participate in the development of the work plan; development of the individual field sampling plans; and in field work, data analysis, report preparation, work plan modifications, and planning of subsequent investigations, as necessary.

The OU 1130 technical team requires these primary disciplines: hydrogeology, statistics, geochemistry, and health physics. The composition of the technical team may change with time as the technical expertise needed to implement the OU 1130 RFI changes.

5.7 Field Team Leader(s)

The field team leaders will implement work assignments in the field from the field team manager. Each field team leader will direct the execution of field sampling activities, using crews of field team members as appropriate. Field team leaders may be contractor personnel.

5.8 Site Safety Officer(s)

The site safety officers observe, advise, and document the execution of the health and safety aspects of the OU 1130 work. They report any procedural violations to the health and safety project leader.

5.9 Field Team Member(s)

Field team members may include sampling personnel, geologists, hydrologists, health physicists, and other required disciplines. All field team members require access to a site safety officer and a qualified field sampler. They are responsible for conducting the work detailed in field sampling plans, under the direction of the field team leaders. Field team members may be contractors.

5.10 Data Analysis and Assessment Team

This team analyzes or manages the analysis of sample data. The team also assesses the sample results and requests additional samples, when appropriate.

SIGNATURE PAGE

Approval for Implementation

1. NAME: Robert Vocke
TITLE: ER Program Manager, Los Alamos National Laboratory

SIGNATURE: ______________________________ DATE: _______

2. NAME: Ted Norris (acting)
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TITLE: Chief of Office of Quality Assurance, Region 6, Environmental Protection Agency

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7. NAME: T. E. Gene Gould
TITLE: Operable Unit Project Leader, Mechanical and Electrical Engineering Group (MEE-4), Los Alamos National Laboratory

SIGNATURE: ______________________________ DATE: _______

1.0 QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPjP) for the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) work plan for OU 1130 was written as a matrix report (Table II-1) that is based on the Los Alamos National Laboratory (the Laboratory) Environmental Restoration (ER) Program Generic QAPjP (LANL 1991, 0412).

The Laboratory ER Program Generic QAPjP describes the format for the individual OU QAPjPs. In the Generic QAPjP, Section 1.0 is the Signature Page, which is included in the front of this annex. Section 2.0 of the Generic QAPjP is a Table of Contents, which was omitted from this annex because the OU 1130 QAPjP is presented as a matrix. Section 3.0 of the Generic QAPjP is the Project Description, and Subsection 3.1 is the Introduction. This introduction will serve as the equivalent of Subsection 3.1 and the matrix (Table II-1) will begin with Subsection 3.2, Facility Description.

The OU 1130 QAPjP matrix (Table II-1) appears as a table in which the Generic QAPjP criteria are listed in the first column; these criteria correspond to the sections of the Generic QAPjP. The second column lists the specific requirements of the Generic QAPjP that the OU 1130 QAPjP must meet; the subsection titles and numbers in the second column correspond directly with those contained in Generic QAPjP. Sections of the Generic QAPjP that do not contain specific requirements are not included in the matrix, e.g., 3.4. The third column lists the location of information in the IWP and/or the OU 1130 work plan that fulfills the requirements in the Generic QAPjP. If OU 1130 will be following the requirements in the Generic QAPjP and no further information is necessary, the column contains the phrase "Generic QAPjP accepted." In some cases, a standard operating procedure (SOP) and/or a clarification note is included.

TABLE II-1

OU 1130 QAPJP MATRIX

Generic QAPjP Criteria	Generic QAPjP Requirements by Subsection	OU 1130 Incorporation of Generic QAPjP Requirements
Project Description	3.2 Facility Description	Los Alamos National Laboratory (LANL) ER Program IWP, Section 3.0, and OU 1130 Work Plan, Chapter 2.0.
	3.3 ER Program	LANL ER Program IWP, Section 2.0.
	3.4.1 Project Objectives	OU 1130 Work Plan, Chapters 1.0 and 5.0.
	3.4.2 Project Schedule	OU 1130 Work Plan, Annex I.
	3.4.3 Project Scope	OU 1130 Work Plan, Chapters 1.0 and 5.0.
	3.4.4 Background Information	OU 1130 Work Plan, Chapters 1.0, 2.0, and 3.0.
	3.4.5 Data Management	OU 1130 Work Plan, Annex IV, and LANL ER Program IWP, Annex IV.
Project Organization	4.1 Line Authority	OU 1130 Work Plan, Annex I.
	4.2 Personnel Qualifications, Training, Resumes	OU 1130 Work Plan, Annex I.
	4.3 Organizational Structure	LANL-ER-QPP, Section 2.0, and OU 1130 Work Plan, Annex I. See also ***Note 1***.
Quality Assurance Objectives for Measurement Data in Terms of Precision, Accuracy, Representativeness, Completeness, and Comparability	5.1 Level of Quality Control	Generic QAPjP accepted.
	5.2 Precision, Accuracy, and Sensitivity of Analyses	Generic QAPjP accepted.
	5.3 QA Objectives for Precision	Generic QAPjP accepted.
	5.4 QA Objectives for Accuracy	Generic QAPjP accepted.
	5.5 Representativeness, Completeness, and Comparability	Generic QAPjP accepted.
	5.6 Field Measurements	Generic QAPjP accepted.
	5.7 Data Quality Objectives	OU 1130 Work Plan, Chapter 5.0.
Sampling Procedures	6.0 Sampling Procedures	OU 1130 Work Plan, Chapters 4 and 5, ER Program SOPs.
	6.1 Quality Control Samples	Generic QAPjP accepted. Including ER Program SOP-01.05.
	6.2 Sample Preservation During Shipment	Generic QAPjP accepted. Including ER Program SOP-01.02.
	6.3 Equipment Decontamination	Generic QAPjP accepted. Including ER Program SOP-01.06.
	6.4 Sample Designation	Generic QAPjP accepted. Including ER Program SOP-01.04.

TABLE II-1 (continued)

OU 1130 QAPJP MATRIX

Generic QAPJP Criteria	Generic QAPJP Requirements by Subsection	OU 1130 Incorporation of Generic QAPJP Requirements
Sample Custody	7.1 Overview	Generic QAPjP accepted. Including ER Program SOP-01.04.
	7.2 Field Documentation	Generic QAPjP accepted. Including ER Program SOP-01.04.
	7.3 Sample Management Facility	Generic QAPjP accepted.
	7.4 Laboratory Documentation	Generic QAPjP accepted.
	7.5 Sample Handling, Packaging, and Shipping	Generic QAPjP accepted. Including ER Program SOP-01.03.
	7.6 Final Evidence File Documentation	Generic QAPjP accepted.
Calibrations Procedures and Frequency	8.1 Overview	Generic QAPjP accepted.
	8.2 Field Equipment	Generic QAPjP accepted.
	8.3 Laboratory Equipment	Generic QAPjP accepted.
Analytical Procedures	9.1 Overview	Generic QAPjP accepted.
	9.2 Field Testing and Screening	Generic QAPjP accepted. Including ER Program SOP-06.02.
	9.3 Laboratory Methods	Generic QAPjP accepted. Sampling plans are described in OU 1130 Work Plan, Chapter 5.0.
Data Reduction, Validation, and Reporting	10.1 Data Reduction	Generic QAPjP accepted.
	10.2 Data Validation	Generic QAPjP accepted.
	10.3 Data Reporting	Generic QAPjP accepted.
Internal Quality-Controlled Checks	11.1 Field Sampling Quality Control Checks	Generic QAPjP accepted.
	11.2 Laboratory Analytical Activities	Generic QAPjP accepted.
Performance and System Audits	12.0 Performance and System Audits	Generic QAPjP accepted.
Preventive Maintenance	13.1 Field Equipment	Generic QAPjP accepted.
	13.2 Laboratory Equipment	Generic QAPjP accepted.
Specific Routine Procedures Used to Assess Data Precision, Accuracy, Representativeness, and Completeness	14.1 Precision	Generic QAPjP accepted.
	14.2 Accuracy	Generic QAPjP accepted.
	14.3 Sample Representativeness	Generic QAPjP accepted. See also ***Note 2.***
	14.4 Completeness	Generic QAPjP accepted
Corrective Action	15.1 Overview	Generic QAPjP accepted. Including LANL-ER-QP-01.3Q.
	15.2 Field Correction Action	Generic QAPjP accepted.
	15.3 Laboratory Corrective Action	Generic QAPjP accepted.

TABLE II-1 (concluded)

OU 1130 QAPjP MATRIX

Generic QAPjP Criteria	Generic QAPjP Requirements by Subsection	OU 1130 Incorporation of Generic QAPjP Requirements
Quality Assurance Reports to Management	16.1 Field Quality Assurance Reports to Management	Generic QAPjP accepted. See also ***Note 3.***
	16.2 Laboratory Quality Assurance Reports to Management	Generic QAPjP accepted.
	16.3 Internal Management Quality Assurance Reports	Generic QAPjP accepted.

Note 1: Section 4.0: Project Organization and Responsibility
The organizational structure of the ER Program is presented in Section 2.0 of the LANL ER Quality Program Plan (QPP) to the Project Leader (PL) level, including quality assurance functions. The OU 1130 work plan, Annex I, describes the organizational structure from the PL-level downward and presents an organizational chart to demonstrate line authority.

Note 2: Section 14.3: Sample Representativeness
The field sampling plans presented in the OU 1130 work plan, Chapter 5.0, were developed to meet the sample representativeness criteria described in Subsection 14.3 of the Laboratory ER Program Generic QAPjP (LANL 1991, 0412).

Note 3: Section 16.1: Field Quality Assurance Reports to Management
The OU 1130 QA Officer, or a designee, will provide a monthly field progress report to the Laboratory ER PL. This report will consist of the information identified in Subsection 16.1 of the ER Program Generic QAPjP (LANL 1991, 0412).

REFERENCES FOR ANNEX II

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan," Rev. 0, Environmental Restoration Program, Los Alamos, New Mexico. (LANL 1991, 0412)

Annex II

Quality Assurance Project Plan

Executive Summary

Chapter 1
Introduction

Chapter 2
Background Information for Operable Unit 1130

Chapter 3
Environmental Setting

Chapter 4
Technical Approach

Chapter 5
Evaluation of Potential Release Sites

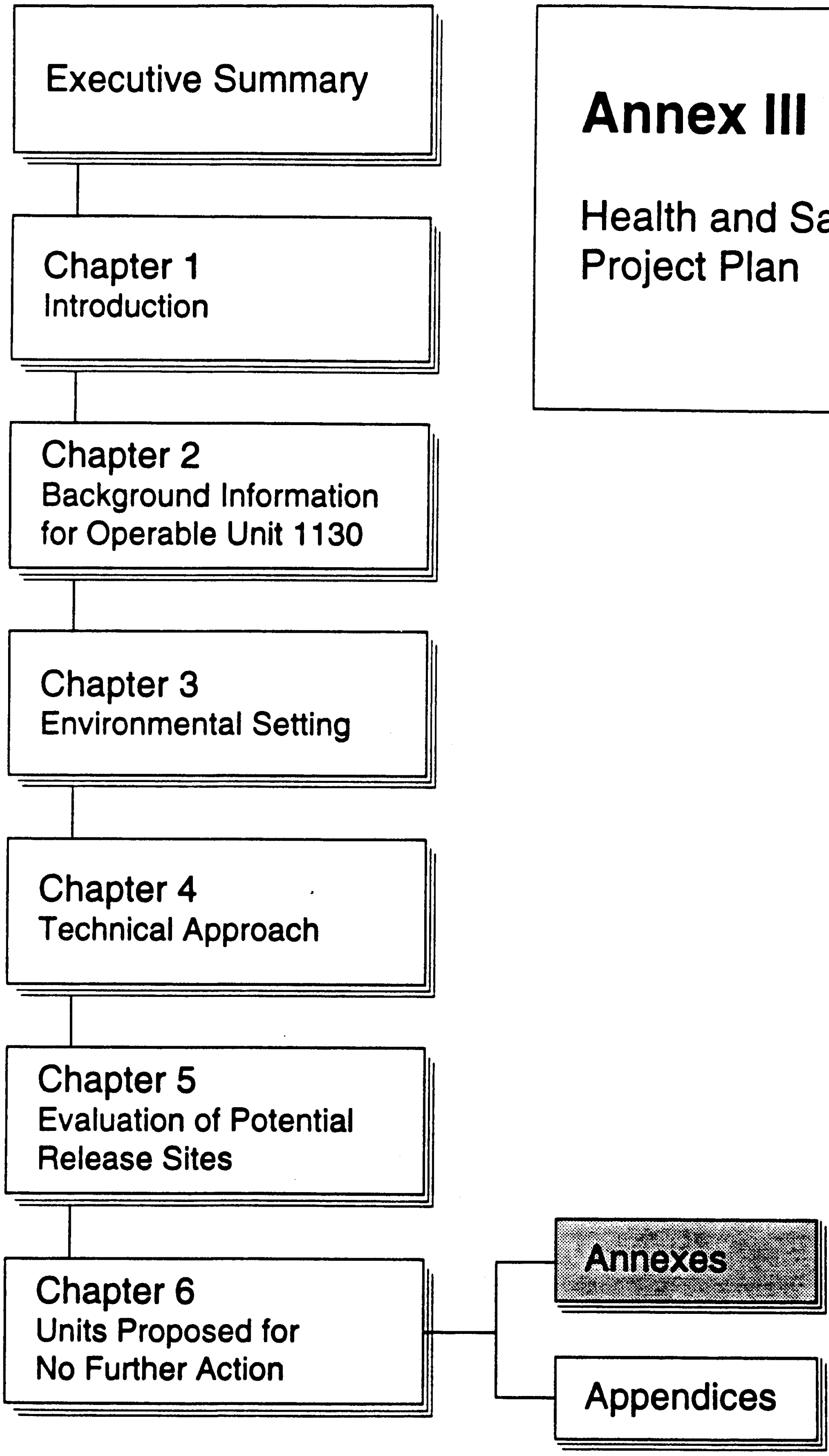
Chapter 6
Units Proposed for No Further Action

Annexes

Appendices

Annex III

Health and Safety Project Plan



ANNEX III

HEALTH AND SAFETY PLAN, OPERABLE UNIT 1130

CONTENTS

TABLES

FIGURES

ACRONYMS AND INITIALISMS

ACGIH	American Conference of Governmental Industrial Hygienists
ALARA	as low as reasonably achievable
AR	Administrative Requirement
CGI	combustible gas indicator
DOE	U.S. Department of Energy
EM	Environmental Management (Division)
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration (Program)
ERPG	Emergency Response Planning Guideline
ES&H	Environment, Safety, and Health
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSPL	Health and Safety Project Leader
IDLH	immediately dangerous to life and health
IWPHSPP	Installation Work Plan, Health and Safety Program Plan
LP	Laboratory Procedure
NIOSH	National Institute for Occupational Safety and Health
OEL	occupational exposure limit
OSHA	Occupational Safety and Health Administration
OU	operable unit
OUHSP	Operable Unit Health and Safety Plan
OUPL	Operable Unit Project Leader
PC	protective clothing
PEL	permissible exposure limit
PPE	personal protective equipment
PRS	potential release site
RCRA	Resource Conservation and Recovery Act of 1976
SARA	Superfund Amendments and Reauthorization Act of 1986
SSHSP	Site-Specific Health and Safety Plan
SSO	Site Safety Officer
TLD	thermoluminescent dosimeter
TLV	threshold limit value

1.0 INTRODUCTION

1.1 Purpose

The purpose of this Operable Unit Health and Safety Plan (OUHSP) is to recognize potential safety and health hazards, describe techniques for their evaluation, and identify control methods. The goal is to eliminate injuries and illness; to minimize exposure to physical, chemical, biological, and radiological agents during environmental restoration (ER) activities; and to provide contingencies for events that may occur while these efforts are under way.

It is intended that project managers, health and safety professionals, laboratory managers, and regulators use this OUHSP as a reference for information about health and safety programs and procedures as they relate to this operable unit (OU). Detailed Site-Specific Health and Safety Plans (SSHSPs) and procedures will be prepared subsequent to this document.

The Health and Safety Division Hazardous Waste Operations (HAZWOP) Program establishes laboratory policies for health and safety activities at ER sites. The hierarchy of health and safety documents for the Los Alamos National Laboratory (the Laboratory) ER Program is as follows:

1. Installation Work Plan, Health and Safety Program Plan (IWPHSPP)
2. OUHSP
3. SSHSP

The first document is more general, while the others become increasingly more specific and detailed. While each document is written so it can stand alone, the contents and references to these and other documents should always be considered when making decisions.

1.2 Applicability

These requirements apply to all personnel at ER sites, including Laboratory employees, supplemental work force personnel, regulators, and visitors. There are no exceptions.

1.3 Regulatory Requirements

Government-owned, contractor-operated facilities must comply with Occupational Safety and Health Administration (OSHA), U.S. Environmental Protection Agency (EPA) regulations, and U.S. Department of Energy (DOE) orders. The following is a brief synopsis of hazardous waste-related requirements.

The first federal effort to address hazardous waste problems followed the passage of the Resource Conservation and Recovery Act of 1976 (RCRA).

RCRA mandated the development of federal and state programs for the disposal and resource recovery of waste materials. RCRA regulates generation, treatment, storage, disposal, and transportation of hazardous waste.

Historically, there were many hazardous waste sites abandoned. Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, commonly known as "Superfund" to clean up and reclaim these sites.

The treatment and disposal of hazardous wastes posed health and safety risks to the workers engaged in these operations. These risks and the need for protecting workers engaged in hazardous waste site operations are addressed in the Superfund Amendments and Reauthorization Act of 1986 (SARA).

Under SARA, the Secretary of Labor is required to promulgate worker protection regulations. After consulting with many organizations, including EPA, OSHA, the U.S. Coast Guard, and the National Institute for Occupational Safety and Health (NIOSH), a set of regulations was published in March 1989. This is 29 Code of Federal Regulations (CFR) Part 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER).

DOE Orders 5480.4 and 5483.1A require DOE employees and contractors to comply with federal OSHA regulations. DOE 5480.11 sets radiation protection standards for all DOE activities. The DOE Radiological Control Manual established practices for the conduct of radiological control activities at all DOE sites and is used by DOE to evaluate contractor performance.

Laboratory Director's policies "Environment, Safety, and Health" and "Environmental Protection and Restoration," both dated September 1991, require compliance with federal regulations, DOE orders, and state and local laws.

1.4 Variances From Health and Safety Requirements

When special conditions exist, the Site Safety Officer (SSO) may submit to the Health and Safety Project Leader (HSPL) a written request for variance from a specific health and safety requirement. If the HSPL agrees with the request, it will be reviewed by the Operable Unit Project Leader (OUPL) or a designee. Higher levels of management may be consulted as appropriate. The condition of the request will be evaluated, and if appropriate, the HSPL will grant a written variance specifying the conditions under which the requirements may be modified. The variance will become part of the SSHSP.

1.5 Review and Approval

This document will be effective after it has been reviewed and approved by the appropriate Laboratory subject matter experts. Signatures of approval are required.

This document will be revised at least annually. Revisions will reflect changes in the scope of work, site conditions, work procedures, site data, contaminant monitoring, or visual information technology, policies, and/or procedures. Changes must be approved by the HSPL and OUPL. A complete review will be conducted should feasibility studies or remediation be necessary.

2.0 ORGANIZATION, RESPONSIBILITY, AND AUTHORITY

This section describes the general and individual responsibilities for health and safety, roles in field organization, and organizational structure. The health and safety oversight mechanism is also provided.

2.1 General Responsibilities

The Laboratory's Environment, Safety, and Health (ES&H) Manual delineates managers' and employees' responsibilities for conducting safe operations and providing for the safety of contract personnel and visitors. The general safety responsibilities for ER activities are summarized in the IWPHSPP. Line Management is responsible for implementing health and safety requirements.

An individual observing an operation that presents a clear and imminent danger to the environment or to the safety and health of employees, subcontractors, visitors, or the public has the authority to initiate a stop-work action. The requirements, responsibilities, and basis for stop-work actions and for restarting activities is established in Laboratory Procedure (LP) 116-01.0. Any individual observing or performing operations that meet the criteria for stop-work actions shall follow the procedural steps as described in LP 116-01.0. Those with stop-work authority include employees, subcontractors, or visitors performing the affected work, ES&H discipline experts, and line managers responsible for the operation. Any other individual that observes work being performed by another individual that presents a clear and imminent danger shall follow reporting requirements as specified in LP 116-01.0. Upon initiation of stop-work actions, related activities are documented on the Stop-Work Report Form and the log for Stop-Work Reports.

Personnel conducting work for the ER Program shall comply with the Laboratory's stop-work policy and the requirements of LP 116-01.0. In addition, upon initiation of stop-work actions, ER Program personnel shall notify the SSO, the ER Program HSPL, and the OUPL.

2.1.1 Kick-Off Meeting

A health and safety kick-off meeting will be held before field work begins. The purpose of the meeting is to reach a consensus on responsibility, authority, lines of communication, and scheduling. The HSPL will organize the meeting and has the authority to delay field work until the kick-off meeting is held.

2.1.2 Readiness Review

A field readiness review must be completed by the OUPL before field activities begin. The HSPL is responsible for approving the health and safety section of the readiness review.

2.2 Individual Responsibilities

Laboratory employees and supplemental work force personnel are responsible for health and safety during ER Program activities. Figure III-1 illustrates the field work organizational chart, showing the line organization.

2.2.1 Environmental Management and Health and Safety Division Leaders

The Environmental Management (EM) and Health and Safety Division Leaders are responsible for addressing programmatic health and safety concerns. They shall promote a comprehensive health and safety program that includes radiation protection, occupational medicine, industrial safety, industrial hygiene, criticality safety, waste management, and environmental protection and preservation.

2.2.2 Environmental Restoration Program Manager

The ER Program Manager (EM-13) is responsible for implementing the overall heath and safety program plan. The program manager provides for the establishment, implementation, and support of health and safety measures.

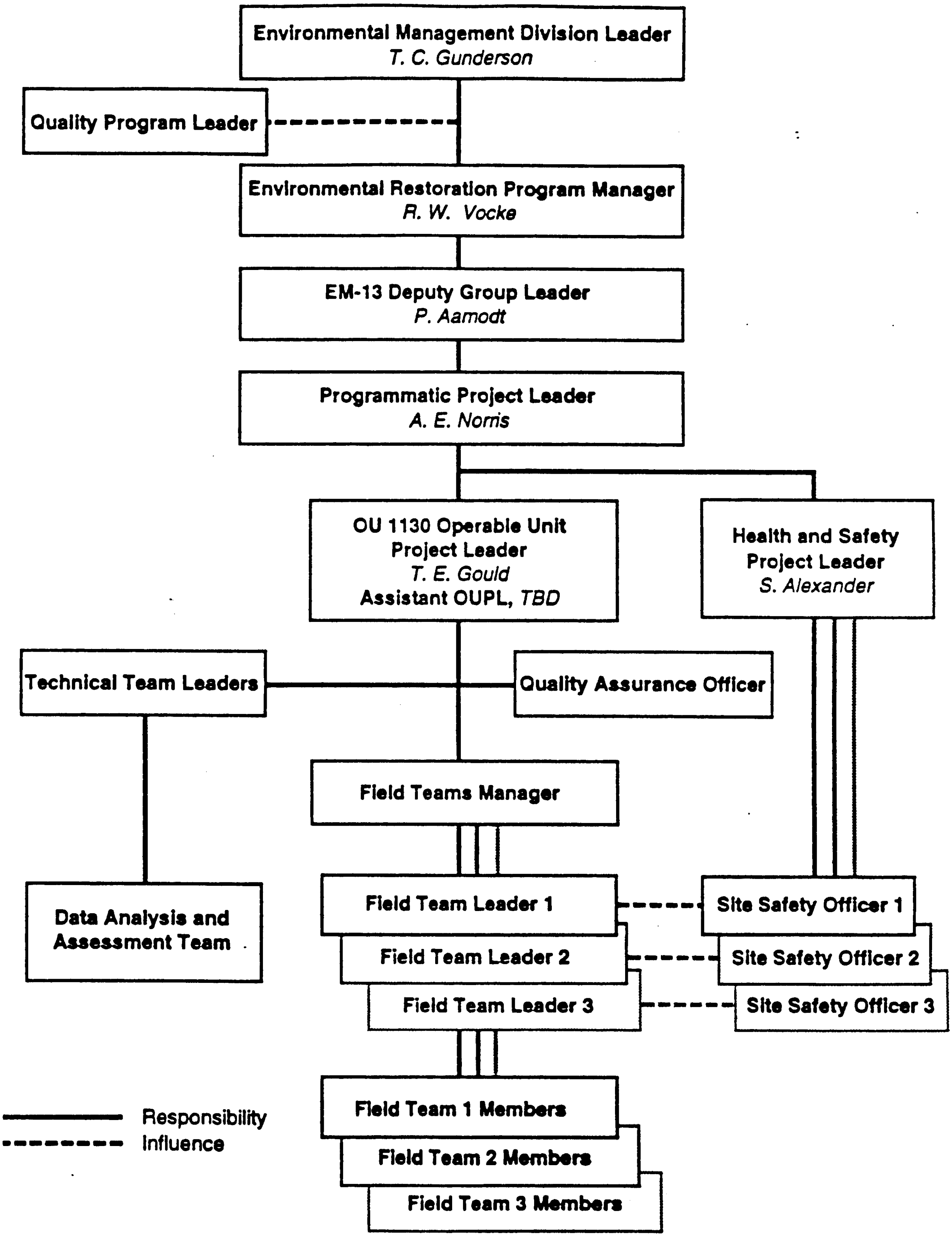


Figure III-1. OU field work organizational chart.

2.2.3 Health and Safety Project Leader

The HSPL is responsible for preparing and updating the IWPHSPP. The HSPL helps the OUPL in identifying resources to be used for the preparation and implementation of the OUHSP. Final approval of the IWPHSPP, OUHSP, and SSHSP is the responsibility of the HSPL. In conjunction with the field team leaders, the HSPL oversees daily health and safety activities in the field, including scheduling, tracking deliverables, and resource utilization.

2.2.4 Operable Unit Project Leader

The OUPL is responsible for all investigation activities for his/her assigned OU. Specific health and safety responsibilities include:

- preparing, reviewing, implementing, and revising OUHSPs;
- interfacing with the HSPL to resolve health and safety concerns; and
- notifying the HSPL of schedule and project changes.

2.2.5 Operable Unit Field Team Leader

The OU field team leader is responsible for:

- scheduling tasks and manpower,
- conducting site tours,
- overseeing engineering and construction activity at the sites, and
- overseeing waste management.

2.2.6 Field Team Leader

The field team leader is responsible for implementing the sampling and analysis plan, the OUHSP, and the project-specific Quality Assurance Project Plan (Annex II). He/she may also serve as the SSO. Safety responsibilities include:

- ensuring the health and safety of field team members,
- implementing emergency response procedures and fulfilling notification requirements, and
- notifying the HSPL of schedule changes.

2.2.7 Site Safety Officer

An SSO other than the field team leader may be assigned depending on the potential hazards. Contractors must assign their own SSO.

The SSO is responsible for ensuring that trained and competent personnel are on-site. This includes industrial hygiene and health physics technicians and first aid/cardiopulmonary resuscitation responders. The SSO may fill any or all of these roles.

The SSO has the following responsibilities:

- advising the HSPL and OUPL of health and safety issues;
- performing and documenting initial inspections for all site equipment;
- notifying proper Laboratory authorities of injuries or illnesses, emergencies, or stop-work orders;
- evaluating the analytical results for health and safety concerns;
- determining protective clothing (PC) requirements;
- determining personal dosimetry requirements for workers;
- maintaining a current list of telephone numbers for emergency situations;
- providing an operating radio transmitter/receiver if necessary;
- maintaining an up-to-date copy of the SSHSP for work at the site;
- establishing and enforcing the safety requirements to be followed by visitors;
- briefing visitors on health and safety issues;
- maintaining a logbook of workers entering the site;

- determining whether workers can perform their jobs safely under prevailing weather conditions;
- controlling emergency situations in collaboration with Laboratory personnel;
- ensuring that all personnel are trained in the appropriate safety procedures and are familiar with the SSHSP and that all requirements are followed during OU activities;
- conducting daily health and safety briefings for field team members;
- stopping work when unsafe conditions develop or an imminent hazard is perceived; and
- maintaining first aid supplies.

2.2.8 Field Team Members

Field team members are responsible for following safe work practices, notifying their supervisor or the SSO if unsafe conditions exist, and immediately reporting any injury, illness, or unusual event that could impact the health and safety of site personnel.

2.2.9 Visitors

Site access will be controlled so that only verified team members and previously approved visitors will be allowed in work areas or areas containing potentially hazardous materials or conditions. Special passes or badges may be issued. There are two types of visitors: those that collect samples and those who do not.

Any visitors who are on-site to collect samples or split samples must meet all the health and safety requirements of any field sampling team for that site. Visitors must comply with the provisions of the SSHSP and sign an acknowledgement agreement to that effect. In addition, visitors will be expected to comply with relevant OSHA requirements, such as medical monitoring, training, and respiratory protection.

The following rules govern the conduct of site visitors who will not be collecting samples. The site visitor will:

1. Report to the SSO upon arrival at the site.
2. Login/logout upon entry/exit to the site.
3. Receive abbreviated site training from the SSO on the following topics:
    - site-specific hazards,
    - site protocol,
    - emergency response actions, and
    - muster areas.
4. Not be permitted to enter the exclusion zone.
5. Receive escort from SSO or other trained individuals at all times.

If a visitor does not adhere to these requirements, the SSO will request the visitor to leave the site. All nonconformance incidents will be recorded on the site log.

2.2.10 Supplemental Work Force

All supplemental work force personnel performing site investigations will be responsible for developing health and safety plans that cover their specific project assignments. As a minimum, the plans shall conform to the requirements of this OUHSP. Deficiencies in health and safety plans will be resolved before the contractor is authorized to proceed.

Contractors will adhere to the requirements of all applicable health and safety plans. Laboratory personnel will monitor activities to ensure that this is done. Failure to adhere to these requirements can cause work to stop until compliance is achieved.

Contractors will provide their own health and safety functions unless other contractual agreements have been arranged. Such functions may include, but are not limited to, providing qualified health and safety officers for site work, imparting a corporate health and safety environment to their employees, providing calibrated industrial hygiene and radiological monitoring equipment, enrolling in an approved medical surveillance program, supplying approved respiratory and personal protective equipment (PPE), providing safe work practices, and training hazardous waste workers.

2.3 Personnel Qualifications

The HSPL will establish minimum training and competency requirements for on-site personnel. These requirements will meet or exceed 29 CFR 1910.120 regulations.

2.4 Health and Safety Oversight

Oversight will be maintained to ensure compliance with regulatory requirements. The Health and Safety Division is responsible for developing and implementing the oversight program. The frequency of field verifications will depend on the characteristics of the site, the equipment used, and the scope of work.

2.5 Off-Site Work

The HSPL and OUPL will review health and safety requirements and procedures for off-site work. Alternate approaches may be used if they are in the best interest of the public and the Laboratory; they will be handled on a case-by-case basis.

3.0 SCOPE OF WORK

3.1 Comprehensive Work Plan

The IWPHSPP for ER targets OU 1130 for investigation. The initial phase is investigation and characterization, involving environmental sampling and field assessment of the areas. This OUHSP addresses the tasks in the Phase I study. Tasks for additional phases will be addressed in revisions to this document.

3.2 Operable Unit Description

OU 1130 consists of 13 potential release site (PRS) aggregates. These include solid waste management units and areas of concern. Thorough descriptions and histories of these sites can be found in Section 5 of the Work Plan. The following is a list of the PRS aggregates for OU 1130. Table III-1 summarizes the aggregates, the potential hazards, and the work planned at this time.

1. SWMU 36-001 Material Disposal Area
2. SWMU 36-002 The Sump
3. SWMU 36-003(a) Septic System
4. SWMU 36-003(b) Septic System
5. SWMU 36-003(d) Septic System
6. SWMU 36-004(a) Eenie Firing Site
7. SWMU 36-004(b) Meenie Firing Site
8. SWMU 36-004(c) Minine Firing Site
9. SWMU 36-004(d) Firing Site
10. SWMU 36-004(e) I-J Firing Site
11. SWMU 36-005 The Boneyard
12. SWMU 36-006 Subsurface Disposal Area
13. SWMU 36-003

Table III-1. Summary of PRSs, OU 1130

Description	Tasks	Chemicals of concern	Radionuclides of concern
SWMU 36-001 Material Disposal Area	Subsurface soil sampling with drill rip and hand auger	High explosives, barium, lead, zinc, chromium, cadmium	Depleted uranium
SWMU 36-002 The Sump	Subsurface sampling, rock removal	High explosives, acetone, zinc chloride, acids, glues, heavy metals	Depleted uranium
SWMU 36-003(a) Septic System	Soil sampling, liquid sampling	Silver, thiosulfates, photo processing chemicals	Depleted uranium
SWMU 36-003(b) Septic System	No action planned	Not determined	Not determined
SWMU 36-003(d) Septic System	No action planned	Not determined	Not determined
SWMU 36-004(a) Eenie Firing Site	No action planned	High explosives, liquid explosives, heavy metals	Depleted uranium
SWMU 36-004(b) Meenie Firing Site	No action planned	High explosives, metals, liquid explosives	Depleted uranium
SWMU 36-004(c) Minine Firing Site	No action planned	High explosives, metals, liquid explosives	Depleted uranium
SWMU 36-004(d) Firing Site	No action planned	High explosives, beryllium, lead, copper, aluminum, steel, barium, plastics	Depleted uranium
SWMU 36-004(e) I-J Firing Site	No action planned	High explosives, beryllium, barium, mercury, other metals	Depleted uranium Plutonium
SWMU 36-005 The Boneyard	Soil sampling	High explosives, chromium, silver, zinc, beryllium, copper, lead	Depleted uranium
SWMU 36-006 Subsurface Disposal Area	No action planned	High explosives, barium, beryllium, lead, mercury, silver, zinc, copper	Depleted uranium
SWMU 36-003	No action planned	Not determined	Not determined

4.0 HAZARD IDENTIFICATION AND ASSESSMENT

The SSO or designee will monitor field conditions and personnel exposure to physical, chemical, biological, and radiological hazards. If a previously unidentified hazard is discovered, the SSO will contact the field team leader and the HSPL and assess the hazard. A hazard assessment will be performed to identify the potential harm, the likelihood of occurrence, and the measures to reduce risk. The assessment will be documented, reviewed, and approved by the HSPL and OUPL. Appropriate field team leaders and field team members will receive copies of the assessment, and it will be discussed in a tailgate meeting or other appropriate forum. The approved assessment will be added to this plan as an amendment.

4.1 Physical Hazards

Injuries caused by physical hazards are preventable. Some physical hazards such as open trenches, loud noise, and heavy lifting are easily recognized. Others, such as heat stress and sunburn, are less apparent. The purpose of this section is to list some anticipated physical hazards. These hazards are listed because they often occur during these types of ER activities. Some, such as altitude sickness, are more unique. For these unique physical hazards, a brief discussion is provided. For other, more common hazards, no detailed discussion is provided. Detailed information about these potential hazards can be found in Health and Safety Division HAZWOP Program documentation or almost any industrial hygiene reference book (e.g., *Fundamentals of Industrial Hygiene*, 1988).

Table III-2 lists some of the anticipated physical hazards representative of the types of hazards inherent to ER work. It is not inclusive. If additional physical hazards are identified, they will be added to this table by the SSO.

Table III-2. Physical hazards of concern, OU 1130

Hazard description	PPE	Prevention methods	Monitoring methods
Noise	Ear plugs and ear muffs	Engineering controls, mufflers, noise absorbers, PPE	Sound level meter, noise dosimeter
Vibration	Gloves	Prevention or attenuation, isolation, increase distance from source	Accelerometers and mechanoelectrical transducers with electronic instrumentation
Energized equipment	Gloves, safety shoes, safety glasses	Lockout/tagout of equipment	Circuit test light/meter, grounding stick
Confined space entry	Gloves, boots, full-body suit, supplied- air or SCBA, safety glasses	Ventilation, oxygen, and combustible gas monitoring	Combustible gas meter, oxygen monitors
Trenching	Hard hats, safety shoes, safety glasses	Protective shoring, proper excavation access, and egress	Visual, oxygen meter. Determine soil type
Fire/Explosion	Hard hat, gloves, face shield, fire-resistant full-body suit	Ventilation, containment of fuel source, isolation/ insulation from ignition source or heat	Combustible gas meter
Welding/ Cutting/ Brazing	Fire-resistant gloves and clothing (aprons, coveralls, leggings), welding helmets or welding goggles	Ventilation, PPE	Personal sampling for metal fumes
Compressed gas cylinders	Face shield, safety shoes, gloves	PPE. Cylinders should be stored in a areas protected from weather. Cylinders should be secured and stored with protective caps in place. Regulators are not to be used on cylinders.	Visual, combustible gas meter, HNu
Material handling	Hard hat, safety shoes, gloves	Use of lifting aids. Use of correct lifting procedure. Work/rest periods	Weigh or estimate weight of typical materials and set limits for lifting

Table III-2. (continued)

Hazard description	PPE	Prevention methods	Monitoring methods
Walking/ Working surfaces	Safety shoes	Keep surfaces clean and dry	Visual inspection
Machine guarding	Face shield, gloves, safety shoes	Provide interlocks on guards. Maintain guards in good condition	Visual monitoring by supervisor
Motor vehicle accidents	Seatbelt	Defensive driving training, reduce speed during adverse conditions	Visual
Heavy equipment accidents	Hard hat, safety shoes, gloves	Operator training. Stay clear of energized sources	
Heat stress	Hat, cooling vest	Follow ACGIH work/rest regimens	Wet bulb globe thermometer
Cold stress	Hat, gloves, insulated boots, coat, face protection	Follow ACGIH work/warm-up schedule, heated shelters	Thermometer and wind, speed measurement. Wind chill chart
Sunburn	Hat, safety sunglasses, full-body protection	Keep body covered with clothing or sunscreen	Solar load
Altitude sickness	None	Acclimatization ascent/descent schedule	Self monitoring for symptoms
Lightning	None	Grounding of all equipment. Stop work during thunderstorms and seek shelter	Weather reports and visual observation
Flash floods	None	Seek shelter on high ground	Weather reports and visual observation

4.1.1 Altitude Sickness

Individuals coming to the Laboratory from lower elevations may experience altitude sickness. Workers coming from sea level and who are expected to perform heavy physical labor may be at highest risk. Recognition of individual risk factors and allowance for acclimatization are the keys to prevention.

At higher altitude, atmospheric pressure is reduced. There are a smaller number of oxygen molecules per unit volume and the partial pressure of oxygen is lower. A unit of work, whether performed at altitude or sea level, requires the same amount of oxygen. Oxygen flow to body tissues must remain constant to maintain that level of work. Increased respiration and cardiovascular response can only partially compensate for these factors in individuals suddenly placed at high altitude.

The factors playing a part in determining working capacity at altitude are:

- actual height (low, moderate, high altitude)
- duration of exposure
- individual factors

The Laboratory's moderate altitude (approximately 7,500 feet) will probably have an effect on prolonged endurance for unacclimatized individuals. At this level, acclimatization should be rapid (one or two weeks). Duration of exposure will dictate whether persons have an opportunity to acclimate or not. Individuals working on short-term assignments of less than two weeks will probably not acclimate.

It is not anticipated that work will require ascents of more than 200 to 300 feet at any time. Thus, too rapid ascension to high altitudes should not be a problem. It is assumed that all workers will be enrolled in a medical surveillance program. This will help identify individuals who may have existing conditions, such as respiratory or cardiovascular disease, that would put them at higher risk of altitude sickness. Each individual will adapt at a slightly different rate, but in about two weeks the impact of altitude on work capacity should be minimal.

4.2 Chemical Hazards

This section identifies and provides information on chemical contaminants that are known or are suspected to be present at this OU. When unknowns are identified, they will be added to the plan's list of chemical contaminants of concern. The SSO will be responsible for adding chemicals to this table and notifying field personnel as needed.

The SSHSP will provide information for known contaminants, which will include: American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV), immediately dangerous to life and health concentrations, exposure symptoms, ionization potential and relative response factor for commonly used instruments (re-evaluated when the particular instrument is selected), and the best instrument for screening.

Table III-3 lists the chemical contaminants of concern. This table should be used for general recognition of the chemicals to which workers may be exposed. More detailed information should be obtained from reliable references, such as *Patty's Industrial Hygiene and Toxicology* (1981).

4.3 Radiological Hazards

The principal pathways by which individuals may be exposed to radioactivity during field investigations include:

- inhalation or ingestion of radionuclide particles or vapors,
- dermal absorption of radionuclide particulates or vapors through wounds,
- dermal absorption through intact skin, and
- exposure to direct gamma radiation from contaminated materials.

Table III-4 provides the specific properties of the radionuclides of concern in this OU, including type of emission and half-life. As concentrations of these radionuclides are determined and additional radionuclides identified, the table will be updated. The SSO will be responsible for adding radionuclides to this table and notifying field personnel as needed.

Table III-3. Chemical contaminants of concern[a]

Contaminant	Exposure limit	IDLH	Symptoms of exposure	Route(s) of exposure	1P(eV)	Monitoring instrument	Relative response
Aluminum	10 mg/m^3	N/A	Weakness, fatigue, respiratory distress	Inhalation, ingestion	N/A	Filter, ICP	N/A
Barium	0.5 mg/m^3	1100 mg/m^3	Gastroenteritis, muscular paralysis	Inhalation Ingestion	N/A	Filter, AA	N/A
Beryllium	0.002 mg/m^3	Ca	Dermatitis, pneumonitis dyspnea, chronic cough, weight loss, weakness, chest pain	Inhalation, ingestion, skin contact	N/A	Filter, ICP	N/A
Cadmium	0.05 mg/m^3	Ca	Pulmonary edema, dyspnea, cough, tight chest, chills, nausea, vomiting, muscle aches, diarrhea	Inhalation, ingestion	N/A	Filter, AA	N/A
Chromium	0.5 mg/m, 0.05 mg/m^3 (hexavalent compounds)	N/A Ca 30 mg/m^3	Fibrosis, dermatitis, perforation of nasal septum, respiratory system irritation	Inhalation, ingestion	N/A	Filter AA or IC	N/A
Copper	0.2 mg/m^3 (fume), 1.0 mg/m^3 (dust and mist)	N/A	Fever, chills, nausea, muscle aches, cough, weakness, eye irritation, dermatitis	Inhalation, ingestion, skin contact	N/A	Filter, AA	N/A
Lead	0.05 mg/m^3	700 mg/m^3	Weakness, insomnia, constipation, abdominal pain, tremor, anorexia	Inhalation, ingestion, skin contact	N/A	Filter, AA	N/A

Table III-3. (continued)

Contaminant	Exposure limit	IDLH	Symptoms of exposure	Route(s) of exposure	1P(eV)	Monitoring instrument	Relative response
Mercury	0.01 mg/m^3 (alkyl compounds), 0.05 mg/m^3 (all forms except alkyl vapor), 0.1 mg/m^3 (aryl and inorganic forms)	10 mg/m^3, 28 mg/m^3	Cough, chest pains, tremor, insomnia, weakness, excessive salivation, dizziness, nausea, vomiting, constipation	Inhalation, ingestion, skin contact	N/A	Jerome mercury monitor	N/A
Silver	0.1 mg/m^3 (metal), 0.01 mg/m^3 (soluble forms)	N/A	Throat and skin irritation, skin ulceration, gastrointestinal irritation. Blue-gray eyes and patches on skin.	Inhalation, ingestion, skin contact	N/A	Filter, ICP	N/A
Zinc	5 mg/m (fume), 10 mg/m^3 (dust)	N/A	Cough, chills, fever, tight chest, blurred vision, dyspnea, nausea, vomiting, cramps	Inhalation	N/A	Filter, X-ray diffraction	N/A
Zinc chloride	1 mg/m^3	4800 mg/m^3	Irritation of eyes, nose and throat; chest pain; dyspnea; cough; fever	Inhalation, skin contact	N/A	Filter, AA	N/A
Acetone	750 ppm	20,000 ppm	Irritation of eyes, nose, and throat; dermatitis; dizziness	Inhalation, ingestion, skin contact	6.3	PID	

[a] High explosives of concern will be added to this table.

AA = atomic absorption
Ca = potential human carcinogens
CP = capital project
IC = ion chromotography
ICP = inductively coupled plasma

IDLH = immediately dangerous to life and health
IP(eV) = ionization potential electron volts (eV)
N/A = not available
PID = photoionization detector

Table III-4. Radionuclides of concern

Radionuclide	Major radiation	DAC[1] (microCi/mL)	Radioactive half-life	Monitoring instrument
Plutonium-238	Alpha, gamma	3×10^{-12}	87.7 years	Alpha scintillometer, FIDLER
Plutonium-239	Alpha, gamma	2×10^{-12}	2.4×10^{4} years	Alpha scintillometer, FIDLER
Plutonium-240	Alpha, gamma	2×10^{-12}	6537 years	Alpha scintillometer, FIDLER
Tritium	Beta	2×10^{-5}	12.26 years	Liquid scintillation counter
Uranium-235	Alpha, gamma	2×10^{-11}	7×10^{8} years	Alpha scintillometer, FIDLER
Uranium-238	Alpha, gamma	2×10^{-11}	4.5×10^{9} years	Alpha scintillometer, FIDLER
Polonium-210	Alpha, gamma	3×10^{-10}	138.4 days	Alpha scintillometer

DAC = derived air concentration (DOE Order 5480.11)
FIDLER = field instrument for the detection of low-energy radiation

4.4 Biological Hazards

There are several biological hazards found at Los Alamos that are not common in other parts of the country. These include, but are not limited to: rattlesnakes, wild animals, ticks, plague, giardia lamblia, and black widow spiders. Table III-5 summarizes some of the potential biological hazards for this OU.

4.5 Task-by-Task Risk Analysis

A task-by-task risk analysis is required by 29 CFR 1910.120 and will be included with each SSHSP. This process analyzes the operations and activities for specific hazards by task. Examples of some of the tasks that should be analyzed and documented in the SSHSP are:

- drilling,
- hand augering,

- trenching,
- septic system sampling,
- canyon side sampling.

Other tasks should be considered for inclusion by the SSO.

Table III-5. Biological hazards of concern, OU 1130

Hazard description	PPE	Prevention methods
Snake bites (rattlesnake)	Long pants, snake leggings, boots	Wear PPE where footing is difficult to see. Avoid blind reaches
Animal bites (dog, cat, coyote, mountain lion)	Long pants, boots	Avoid wild or domestic animals; do not approach or attempt to feed
Ticks (may cause Lyme disease or tick fever)	Long pants, long sleeved shirts, boots	Perform tick inspections of team members after working in brushy or wooded areas
Rodents (prairie dogs and squirrels may carry plague infected fleas)	Long pants, boots	Do not handle live or dead rodents
Human sewage (may contain pathogenic bacteria)	Disposable coveralls and gloves	When sampling in septic systems, wear protective gear and dispose of properly. Wash hands thoroughly after contact
Bloodborne pathogens (blood, blood products, and human body fluids may contain Hepatitis B virus or HIV)	Latex gloves, mouthguards, protective eyewear	Only trained personnel should perform first aid procedures. Follow laboratory bloodborne pathogen control procedures
Poisonous plants (poison ivy)	Gloves, long pants, long-sleeved shirts, boots	Recognize plants, avoid contact, wash hands and garments thoroughly after contact
Waterborne infection agents (stream water may contain giardia)	None	Drink water only from potable sources
Spiders (brown recluse, black widow)	Gloves, long pants, long-sleeved shirt, boots	Use caution when in wood piles or dark, enclosed places

5.0 SITE CONTROL

5.1 Initial Site Reconnaissance

Initial site reconnaissance may involve surveyors, archaeologists, biological resource personnel, etc. Health and safety concerns that may be present must be addressed to protect personnel. The OUPL and HSPL will identify these concerns and institute measures to protect environmental impact assessment personnel.

5.2 Site-Specific Health and Safety Plans

Each field event within an OU requires an SSHSP. Planning, special training, supervision, protective measures, and oversight needs are different for each event, and the SSHSP addresses this variability.

The OUHSP provides detailed information to project managers, Laboratory managers, regulators, and health and safety professionals about health and safety programs and procedures as they relate to an OU. The SSHSP addresses the safety and health hazards of each phase of site operations and includes requirements and procedures for employee protection. All SSHSPs in that OU derive from the OUHSP.

The standard outline for an SSHSP follows OSHA requirements and serves as a guide for best management practice. Those performing the field work are responsible for completing the plan.

Changes to the SSHSP must be made in writing. The HSPL shall approve changes, and site personnel shall be updated through daily tailgate meetings. Records of SSHSP approvals and changes will be maintained by the SSO.

5.3 Work Zones

Maps identifying work zones will be included with each SSHSP. Markings used to designate each zone boundary (red or yellow tape, fences, barricades, etc.) will be discussed in the plan. Evacuation routes should be upwind or crosswind of the exclusion zone. A muster area must be designated for each evacuation route. Discrete zones are not required for every field event. The SSO will determine work zones. The following sections discuss the work zones.

- **Exclusion zone**. The exclusion zone is the area where contamination is either known or likely to be present or, because of work activities, will present a potential hazard to personnel. Entry into the exclusion zone requires the use of PPE.
- **Decontamination zone**. The decontamination zone is the area where personnel conduct personal and equipment decontamination. This zone provides a buffer between contaminated areas and clean areas. Activities in the decontamination zone require the use of PPE as defined in the decontamination plan.
- **Support zone**. The support zone is a clean area where the chance to contact hazardous materials or conditions is minimal. PPE other than safety equipment appropriate to the tasks performed (e.g., safety glasses, protective footwear, etc.) is not required.

5.4 Secured Areas

Secured areas shall be identified and shown on the site maps. Procedures and responsibilities for maintaining secured areas must be described. Standard Laboratory security procedures should be followed for accessing secure areas.

All contractors and visitors must be processed through the badge office before entering secure areas. It is the responsibility of the OUPL to see that contractor personnel have badges. It is the responsibility of all Laboratory employees to enforce security measures.

5.5 Communications Systems

Portable telephones, CB radios, and two-way radios may be used for on-site communications. This type of equipment must not be used in areas where there may be high explosives; hand signals and verbal communications should be used in these areas.

5.6 General Safe Work Practices

Workers will be instructed on safe work practices to be followed when performing tasks and operating equipment needed to complete the project. Daily safety tailgate meetings will be conducted at the beginning of the shift to brief workers on proposed activities and special precautions to be taken.

The following items are requirements necessary to protect field workers and will be reiterated in SSHSPs. Depending on site-specific conditions, items may be added or deleted.

- The buddy system will be used. Hand signals will be established and used.
- During site operations, each worker should be a safety backup to his/her partner. All personnel should be aware of dangerous situations that may develop.
- Visual contact must be maintained between buddies on-site.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of potentially contaminated material is prohibited in any area designated as contaminated.
- Prescription drugs should not be taken by personnel where the potential for contact with toxic substances exist, unless specifically approved by a qualified physical.
- Alcoholic beverage intake is prohibited during the work day.

- Disposable clothing will be used whenever possible to minimize the risk of cross-contamination.
- The number of personnel and equipment in any contaminated area should be minimized, but effective site operations must be allowed for.
- Staging areas for various operational activities (equipment testing, decontamination, etc.) will be established.
- Motorized equipment will be inspected to ensure that brakes, hoists, cables, and other mechanical components are operating properly.
- Procedures for leaving any contaminated area will be planned and reviewed before entering these areas.
- Work areas and decontamination procedures will be established based on prevailing site conditions and will be subject to change.
- Wind direction indicators will be strategically located on-site.
- Contact with contaminated or potentially contaminated surfaces should be avoided. Whenever possible, do not walk through puddles, mud, or discolored ground surface; do not kneel on the ground or lean, sit, or place equipment on drums, containers, vehicles, or on the ground.
- No personnel will be allowed to enter the site without proper safety equipment.
- Proper decontamination procedures will be followed before leaving the site, except in medical emergencies.
- Any medical emergency supersedes routine safety requirements.
- Housekeeping will be emphasized to prevent injury from tripping, falling objects, and accumulation of combustible materials.
- All personnel must comply with established safety procedures. Any staff member or visitor who does not comply with safety policy, as established by the Field Safety Coordinator, will be immediately dismissed from the site.

5.7 Specific Safe-Work Practices

5.7.1 Electrical Safety-Related Work Practices

The most effective way to avoid accidental contact with electricity is to de-energize the system or maintain a safe distance from the energized parts/line. OSHA regulations require minimum distances from energized parts. An individual working near power lines must maintain at least a 10 foot clearance from overhead lines of 50 kilovolts (kV) or less. The clearance includes any conductive material the individual may be using. For voltages over 50 kV, the 10 foot clearance must be increased 4 inches for every 10 kV over 50 kV.

5.7.2 Grounding

Grounding is a secondary form of protection that ensures a path of low resistance to ground if there is an electrical equipment failure. A properly installed ground wire becomes the path for electrical current if the equipment malfunctions. Without proper grounding, an individual could become the path to ground if he/she touches the equipment. An assured electrical grounding program or ground fault circuit interrupters is required.

5.7.3 Lockout/Tagout

All site workers follow a standard operating procedure for control of hazardous energy sources [Laboratory Administrative Requirement (AR) 8-6, LP 106-01.1]. Lockout/tagout procedures are used to control hazardous energy sources, such as electricity, potential energy, thermal energy, chemical corrosivity, chemical toxicity, or hydraulic and pneumatic pressure.

5.7.4 Confined Space

Entry and work to be conducted in confined spaces shall adhere to procedures proposed in the Laboratory Confined Space Entry Program. These procedures require that a Confined Space Entry Permit be obtained and posted at the work site. Prior to entry, the atmosphere shall be tested for oxygen content, flammable vapors, carbon monoxide, and other hazardous gases. Continuous monitoring for these constituents shall be performed if conditions or activities have the potential to adversely affect the atmosphere.

5.7.5 Handling Drums and Containers

Drums and containers used during clean up shall meet U.S. Department of Transportation, OSHA, and EPA regulations. Work practices, labeling requirements, spill containment measures, and precautions for opening drums and containers shall be in accordance with 29 CFR 1910.120. Drums and containers that contain radioactive material must also be labeled in accordance with AR 3-5, Shipment of Radioactive Materials; AR 3-7, Radiation Exposure Control; and Article 412, Radioactive Material Laboratory, DOE Radiological Control Manual. Provisions for these activities shall be clearly outlined in the SSHSP, if applicable.

5.7.6 Illumination

Illumination shall meet the requirements of Table H-120.1, 29 CFR 1910.120. Table III-6 lists OSHA-required illumination levels.

5.7.7 Sanitation

An adequate supply of potable water shall be provided at the site. Nonpotable water sources shall be clearly marked as not suitable for drinking, washing, or washing purposes. There shall be no cross-connections between potable and nonpotable water systems.

At remote sites, at least one toilet facility shall be provided, unless the crew is mobile and has transportation readily available to nearby toilet facilities.

Adequate washing facilities shall be provided when personnel are potentially exposed to hazardous substances. Washing facilities shall be in areas where exposures to hazardous materials are below permissible exposure limits

Table III-6. Illumination levels

Foot-candles	Area or operations
5	General site areas
3	Excavation and waste areas, accessways, active storage areas, loading platforms, refueling, and field maintenance areas
5	Indoors: warehouses, corridors, hallways, and exitways
5	Tunnels, shafts, and general underground work areas. (Exception: a minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines-approved cap lights shall be acceptable for use in the tunnel heading.)
10	General shops (e.g., mechanical and electrical equipment rooms, active storerooms, barracks or living quarters, locker or dressing rooms, dining areas, and indoor toilets and workrooms)
30	First aid stations, infirmaries, and offices

(PELs) and where employees may decontaminate themselves before entering clean areas. When showers and change rooms are required, they shall be provided and meet the requirements of 29 CFR 1910.141. In this instance, employees shall be required to shower when leaving the decontamination zone.

5.7.8 Packaging and Transport

The OUPL should contact HS-7 to determine requirements for storing and transporting hazardous waste to ensure that practices for storage, packaging, and transportation comply with ARs 10-2 and 10-3. Disposal of hazardous wastes generated from a project will be handled by HS-7.

5.7.9 Government Vehicle Use

Only government vehicles can be driven onto contaminated sites. No personal vehicles are allowed. All personnel must wear a seat belt when in a moving vehicle, whether it is government or personally owned.

5.7.10 Extended Work Schedules

Scheduled work outside normal work hours must have the prior approval of the OUPL and SSO.

5.8 Permits

5.8.1 Excavation Permits

Any excavation at OU sites must be conducted in accordance with Laboratory AR 1-12, Excavation or Fill Permit Review. Field team leaders will be responsible for determining when excavation permits are required. The OUPL and field team leader are responsible for requesting the excavation permit (Form 70-10-00.1) from the support services contractor. At the top of the form, indicate that this is an ER Program activity. The permit is reviewed by Health and Safety and EM Divisions for environmental safety and health concerns.

5.8.2 Other Permits

The following permits may be required for field activities. The SSO and OUPL are responsible for obtaining permits and maintaining documentation. Permits are specifically addressed in the SSHSP.

- Radiation Work Permits
- Special Work Permit for Spark/Flame-Producing Operations
- Confined Space Entry
- Lockout/Tagout

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 General Requirements

PPE shall be selected, provided, and used in accordance with the requirements of this section.

If engineering controls and work practices do not provide adequate protection against hazards, PPE may be required. Use of PPE is required by OSHA regulations in 29 CFR Part 1910 Subpart I (see Table III-7). These regulations are reinforced by EPA regulation 40 CFR Part 300, which requires private contractors working on Superfund sites to conform to applicable OSHA provisions and any other federal or state safety requirements deemed necessary by the lead agency overseeing the activities.

Table III-7. OSHA standards for PPE use

Type of protection	Regulation
General	29 CFR Part 1910.132 29 CFR Part 1910.1000 29 CFR Part 1910.1001-1045
Eye and face	29 CFR Part 1910.133(a)
Hearing	29 CFR Part 1910.95
Respiratory	29 CFR Part 1910.134
Head	29 CFR Part 1910.135
Foot	29 CFR Part 1910.136
Electrical protective devices	29 CFR Part 1910.137

In addition, the use of PPE for radiological protection shall be governed by the Radiation Work Permit (or Safety Work Permits/Radiation Work). AR 3-7 and Article 325, Article 461, Table III-1, and Appendix 3C of the DOE Radiological Control Manual contain guidelines for the use of PC during radiological operations. Efforts should be made to keep disposable PPE used exclusively for radiological work from becoming contaminated with hazardous chemicals, which would generate mixed waste unnecessarily. In sites where both types of contaminants are present, this may not be possible.

6.1.1 PPE Program Elements

PPE programs protect workers from health and safety hazards and prevent injuries as a result of incorrect use and/or malfunction of PPE. Hazard identification, medical monitoring, training, environmental surveillance, selection criteria, use, maintenance, and decontamination of PPE are the essential program elements.

6.1.2 Medical Certification

Medical approval may be required before donning certain PPE. See Section 9 for more details.

6.2 Levels of PPE

The individual components of clothing and equipment must be assembled into a full protective ensemble that protects the worker from site-specific hazards and minimizes the hazards and disadvantages of the PPE. Attachment A lists ensemble components based on the widely used EPA Levels of Protection: Levels A, B, C, and D. These lists can be used as a starting point for ensemble creation; however, each ensemble must be tailored to the specific situation in order to provide the most appropriate level of protection.

The type of equipment used and the overall level of protection should be re-evaluated periodically as information about the site increases and as workers are required to perform different tasks. Personnel should be able to upgrade or downgrade their level of chemical protection with the concurrence of the SSO. The level of radiological PPE may only be changed as specified in the Radiation Work Permits (or Safety Work Permits/Radiation Work). The following are reasons to upgrade:

- known or suspected presence of dermal hazards,
- occurrence or likely occurrence of gas or vapor emission,

- change in work task that will increase contact or potential contact with hazardous materials, or
- request of the individual performing the task.

The following are reasons to downgrade:

- new information indicating that the situation is less hazardous than was originally thought,
- change in site conditions that decreases the hazard, or
- change in work task that will reduce contact with hazardous materials.

6.3 Selection, Use, and Limitations

Selection of PPE for a particular activity will be based on an evaluation of the hazards anticipated or previously detected at a work site. The equipment selected will provide protection from chemical and/or radiological materials contamination that is known or suspected to be present and that exhibits any potential for worker exposure.

6.3.1 Chemical Protective Clothing

The selection of chemical PC shall be based on an evaluation of the performance characteristics of the clothing relative to the requirements and limitations of the site, the task-specific conditions and duration, and the potential hazards identified at the site.

6.3.2 Radiological Protective Clothing

Radiological PC as prescribed by the Radiological Work Permit should be selected based on the contamination level in the work area, the anticipated work activity, worker health considerations, and regard for nonradiological hazards that may be present. A full set of radiological PC includes coveralls, cotton glove liners, gloves, shoe covers, rubber overshoes, and a hood. A double set of PC includes two pairs of coveralls, cotton glove liners, two pairs of gloves, two pairs of shoe covers, rubber overshoes, and a hood. The following practices apply to radiological PC:

1. Cotton glove liners may be worn inside standard gloves for comfort but should not be worn alone or considered a layer of protection.
2. Shoe covers and gloves should be sufficiently durable for the intended use. Leather or canvas work gloves should be worn in lieu of or in addition to standard gloves for work activities requiring additional strength or abrasion resistance.
3. Use of hard hats in contamination areas should be controlled by the Radiological Work Permit. Hard hats designated for use in such areas should be distinctly colored or marked.

Table III-8 provides general guidelines for selection.

Table III-8. Guidelines for selecting radiological protective clothing

Work activity	Removable contamination levels		
	Low (1 to 10 times Table III-10 values)	Moderate (10 to 100 times Table III-10 values)	High (>100 times Table III-10 values)
Routine	Full set of PC	Full set of PC	Full sets of PC, double gloves, double shoe covers
Heavy work	Full set of PC, work gloves	Double set of PC, work gloves	Double set of PC, work gloves
Work with pressurized or large volume liquids, closed system breach	Full set of non-permeable PC	Double set of PC (outer set nonpermeable), rubber boots	Double set of PC and nonpermeable outer clothing, rubber boots

6.3.3 Protective Equipment

Protective equipment, including protective eyewear and shoes, head gear, hearing protection, splash protection, lifelines, and safety harnesses, must meet American National Standards Institute standards.

6.4 Respiratory Protection Program

When engineering controls cannot maintain airborne contaminants at acceptable levels, appropriate respiratory protective measures shall be instituted. The Health and Safety Division administers the respiratory protection program, which defines respiratory protection requirements; verifies that personnel have met the criteria for training, medical surveillance, and fit testing; and maintains the appropriate records.

All supplemental workers shall submit documentation of participation in an acceptable respiratory protection program to the Industrial Hygiene Group (HS-5) for review and signature approval before using respirators on-site.

7.0 HAZARD CONTROLS

7.1 Engineering Controls

OSHA regulations state that when possible engineering controls should be used as the first line of defense for protecting workers from hazards. Engineering controls are mechanical means for reducing hazards to workers, such as guarding moving parts on machinery and tools or using ventilation during confined space entry.

7.1.1 Engineering Controls for Airborne Dust

Airborne dust can be a hazard when it is a nuisance or when radionuclides and/or hazardous substances attach to soil particles.

During drilling or any other activity where localized dust is being generated, a sprayer containing water or water amended with surfactants may be used to wet the soil and suppress the dust. Spraying must be repeated often to maintain moist soil.

A windscreen may be effective in reducing dust from relatively small earth-moving operations. In extreme cases, a temporary enclosure can be constructed to control dust. This method is the more expensive and may increase the level of PPE required for workers (in the enclosure).

Where there are high winds in an area of little or no vegetation or a large, dusty area, small quantities of water are not effective. In these instances, a water truck may be used to wet the area to suppress the dust. This may require frequent spraying to be effective. Other materials may also be considered for dust suppression. The amount of water applied needs to be carefully controlled so that enough is used to be effective without spreading contamination by runoff or as mud tracked off-site on vehicle tires. Positive air pressure cabs are an effective method for controlling equipment operator dust exposure.

7.1.2 Engineering Controls for Airborne Volatiles

Drilling, trenching, and soil and tank sampling activities may produce gases, fumes, or mists that may be inhaled or ingested by workers without protection. Engineering controls may be implemented to reduce exposure to these hazards. Natural ventilation (wind) can be an effective control measure; workers should be located upwind of the activity whenever possible.

Mechanical ventilation is desirable in closed or confined spaces. The fan or blower may be attached to a large hose to push or pull the contaminant from the confined space. Pulling the air from the space is more effective at removing the vapors, whereas forcing air into the confined area ensures acceptable oxygen levels from ambient air..

7.1.3 Engineering Controls for Noise

Drilling and trenching are likely to produce high noise levels. On most rigs, the highest noise levels are encountered on the side of the rig because the front and rear of the rig's engine is covered, whereas the sides are left open to cool the engine. Additional barriers may be constructed to reduce high noise levels on the sides of the rig. Insulated cabs usually reduce noise to an acceptable level for equipment operators.

7.1.4 Engineering Controls for Trenching

Entry into an excavation deeper than 5 feet should be avoided if possible. However, it is sometimes necessary to enter trenches to obtain needed information. OSHA regulations for trenches and excavations require engineering controls to prevent cave-ins. These controls include the use of shoring, sloping, and benching.

Benching is a series of steps dug around the excavation at a specified angle of repose determined by the soil type. Benching will normally be found in large excavations. Sloping is a similar system of stabilizing soil but is performed without the steps. Again, the angle of repose is determined by the soil type.

This method is generally used for medium-sized excavations, such as tank removal. Shoring is available in many different varieties, but the principle theory is the same. The sides of the excavation are supported by some type of wall that is braced to prevent cave-ins. This method is used most often in deep, narrow trenches for installing water pipe or drainage systems and exploratory trenching. Engineering controls for excavations should be approved by a competent person before entering the excavation.

7.1.5 Engineering Controls for Drilling

Working with and around drilling rigs presents workers with a number of hazards from moving parts and hazardous energy associated with the equipment. Engineering controls include guards to prevent crushing injuries and a maintenance program to ensure replacement of worn or broken parts. Inspections should be performed at the beginning of the job and periodically during the project.

7.2 Administrative Controls

Administrative controls are necessary when hazards are present and engineering controls are not feasible. Administrative controls are a method for controlling the degree of exposure (e.g., how long or how close to the hazard the worker remains). Worker rotation shall not be used to achieve compliance with PELs or dose limits.

7.2.1 Administrative Controls for Airborne Chemical and Radiological Hazards

Personnel should only enter the exclusion zone when required. Chemical and radiological hazards are to be monitored during performance of duties in the exclusion zone. If the concentration of radionuclides or toxic materials exceeds acceptable limits, personnel should be removed from the area until natural or mechanical ventilation reduces concentrations to an acceptable level.

7.2.2 Administrative Controls for Noise

Another approach to noise exposure control, besides engineering measures, is the use of administrative controls. This is often thought of as the rotation of workers between noisy jobs and less noisy jobs. This is not a good health practice because, while it may reduce the amount of hearing loss individuals incur, it spreads the risk among other workers. The final result tends to be that many workers develop small hearing losses rather than a few workers developing greater loss. One control than can partially mitigate the problem is to provide workers with rest and lunch areas that are quiet enough to allow some recovery from temporary threshold shifts. The levels in these areas should not exceed 70 decibels. Workers should also be located as far from loud noise sources as practicable. This allows for noise attenuation before it reaches the individual. Finally, duration of exposure should be limited to the minimum time. Under no circumstances should workers be exposed to noise levels in excess of the time limits specified in 29 CFR 1910.95, Occupational Noise Exposure, Table G-16.

7.2.3 Administrative Controls for Trenching

Trenches less than 5 foot deep do not require protective systems (sloping, benching, or shoring). All trenches should be excavated to a depth of less than 5 feet if possible. However, monitoring inside the trench and means of egress (every 25 feet) must be implemented when the trench reaches a depth of 4 feet. Soil piles, tools, and other debris must be stored at least 2 feet from the edge of the excavation. Inspections should be made by a competent person before any field team member is allowed to enter the excavation. When the area is not occupied, all excavations must be marked to restrict access.

7.2.4 Administrative Controls for Working Near the Mesa Edge

Slip, trip, and fall hazards exist around the mesa edge. These hazards may be avoided by good housekeeping in the work area near the edge of the mesa. Additionally, personnel shall remain 5 feet from the edge. If necessary, ropes or guards will be used to delineate this restricted area. Exceptions to this requirement are for canyon-side sampling and outfall sampling. In those instances, the worker taking the sample must be tied to a lifeline before descending over the edge. When working with a lifeline, an attendant must always be present.

8.0 SITE MONITORING

This section describes the requirements for chemical, physical, and radiological agent monitoring. This does not include biological monitoring, which is covered in Sections 9 and 10. This information will be used to delineate work zone boundaries, identify appropriate engineering controls, select the appropriate level of PPE, ensure the effectiveness of decontamination procedures, and protect public health and safety.

A monitoring program or plan that meets the requirements of 29 CFR 1910.120 will be implemented for each OU. Laboratory-approved sampling, analytical, and recordkeeping methods must be used. A detailed monitoring strategy will be incorporated into each SSHSP. The strategy will describe the frequency, duration, and type of samples to be collected.

If exposures exceed acceptable limits, the ER Program Manager and HSPL will be notified. An investigation of the source, exposures to personnel working in the OU and in adjoining areas, any bioassay or other medical evaluations needed, and an assessment of environmental impacts shall be initiated as soon as possible under the guidance of the Health and Safety Division.

Contractors will be responsible for providing their own monitoring equipment and for determining their employees' occupational exposures to hazardous chemical and physical agents during activities performed at the OU. The Laboratory will perform oversight duties during these activities.

8.1 Chemical Air Contaminants

DOE has adopted OSHA PELs and ACGIH TLVs as standards for defining acceptable levels of exposure. The more stringent of the two limits applies.

8.1.1 Measurement

Measurements of chemical contaminants can be performed using direct or indirect sampling methods. Direct methods provide near real-time results and are often used as screening tools to determine levels of PPE, the need for additional sampling, etc. Examples of direct-reading instruments include the HNu photoionization detector, the organic vapor analyzer with flame ionization detector, and a gas detector pump with colorimetric tubes. Generally, these instruments are portable, easy to operate, and durable. They are less specific and sensitive than many indirect methods.

Indirect sampling means that a sample is collected in the field and transported to a laboratory for analysis. This usually involves setting up a sampling train consisting of a portable sampling pump, tubing, and sampling media (cassette, sorbent tube, impinger, etc.). The advantage of the indirect method is greater specificity and sensitivity than many direct-reading instruments. The disadvantage is the longer turnaround time for results and the inconvenience.

Air sampling for chemical contaminants at this OU will use both direct and indirect methods. It will be up to the SSO to determine the most appropriate sampling method for each situation. If there are any questions about sampling methodology, the SSO should consult with the HSPL or a certified industrial hygienist.

8.1.2 Personal Monitoring

The site history should be used to determine the need for monitoring for specific chemical agents. Instruments that monitor for a wide range of chemicals, such as the organic vapor analyzer, combustible gas indicator, and HNu, may be used for screening purposes.

Initial air monitoring shall be performed to characterize the exposure levels at the site and to determine the appropriate level of personal protection needed. In addition, periodic monitoring is required when:

- work is initiated in a different part of the site,
- unanticipated contaminants are identified,

- a different type of operation is initiated (i.e., soil boring versus drum opening), or
- spills or leakage of containers is discovered.

Instrument readings should be taken in or near the worker's breathing zone. Individuals working closest to the source have the greatest potential for exposure to concentrations above acceptable limits. Monitoring strategies will emphasize worst-case conditions if monitoring each individual is inappropriate.

8.1.3 Perimeter Monitoring

Perimeter monitoring shall be performed to characterize airborne concentrations in adjoining areas. If results indicate that contaminants are moving off-site, control measures must be re-evaluated. The perimeter is defined as the boundary of the OU site.

8.2 Physical Hazards

Physical hazards of concern that can be readily measured include noise, vibration, and temperature. These variables must be monitored to prevent injuries and illnesses related to overexposure.

8.2.1 Measurement

Most of the instruments used to measure these agents are direct reading. Many have the ability to take short-term measurements and/or integrated, longer term measurements. Typically, short-term measurements are made during an initial survey. The results can then be used to determine whether longer term (i.e., full shift) monitoring is warranted.

8.2.2 Personal Monitoring

Noise dosimeters are used to estimate the actual exposure or dose that a worker receives during the shift. Results of personal noise monitoring should be compared to the ACGIH TLVs in accordance with Laboratory policy.

These results dictate whether workers must be included in a hearing conservation program.

Instrumentation is now available for personal monitoring for heat stress. This type of measurement is not mandated but can provide useful exposure information. Use of personal heat stress monitors must be approved by the HSPL prior to field use.

Personal monitoring for vibration and cold stress is generally not performed or warranted for this type of operation.

8.2.3 Area Monitoring

A sound level survey meter should be used to initially characterize sound pressure levels. These data can help guide the personal monitoring efforts. If the sound level survey and personal dosimetry indicate that sound levels exceed acceptable levels, then an octave band analyzer may be used to characterize the noise. This provides important data for designing engineering controls.

Area monitoring for temperature extremes are usually sufficient for determining whether workers are potentially exposed to harmful conditions. Thermometers, psychrometers, and anemometers are direct-reading instruments that provide the data necessary to make heat and cold stress calculations.

Accelerometers can be used to monitor vibration levels. Vibration is usually an isolated problem and does not warrant an ongoing monitoring program. Rather, the SSO should be alert for equipment and tasks that might expose workers to significant whole-body or hand and arm vibration. Typically, these include operation of dozers, scrapers, and other heavy equipment and power hand tools, such as impact wrenches and concrete breakers.

8.3 Radiological Hazards

When radiological hazards are known or suspected, workplace monitoring shall be performed as necessary to ensure that exposures are within the requirements of DOE Order 4380.11 and are as low as reasonably achievable (ALARA). Workplace monitoring consists of monitoring for airborne radioactivity, external radiation fields, and surface contamination. The Laboratory's workplace monitoring program is described in AR 3-7, Radiation Exposure Control. The success of the monitoring program in controlling exposures is measured by the personnel dosimetry and bioassay programs. Chapter 3, Part 7, of the DOE Radiological Control Manual provides additional guidelines for radiological control during construction and restoration projects. All monitoring instruments shall meet the Laboratory's requirements for sensitivity, calibration, and quality assurance. In addition, all monitoring shall be carried out in accordance with approved procedures.

8.3.1 Airborne Radioactivity Monitoring

Air monitoring shall be performed in occupied areas with the potential for airborne radioactivity. Air monitoring may include the use of portable high and low volume samplers, continuous air monitors, and personnel breathing zone samplers. In areas where concentrations are likely to exceed 10% of any derived air concentration listed in DOE Order 5480.11, real-time continuous air monitoring shall be provided. Action levels based on air monitoring results shall be established to increase dust suppression activities, upgrade PPE, and stop work.

8.3.2 Area Monitoring for External Radiation Fields

Area monitoring for external radiation fields shall be performed with portable survey instruments capable of measuring a wide range of beta/gamma dose rates. In areas where dose rates above a preset action level are expected, the monitoring should be continuous. Additional action levels shall be established based on external radiation monitoring results.

8.3.3 Monitoring for Surface Contamination

Area monitoring for surface contamination during operations shall be conducted whenever a new surface is uncovered in a suspected radioactively contaminated area (i.e., the levels may exceed the surface contamination limits in DOE Order 4380.11). Personnel and equipment shall be monitored whenever there is reason to suspect contamination and upon exit from a suspected radioactively contaminated area. Action levels for decontamination shall be established.

8.3.4 Personnel Monitoring for External Exposure

Personnel dosimetry shall be provided to OU workers who have the potential in a year to exceed any one of the following from external sources in accordance with DOE Order 5480.11:

- 100 mrem (0.001 sievert) annual effective dose equivalent to the whole body,
- 5 rem (0.05 sievert) annual dose equivalent to the skin,
- 5 rem (0.05 sievert) annual dose equivalent to any extremity, or
- 1.5 rem (0.015 sievert) annual dose equivalent to the lens of the eye.

Normally, workers meeting the above criteria will be monitored with thermoluminescent dosimeters (TLDs). TLDs shall either be provided by the Laboratory or shall meet DOE requirements if provided by the subcontractor. Section 10 (Bioassay Program) discusses personnel monitoring for internal exposure.

8.3.5 ALARA Program

ALARA considerations in the workplace are best served by near real-time knowledge of personnel exposures and frequent workplace monitoring to establish adequate administrative control of exposure conditions.

Consequently, for the OU site projects, ALARA efforts consist of two integrated approaches, which are described in the following sections.

8.3.5.1 Workplace ALARA Efforts

Judicious application of basic time, distance, physical controls, and PPE principles will be used to limit exposures to ALARA levels. To verify that established control is adequate, workplace monitoring for radioactive materials and field instrument detectable chemicals will be conducted in direct proportion to expected and/or observed levels of exposure. Activities that result in unexpectedly high potential exposures will be terminated until provisions are made that permit work to proceed in acceptable ALARA fashion.

8.3.5.2 Programmatic ALARA Efforts

External and internal exposures of record are comprised of TLD badges and bioassay data, respectively. Field dose calculation, direct-reading pocket meters, and event-based lapel air sampling data are used to maintain estimates of personnel exposures to both radioactive materials and hazardous chemicals. These estimates are correlated with job-specific activities (work location and work category) and individual-specific activities (job function).

Periodic reviews of personnel exposure estimates are conducted to identify unfavorable trends and unexpectedly high potential exposures. Activities (as functions of work location, work categories, and job functions) that indicate unfavorable trends will be investigated, and recommendations will be made for additional administrative and/or physical controls, as appropriate.

All unfavorable trends and unexpectedly high potential exposures must be reported to the HSPL, who will make recommendations for corrective action.

9.0 MEDICAL SURVEILLANCE AND MONITORING

9.1 General Requirements

A medical surveillance program shall be instituted to assess and monitor the health and fitness of workers engaged in hazardous waste operations. Medical surveillance is required for personnel who are or may be exposed to hazardous substances at or above established PELs for 30 days in a 12-month period, as detailed in 29 CFR 1910.120. Medical surveillance is also required for personnel with duties that require the use of respirators or with symptoms indicating possible overexposure to hazardous substances.

Contractors are responsible for medical surveillance of their employees. The Health and Safety Division will audit contractor programs.

9.2 Medical Surveillance Program

All field team members who participate in ER Program investigations shall participate in a medical surveillance program. The program shall conform to DOE Order 5480.10, 29 CFR 1910.120, AR 2-1, and any criteria established by the Occupational Medicine Group (HS-2) at the Laboratory. The program shall provide for initial medical evaluations to determine fitness for duty and subsequent medical surveillance of individuals engaged in hazardous waste operations. As a minimum, the program shall include:

- **Surveillance.** An occupational and medical history, a baseline exam prior to employment, periodic medical exams, and termination exams shall be included. The frequency of medical exams may vary because of the exposure potential at hazardous waste sites. The frequency of exams will be determined by the physician.
- **Treatment.** Immediate consultation shall be made available to any employee who develops signs or symptoms of exposure or who has been exposed at or above PELs in an uncontrolled or emergency situation.

- **Recordkeeping.** An accurate record of the medical surveillance required by 20 CFR 1910.120 shall be retained. This record shall be retained for the period specified and meet the criteria of 29 CFR 1910.20.
- **Program review.** Contractors must provide adequate documentation that their medical program complies with all applicable standards, DOE orders, and Laboratory requirements. This documentation must be submitted for review and approval before work begins.
- **Program participation.** Line management is responsible for identifying employees for inclusion in the surveillance program.

9.2.1 Medical Surveillance Exams

AR 2-1 from the Laboratory's ES&H Manual specifies that medical surveillance examinations are required for employees who work with asbestos, beryllium, carcinogens, hazardous waste, high noise, lasers, and certain other materials. As specified above, Laboratory employees who work with hazardous waste must undergo periodic special examinations by HS-2.

The content and frequency of medical exams is dependent on site conditions, current and expected exposures, job tasks, and the medical history of the workers.

9.2.2 Certification Exams

In addition to the above medical surveillance requirements, medical certification is required for employees whose work assignments include respirator use, Level A chemical PC, and/or operation of cranes and heavy equipment. To become certified and maintain certification, medical evaluations as specified by HS-2 are required.

9.3 Fitness for Duty

A fitness for duty determination will be made for each site worker. The examining physician shall provide a report to the OUPL indicating:

- approval to work on hazardous waste sites,
- approval to wear respiratory protective equipment, and
- a statement of work restrictions.

9.4 Emergency Treatment

In the event of an on-the-job injury, HS-2 will implement required reporting and recordkeeping procedures. The SSHSP describes the actions to be taken by the employee at the time of the injury/illness.

10.0 BIOASSAY PROGRAM

The OU site field characterization efforts will include intrusive investigations of areas of unknown but highly probable contamination potential. Given the uncertainties associated with this type of field work, the project internal exposure monitoring program is based on the assumption that personnel will be exposed to significant quantities of radioactive and/or hazardous chemical contaminants. Accordingly, the project internal dosimetry program will be conducted in accordance with the provisions of HS-12. These provisions are outlined in the following sections. (Monitoring and control of internal contamination by hazardous chemical contaminants is included in the medical surveillance program.)

10.1 Baseline Bioassays

Individuals who are assigned to field activities or who have reason to visit or inspect field activities are assigned one of the following job categories:

I. Work involving full-time on-site activities.
II. Work involving support activities (e.g., supervision or inspection).
III. Work involving routine or frequent visits (e.g., observing, auditing, etc.).
IV. Work involving nonroutine or infrequent visits (e.g., management observations).

All such individuals (except category IV individuals) must submit urine samples and submit to whole-body counting prior to participation in field activities. The baseline urine samples are analyzed for the solubility Class D and Class W compounds that could reasonably be expected to be encountered at the Laboratory. Whole-body counting analyzes for the gamma-emitting radionuclides that could reasonably be expected to be encountered at the Laboratory.

Results of the baseline bioassay analyses are evaluated by a health physics specialist for evidence of previous exposure. Individuals exhibiting evidence of previous internal contamination will not be permitted to enter OU sites until an evaluation of the previous exposure indicates that additional, planned radiation exposure will not result in doses in excess of applicable regulatory limits. This evaluation may include additional, rigorous sampling and/or counting to establish the physical and temporal parameters necessary to adequately assess the committed effective dose equivalent.

10.2 Routine Bioassays

The routine bioassay program is used as a measure of the effectiveness of the respiratory protection program. As such, the bioassay frequency will be a function of potential exposure to airborne radioactive materials and will be determined by a health physics specialist.

Evidence of inadequate respiratory protection will be cause for an investigation of the responsible field operation(s). The HSPL is responsible for investigating and identifying probable causes of the respiratory protection program failure and for recommending corrective actions.

11.0 DECONTAMINATION

11.1 Introduction

Decontamination is the process of removing or neutralizing contaminants that have accumulated on personnel and equipment and is critical to health and safety at hazardous waste sites. Decontamination protects workers from hazardous substances that may contaminate PC, respiratory protection equipment, tools, vehicles, and other equipment used on-site. It minimizes the transfer of harmful materials into clean areas, helps prevent mixing of incompatible chemicals, and prevents uncontrolled transportation of contaminants from the site into the community.

All personnel and equipment exiting an exclusion zone will be monitored to detect possible contamination. Monitoring will verify that all personnel and equipment are free of significant contamination prior to exiting the exclusion zone and shall be performed in accordance with Health and Safety Division requirements.

If monitoring indicates that an employee is contaminated with chemicals, biological agents, or radioactive materials, the employee's immediate supervisor shall notify the SSO, who records the details of the incident, determines whether any personal injury is involved, initiates decontamination, and, when necessary, notifies the OUPL and HSPL. All contamination incidents shall be immediately reported following Laboratory Occurrence Reporting Program requirements to ensure that prompt notifications and appropriate emergency response actions are enacted.

11.1.1 Decontamination Plan

A site decontamination plan is mandatory. The site decontamination plan shall be part of the SSHSP and must include:

- the number and layout of decontamination stations,
- the decontamination equipment needed,
- appropriate decontamination methods,

- procedures to prevent contamination of clean areas,
- methods and procedures to minimize worker contact with contaminants during removal of personal PC, and
- methods for disposing of clothing and equipment that are not completely decontaminated.

The plan should be revised whenever the type of personal PC or equipment changes, the site conditions change, or the site hazards are re-assessed based on new information.

11.1.2 Facilities

Clean areas shall be separate from contaminated areas and materials. The SSO will verify that decontamination facilities are maintained in acceptable condition and that supplies of decontaminating agents and other materials are available. Personnel decontamination facilities shall be equipped with showers, clean work clothing, decontamination agents, and, when necessary, a decontamination area where Health and Safety Division personnel can assist in decontaminating individuals. All wash solutions shall be retained for appropriate disposal.

11.1.3 General Decontamination Methods

Many factors such as cost, availability, and ease of implementation influence the selection of a decontamination method. From a health and safety standpoint, two key questions must be addressed:

- Is the decontamination method effective for the specific substances present?
- Does the method itself pose any health or safety hazards?

The details of decontamination techniques shall be included in the site decontamination plan. The following are some decontamination methods.

Removal

- Contaminant removal
    - Water rinse using pressurized spray or gravity flow shower
    - Chemical leaching and extraction
    - Evaporation/vaporization
    - Pressurized air jets
    - Scrubbing/scraping (using brushes, scrapers, or sponges and water-compatible solvent cleaning solutions)
    - Steam jets
- Removal of contaminated surfaces
    - Disposal of deeply permeated materials (e.g., clothing, floor mats, and seats)
    - Disposal of protective coverings/coatings

Inactivation

- Chemical detoxification
    - Halogen stripping
    - Neutralization
    - Oxidation/reduction
    - Thermal degradation
- Disinfection/sterilization
    - Chemical disinfection
    - Dry heat sterilization
    - Gas/vapor sterilization
    - Irradiation
    - Steam sterilization

11.1.3.1 Physical Removal

In many cases, gross contamination can be removed by dislodging/displacement, rinsing, wiping off, and evaporation. Physical methods involving high pressure and/or heat should be used only as necessary and with caution because they can spread contamination and cause burns. Contaminants that can be removed by physical means can be categorized as follows:

- **Loose contaminants.** Dusts and vapors that cling to equipment and workers or become trapped in small openings, such as the weave of fabrics, can be removed with water or a liquid rinse. Removal of electrostatically attached materials can be enhanced by coating the clothing or equipment with antistatic solutions. These are available commercially as wash additives or antistatic sprays.
- **Adhering contaminants.** Some contaminants adhere by forces other than electrostatic attraction. Adhesive qualities vary greatly with the specific contaminants and temperature. For example, contaminants such as glues, cements, resins, and muds have much greater adhesive properties than elemental mercury, and consequently, are difficult to remove by physical means. Physical removal methods for gross contaminants include scraping, brushing, and wiping. Removal of adhesive contaminants can be enhanced through certain methods such as solidifying, freezing (e.g., using dry ice or ice water), adsorption or absorption (e.g., with powdered lime or cat litter), or melting.
- **Volatile liquids.** Volatile liquid contaminants can be removed from PC or equipment by evaporation followed by a water rinse. Evaporation of volatile liquids can be enhanced by using steam jets. With any evaporation or vaporization process, care must be taken to prevent worker inhalation of the vaporized chemicals.

11.1.3.2 Chemical Removal

Physical removal of gross contamination should be followed by a wash/rinse process using cleaning solutions. These cleaning solutions normally use one or more of the following methods:

- **Dissolving contaminants.** Chemical removal of surface contaminants can be accomplished by dissolving them in a solvent. The solvent must be chemically compatible with the equipment being cleaned. This is particularly important when decontaminating personal PC. In addition, care must be taken in selecting, using, and disposing of any organic solvents that may be flammable or potentially toxic. Organic solvents include alcohols, ethers, ketones, aromatics, straight-chain alkanes, and common petroleum products.

Halogenated solvents are generally incompatible with PPE and are toxic. They should only be used for decontamination in extreme cases, when other cleaning agents will not remove the contaminant. Use of halogenated solvents must be approved by the HSPL.

Table III-9 provides a general guide to the solubility of several contaminants in four types of solvents: water, dilute acids, dilute bases, and organic solvents. Because of the potential hazards, decontamination using chemicals should only be performed if recommended by an industrial hygienist or other qualified health professional.

- **Surfactants.** Surfactants augment physical cleaning methods by reducing adhesion forces between contaminants and the surface being cleaned and by preventing redeposit of the contaminants. Household detergents are among the most common surfactants. Some detergents can be used with organic solvents to improve the dissolving and dispersal of contaminants into the solvent.
- **Solidification.** Solidifying liquid or gel contaminants can enhance their physical removal. The mechanisms of solidification are: (1) moisture removal through the use of adsorbents such as ground clay or powdered lime, (2) chemical reactions via polymerization catalysts and chemical reagents, and (3) freezing using ice water.
- **Rinsing.** Rinsing removes contaminants through dilution, physical attraction, and solubilization. Multiple rinses with clean solutions remove more contaminants than a single rinse with the same volume of solution. Continuous rinsing with large volumes will remove even more contaminants than multiple rinsings with a lesser total volume.

Table III-9. General guide to contaminant solubility

Solvent	Soluble contaminants
Water	Low-chain hydrocarbons, inorganic compounds, salts, some organic acids and other polar compounds
Dilute acids	Basic (caustic) compounds, amines, hydrazines
Dilute bases — detergent — soap	Acidic compounds, phenols, thiols, some nitro and sulfonic compounds
Organic solvents[a] — alcohols — ethers — ketones — aromatics — straight-chain alkanes (e.g., hexane) — common petroleum products (e.g., fuel oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)

[a] WARNING: Some organic solvents can permeate and/or degrade the PC.

- **Disinfection/Sterilization.** Chemical disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization techniques are generally impractical for large equipment and for personal PC and equipment. For this reason, disposable PPE is recommended for use with infectious agents.

11.1.4 Emergency Decontamination

In the event of personnel contamination with highly caustic, strongly acidic, and/or high levels of radioactive materials (100 mrad/hour), emergency shower facilities shall be used as a first level decontamination. These facilities shall be adequate to treat a minimum of two contaminated individuals at one time. Appropriate medical and radiation safety personnel will be relied upon to assist as needed. Use of these facilities shall be in accordance with Health and Safety Division requirements.

11.2 Personnel

The SSO is responsible for enforcing the decontamination plan. All personnel leaving the exclusion zone must be decontaminated to remove any chemical or infectious agents that may have adhered to them.

11.2.1 Radiological Decontamination

Personnel exiting contamination areas, high contamination areas, airborne radioactivity areas, or radiological buffer areas established for contamination control shall be frisked for contamination. This does not apply to personnel exiting areas containing only radionuclides, such as tritium, that cannot be detected using hand-held or automatic frisking equipment.

Monitoring for contamination should be performed using frisking equipment that, under laboratory conditions, can detect total contamination of at least the values specified in Table III-10. Use of automatic monitoring units that meet the above requirements is encouraged.

Personnel with detectable contamination on their skin or personal clothing, other than noble gases or natural background radioactivity, should be promptly decontaminated.

11.2.2 Chemical Decontamination

The decontamination of chemically contaminated personnel will be detailed in the site decontamination plan. Section 11.1.3.2 provides guidance on chemical decontamination.

Table III-10. Summary of contamination values

Nuclide[a]	Removable (dpm/100 cm^2)[b,c]	Total (fixed + removable) (dpm/100 cm^2)
Natural uranium, uranium-235, uranium-238, and associated decay products	1,000 alpha	5,000 alpha
Transuranics, radium-226, radium-228, thorium-230, thorium-228, protactinium-231, actinium-227, iodine-125, and iodine-129	20	500
Natural thorium, thorium-232, strontium-90, radium-223, radium-224, uranium-232, iodine-126, iodine-131, and iodine-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except strontium-90 and others noted above. Includes mixed fission products containing strontium-90	1,000 beta-gamma	5,000 beta-gamma
Tritium organic compounds, surfaces contaminated by HT, HTO, and metal tritide aerosols	10,000	10,000

[a] The values in this table apply to radioactive contamination deposited on but not incorporated into the interior of the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha- and beta-gamma-emitting nuclides apply independently.

[b] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, radium-228, actinum-227, thorium-228, thorium-230, protactinium-231, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

[c] The levels may be averaged over 1 m^2 provided the maximum activity in any area of 100 cm^2 is less than three times the guide values.

11.3 Equipment Decontamination

11.3.1 Responsibilities and Authorities

The SSO is responsible for ensuring that tools and equipment are surveyed for contamination before they are removed from the site. The SSO is also responsible for ensuring that tools and equipment are decontaminated to acceptable levels prior to release for unrestricted use.

11.3.2 Facilities

Prior to release from the site, tools and equipment contaminated with removable radioactive and chemical materials in excess of applicable limits will be manually decontaminated at the field location.

Tools and equipment that cannot be field decontaminated to below applicable limits may be appropriately packaged and removed to a decontamination facility. Transportation of contaminated tools or equipment off-site must be approved by the HSPL.

11.3.3 Radiological

Decontamination of equipment must follow approved procedures. A surface shall be considered contaminated if either the removable or total radioactivity is detected above the levels in Table III-10. If an item cannot be decontaminated promptly, then it shall be posted as specified in AR 3-7. Radiological Work Permits or technical work documents shall include provisions to control contamination at the source to minimize the amount of decontamination needed. Work preplanning shall include consideration of the handling, temporary storage, and decontamination of materials, tools, and equipment.

Decontamination activities shall be controlled to prevent the spread of contamination. Water and steam are the preferred decontamination agents. Other cleaning agents should be selected based on their effectiveness, hazardous properties, amount of waste generated, and ease of disposal.

Decontamination methods should be used to reduce the number of contaminated areas. Efforts should be made to reduce the level of contamination and the number and size of contaminated areas that cannot be eliminated. Line management is responsible for directing decontamination efforts.

11.3.4 Chemical

Chemical decontamination is performed in accordance with product labels. Random sampling and analysis of final rinse solutions may be performed to check the effectiveness of the decontamination procedures.

11.4 Waste Management

Fluids and materials resulting from decontamination processes will be contained, sampled, and analyzed for contaminants. Those materials determined to be contaminated in excess of appropriate limits are packaged in approved containers and disposed of in accordance with EM Division procedures.

12.0 EMERGENCIES

12.1 Introduction

Emergency response, as defined by 29 CFR 1910.120, will be handled by Laboratory personnel. ER contractors are responsible for developing and implementing their own emergency action plans as defined in 29 CFR 1910.38. All emergency action plans must be consistent with laboratory emergency response plans. The SSO, with assistance from the field team leader, will have the responsibility and authority for coordinating all emergency response activities until the proper authorities arrive and assume control.

12.2 Emergency Response Plan

The Laboratory Emergency Management Office oversees and implements the full range of activities necessary for mitigating, preparing for, responding to, and recovering from emergency incidents at the Laboratory. Additional references for this section include Laboratory AR 1-1, Accident/Incident Reporting; AR 1-2, Emergency Preparedness; AR 1-8, Working Alone; and Technical Bulletin 101, Emergency Preparedness.

The Laboratory Emergency Response Plan establishes an organization capable of responding to the range of emergencies at the Laboratory. Provisions are made for rapid mobilization of the response organizations and for expanding response commensurate with the extent of the emergency.

An Emergency Manager with the authority and responsibility to initiate emergency action under the provisions of the Laboratory Emergency Response Plan is available at all times.

When an emergency occurs at the Laboratory, the Laboratory emergency response organization is responsible for all elements of response throughout the duration of the emergency. The Incident Commander is responsible for initial notification and communications and for providing protective action recommendations to buildings/areas within the emergency response zone and off-site.

The Laboratory Emergency Response Plan is designed to be compatible with emergency plans developed by local, state, tribal, and federal agencies through establishment of communications channels with these agencies and by setting criteria for the notification of each agency.

12.3 Emergency Action Plan

An emergency action plan provides emergency information for contingencies that may arise during the course of field operations. It provides site personnel with instructions for the appropriate sequence of responses in the event of either site emergencies or off-site emergencies. The emergency action plan will be attached to the SSHSP. The following elements, at a minimum, shall be included in the written plan:

- pre-emergency planning,
- emergency escape procedures and routes/site map,
- procedures to be followed by personnel who remain to operate critical equipment before they evacuate,
- procedures to account for all employees after evacuation,
- rescue and medical duties for those who are to perform them,
- names of those who can be contacted for additional information on the OUHSP,
- emergency communications,
- types of evacuation to be used,
- dissemination of emergency action plan to employees initially and whenever the plan changes,
- agreement with local medical facilities to treat injuries/illnesses;
- emergency equipment and supplies,
- personal injuries or illnesses,
- motor vehicle accidents and property damage, and
- site security and control.

12.4 Provisions for Public Health and Safety

Emergency planning is presented in the Laboratory's ES&H Manual (LANL 1990, 0335). The Laboratory identifies four situations in which hazardous materials may be released into the environment. These categories are founded in part on Emergency Response Planning Guideline (ERPG) concentrations developed by the American Industrial Hygiene Association and on the basis of the maximum concentration of toxic material that can be tolerated for up to 1 hour.

The types of emergencies are defined as follows:

- **Unusual event.** An event that has occurred or is in progress that normally would not be considered an emergency but that could reduce the safety of the facility. No potential exists for significant releases of radioactive or toxic materials off-site.
- **Site alert.** An event that has occurred or is in progress that would substantially reduce the safety level of the facility. Off-site releases of toxic materials are not expected to exceed the concentrations defined in ERPG-1.
- **Site emergency.** An event that has occurred or is in progress that involves actual or likely major failures of facility functions necessary for the protection of human health and the environment. Releases of toxic materials to areas off-site may exceed the concentrations described in ERPG-2.
- **General emergency.** An event that has occurred or is in progress that substantially interferes with the functioning of facility safety systems. Releases of radioactive materials to areas off-site may exceed protective response recommendations, and toxic materials may exceed ERPG-3.

12.5 Notification Requirements

Field team members will notify the SSO of emergency situations; the SSO will notify the appropriate emergency assistance personnel (e.g., fire, police, and ambulance), the OUPL, the HSPL, the Laboratory Health and Safety Division according to DOE Order 5500.2 (DOE 1991, 0736), and DOE Albuquerque Operations Office (AL) Order 5000.3 (DOE/AL 1991, 0734). The Laboratory Health and Safety Division is responsible for implementing notification and reporting requirements according to DOE Order 5484.1 (DOE 1990, 0773).

12.6 Documentation

An unusual occurrence is any deviation from the planned or expected behavior or course of events in connection with any DOE or DOE-controlled operation if the deviation has environmental, safety, or health protection significance. Examples of unusual occurrences include any substantial degradation of a barrier designed to contain radioactive or toxic materials or any substantial release of radioactive or toxic materials.

The Laboratory principal investigator will submit a completed DOE Form F 5484.X for any of the following accidents and incidents, according to Laboratory AR 1-1:

- **Occupational injury.** An injury such as a cut, fracture, sprain, or amputation that results from a work accident or from an exposure involving a single incident in the work environment. Note: Conditions resulting from animal bites, such as insect or snake bites, or from one-time exposure to chemicals are considered injuries.
- **Occupational illness.** Any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion, or direct contact with a toxic material.
- **Property damage losses of $1,000 or more.** Regardless of fault, accidents that cause damage to DOE property or accidents, wherein DOE may be liable for damage to a second party, are reportable where damage is $1,000 or more, including damage to facilities, inventories, equipment,

and properly parked motor vehicles but excluding damage resulting from a DOE-reported vehicle accident.

- **Government motor vehicle accidents with damages of $150 or more or involving an injury.** Unless the government vehicle is not at fault or the occupants are uninjured. Accidents are also reportable to DOE if:
    - damage to a government vehicle not properly parked is greater than or equal to $250;
    - damage to DOE property is greater than or equal to $500 and the driver of a government vehicle is at fault;
    - damage to any private property or vehicle is greater than or equal to $250 and the driver of a government vehicle is at fault; or
    - any individual is injured and the driver of a government vehicle is at fault.

The HSPL will work with the OUPL and the field team leader to ensure that health and safety records are maintained with the appropriate Laboratory group, as required by DOE orders. The reports are as follows:

- DOE-AL Order 5000.3 (DOE 1990, 0253), Unusual Occurrence Reporting
- DOE Form 5484.3, Supplementary Record of Occupational Injuries and Illnesses, DOE Order 5484.1 (DOE 1990, 0733)
- DOE Form 5484.4, Tabulation of Property Damage Experience, Attachment 2, DOE Order 5484.1 (DOE 1990, 0733)
- DOE Form 5484.5, Report of Property Damage or Loss, Attachment 4, DOE Order 5484.1 (DOE 1990, 0733)
- DOE Form 5484.6, Annual Summary of Exposures Resulting in Internal Body Depositions of Radioactive Materials, DOE Order 5484.1 (DOE 1990, 0733)
- DOE Form 5484.8, Termination Occupational Exposure Report, Attachment 10, DOE Order 5484.1 (DOE 1990, 0733)

- DOE Form OSHA-200, Log of Occupational Injuries and Illnesses, Attachment 7, DOE Order 5484.1 (DOE 1990, 0733)
- DOE Form EV-102A, Summary of DOE and DOE Contractor Occupational Injuries and Illnesses, Attachment 8, DOE Order 5484.1 (DOE 1990, 0773)
- DOE Form F5821.1, Radioactive Effluent/Onsite Discharges/Unplanned Releases, Attachment 12, DOE Order 5484.1 (DOE 1990, 0773)

Copies of these reports will be stored with the appropriate Laboratory group. Specific reporting responsibilities are given in Chapter 1, General ARs, of the Laboratory ES&H Manual (LANL 1990, 0335).

13.0 PERSONNEL TRAINING

13.1 General Employee Training and Site Orientation

All Laboratory employees and supplemental workers must successfully complete Laboratory general employee training (GET). GET training is performed by the Health and Safety Division. The OUPL is responsible for scheduling GET training for supplemental workers.

Several types of training are required, including:

- OSHA-mandated,
- facility-specific,
- site-specific or pre-entry, and
- tailgate.

Site workers will receive each type of training during the course of field activities.

13.2 OSHA Requirements

OSHA's HAZWOPER standard (29 CFR 1910.120) regulates the health and safety of employees involved in hazardous waste operations. This standard requires training commensurate with the level and function of the employee. Persons shall not participate in field activities until they have been trained to a level required by their job function and responsibility. The SSO is responsible for ensuring that all persons entering the exclusion zone are properly trained.

13.2.1 Pre-Assignment Training

At the time of job assignment, all general site workers shall receive a minimum of 40 hours of initial instruction off-site and a minimum of 3 days of actual field experience under the direct supervision of a trained, experienced supervisor. Occasional site workers shall receive a minimum of 24 hours of initial instruction. Workers who may be exposed to unique or special hazards shall be provided additional training. The level of training provided shall be consistent with the employee's job function and responsibilities.

13.2.2 On-Site Management and Supervisors

On-site management and supervisors directly responsible for or who supervise employees engaged in hazardous waste operations shall receive at least 8 hours of additional specialized training on managing such operations at the time of job assignment.

13.2.3 Annual Refresher

All persons required to have OSHA training shall receive 8 hours of refresher training annually.

13.2.4 Site-Specific Training

Prior to granting site access, personnel must be given site-specific training. Attendance and understanding of the site-specific training must be documented. A weekly health and safety briefing and periodic training (as warranted) will be given. Daily tailgate safety meetings will be used to update workers on changing site conditions and to reinforce safe work practices. Training should include the topics indicated in Table III-11 in accordance with 29 CFR 1910.120(i)(2)(ii).

13.3 Radiation Safety Training

Basic radiation worker training is required for all employees (radiation workers) (1) whose job assignments involve operation of radiation-producing devices, (2) who work with radioactive materials, (3) who are likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year, or (4) who require unescorted entry into a radiological area. This training is a 4-hour extension to GET for new employees.

Table III-11. Training topics

Initial site-specific	Weekly	Periodic as warranted	Subject
X		X	Site Health and Safety Plan, 29 CFR 1910.120(e)(1)
X		X	Site Characterization and Analysis, 29 CFR 1910.120(i)
X		X	Chemical Hazards, Table 1
X		X	Physical Hazards, Table 2
X		X	Medical Surveillance Requirements, 29 CFR 1910.120(f)
X	X		Symptoms of Overexposure to Hazards, 29 CFR 1910.120(e)(1)(vi)
X		X	Site Control, 29 CFR 1910.120(d)
X		X	Training Requirements, 29 CFR 1910.120(e)
X	X	X	Engineering and Work Practice Controls, 29 CFR 1910.120(g)
X	X	X	Personal Protective Equipment, 29 CFR 1910.120(g), 29 CFR 1910.134
X	X	X	Respiratory Protection, 29 CFR 1910.120(g), 29 CFR 1910.134, ANSI Z88.2-1980
X		X	Overhead and Underground Utilities
X	X	X	Scaffolding, 29 CFR 1910.28(a)
X	X		Heavy Machinery Safety
X		X	Forklifts, 29 CFR 1910.27(d)
X		X	Tools
X		X	Backhoes, Front End Loaders

Table III-11. (continued)

Initial site-specific	Weekly	Periodic as warranted	Subject
X		X	Other Equipment Used at Site
X		X	Pressurized Gas Cylinders, 29 CFR 1910.101(b)
X	X	X	Decontamination, 29 CFR 1910.120(k)
X		X	Air Monitoring, 29 CFR 1910.120(h)
X		X	Emergency Response Plan, 29 CFR 1910.120(l)
X	X		Handling Drums and Other Containers, 29 CFR 1910.120(j)
X		X	Radioactive Wastes
X		X	Shock Sensitive Wastes
X		X	Flammable Wastes
X	X	X	Confined Space Entry
X			Illumination, 29 CFR 1910.120(m)
X	X	X	Buddy System, 29 CFR 1910.120(a)
X		X	Heat and Cold Stress
X		X	Animal and Insect Bites
X		X	Spill contaminant

Radiation protection training is required for all Laboratory employees, contractors, visiting scientists, and DOE and Department of Defense personnel. This is a 1-hour presentation as part of GET.

13.4 Hazard Communication

Laboratory employees shall be trained in accordance with Health and Safety Division requirements. Contractors shall provide training to their employees in compliance with 29 CFR 1910.120.

13.5 Facility-Specific Training

Certain areas of the Laboratory (e.g., firing sites) require additional facility specific training before personnel can enter.

13.6 Records

Records of training shall be maintained by the Health and Safety Division and in the project file to confirm that every individual assigned to a task has had adequate training for that task and that every employee's training is up-to-date. The SSO or his designee is responsible for ensuring that persons entering the site are properly trained.

14.0 REFERENCES

American Industrial Hygiene Association, 1986. "Noise and Hearing Conservation Manual," Fourth Edition, Akron, Ohio.

Information Labor Organization, 1989. "Encyclopedia of Occupational Health and Safety," Third Edition, Volume I.

U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, "NIOSH Manual of Analytical Methods."

U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, "Pocket Guide to Chemical Hazards."

American Conference of Governmental Industrial Hygienists, 1992. "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, 1992-1993," Cincinnati, Ohio.

U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, October 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," U.S. Government Printing Office, Washington, D.C.

National Safety Council, 1988. "Fundamentals of Industrial Hygiene."

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Office of the Federal Register, National Archives and Records Administration, 1990. "Code of Federal Regulations, Title 29, Parts 1900-1910 and 1926." Washington, D.C.

U.S. Department of Labor, Occupational Safety and Health Administration, March 1989. "Industrial Exposure and Control."

U.S. Department of Labor Occupational Safety and Health Administration, March 1989. "Industrial Exposure and Control: Technologies for OSHA-Regulated Hazardous Substances," Volumes I and II, Washington, D.C.

Attachment A

LEVELS OF PPE

Attachment A
Levels of PPE

Level of protection	Equipment	Protection provided	Should be used when:	Limiting criteria
A	Recommended: • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA • Fully encapsulating, chemical-resistant suit • Inner chemical-resistant gloves • Chemical-resistant safety boots/shoes • Two-way radio communications Optional: • Cooling unit • Coveralls • Long cotton underwear • Hard hat • Disposable gloves and boot covers	The highest available level of respiratory, skin, and eye protection	• The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either: — measured (or potential for) high concentration of atmospheric vapors, gases, or particulates — site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin • Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible • Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined	• Fully encapsulating suit material must be compatible with the substances involved

B	Recommended: • Pressure-demand, full facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit) • Inner and outer chemical-resistant gloves • Chemical-resistant safety boots/shoes • Hard hat • Two-way radio communications Optional: • Coveralls • Disposable boot covers • Face shield • Long cotton underwear	The same level of respiratory protection but less skin protection than Level A It is the minimum level recommended for initial site entries until the hazards have been further identified	• The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection but less skin protection. This involves atmospheres: — with IDLH concentrations of specific substances that do not represent a severe skin hazard — that do not meet the criteria for use of air-purifying respirators • Atmosphere contains less than 19.5% oxygen • Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin	• Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin • Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin

C	Recommended: • Full facepiece, air-purifying, canister-equipped respirator • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit) • Inner and outer chemical-resistant gloves • Chemical-resistant safety boots/shoes • Hard hat • Two-way radio communications Optional: • Coveralls • Disposable boot covers • Face shield • Escape mask • Long cotton underwear	The same level of skin protection as Level B but a lower level of respiratory protection	• The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin • The types of air contaminants have been identified, concentrations measured, and a canister is available that can remove the contaminant • All criteria for the use of air-purifying respirators are met	• Atmospheric concentration of chemicals must not exceed IDLH levels • The atmosphere must contain at least 19.5% oxygen
D	Recommended: • Coveralls • Safety boots/shoes • Safety glasses or chemical splash goggles • Hard hat Optional: • Gloves • Escape mask • Face shield	No respiratory protection. Minimal skin protection	• The atmosphere contains no known hazard • Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals	• This level should not be worn in the exclusion zone • The atmosphere must contain at least 19.5% oxygen

Attachment B

COMMON CHEMICALS IN PHOTOGRAPHIC PROCESSING

Attachment B
Common Chemicals in Photographic Processing

Common Developer Constituents

Metol (4-methylaminophenol)- black and white developers
Hydroquinone- black and white developers
Paraphenylene diamine derivatives CD2, CD3, etc : developers used for color developing
Ethylene diamine: constituent of certain developers
Pentachlorophenol and Sodium pentachlorophenolate: preservatives for developers
Potassium phosphate, potassium hydroxide, and p-phenylenediamine, diethylene glycol: developer

Common Bleaching Constituents

Acetic Acid, ammonium bromide, and potassium nitrate: bleach replenisher
Ammonium Bromide, hydrobromic acid, ammonium tetraacetoferrate(III), and potassium salt of ethylenediamine tetraacetic acid: bleaching agents
Sodium ethylene diamine tetra-actetate (Na EDTA) and sodium diethene triamine pentacetate: constituents in bleaching solutions

Common Cleaning Constituents

Concentrated Formaldehyde, chlorinated and fluorinated solvents (1,1,1-trichloroethane, methylene chloride, Freon, etc.): used for cleaning and in protective products
Hydrochloric acid: used for cleaning

Miscellaneous

Potassium dichromate: used in reversal solutions
Formaldehyde: used as a stabilizer
Ammonia: adjusts pH values
Hydrochloric acid: used for cleaning
Sodium ethylene diamine tetra-acetate (Na EDTA) and sodium diethene triamine pentacetate: constituents in bleaching solutions
tert-Butylaminoborane: exposure
Sodium hydrosulphite: reducing agents
Methanol
Potassium sulfite, ethylenediamine tetraacetic acid and 1-tyioglycerol: conditioner and replenishers

Sources:
Encyclopedia of Occupational Health and Safety
Processing constituent list from KODAK C-41
Processing constituent list from KODAK Ektachrome E-6
Safe Handling Considerations for the EKTAPRINT 3 PROCESS - KODAK

Executive Summary

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Annex IV

Records Management Project Plan

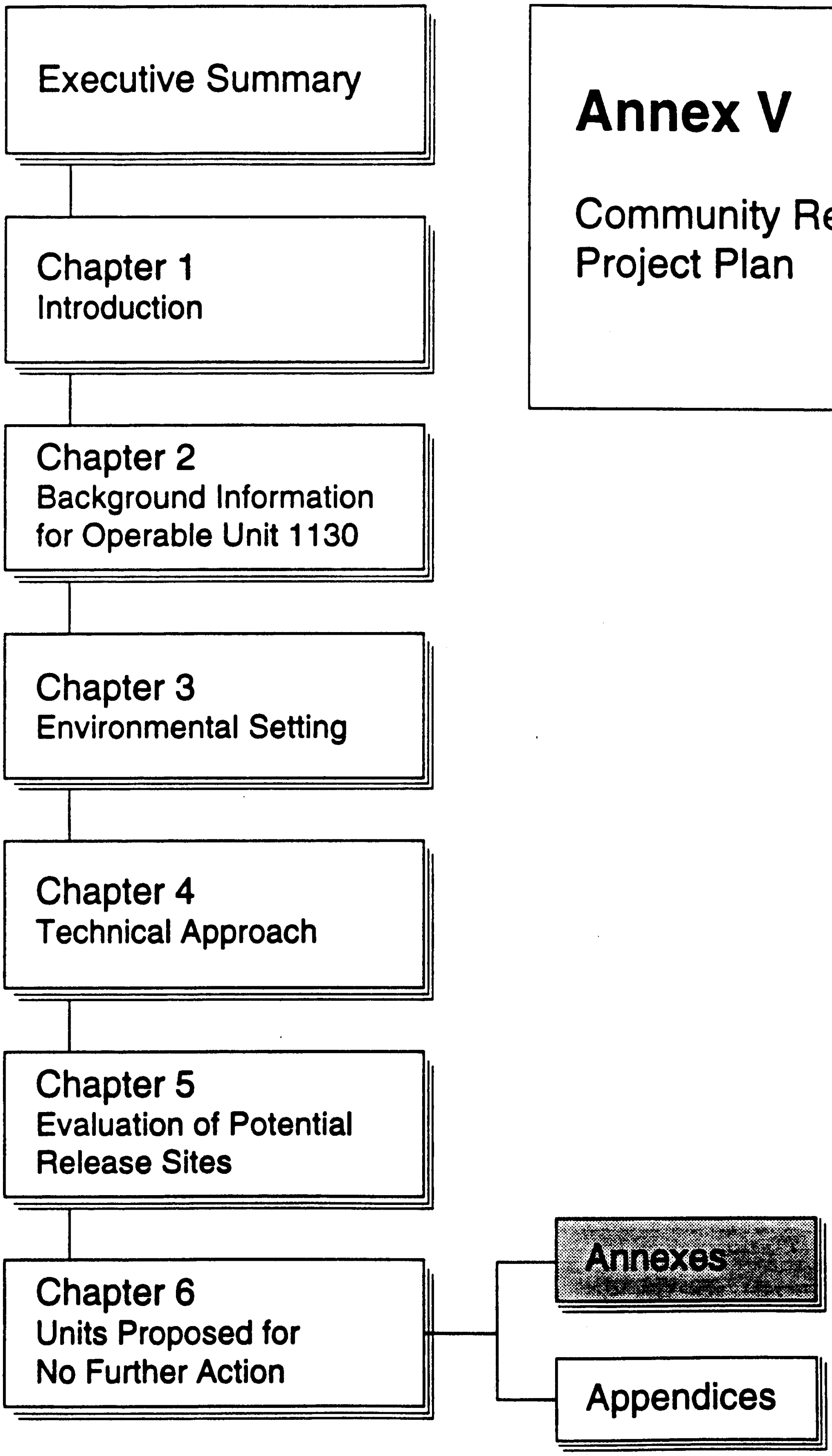
This work plan will follow the records management program plan provided in Annex IV of Revision 2 of the Installation Work Plan (LANL 1992, 0768). (This sentence is the complete text of Annex IV.)

REFERENCES FOR ANNEX IV

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-92-3795, Los Alamos, New Mexico. (LANL 1992, 0768)

Annex V

Community Relations Project Plan



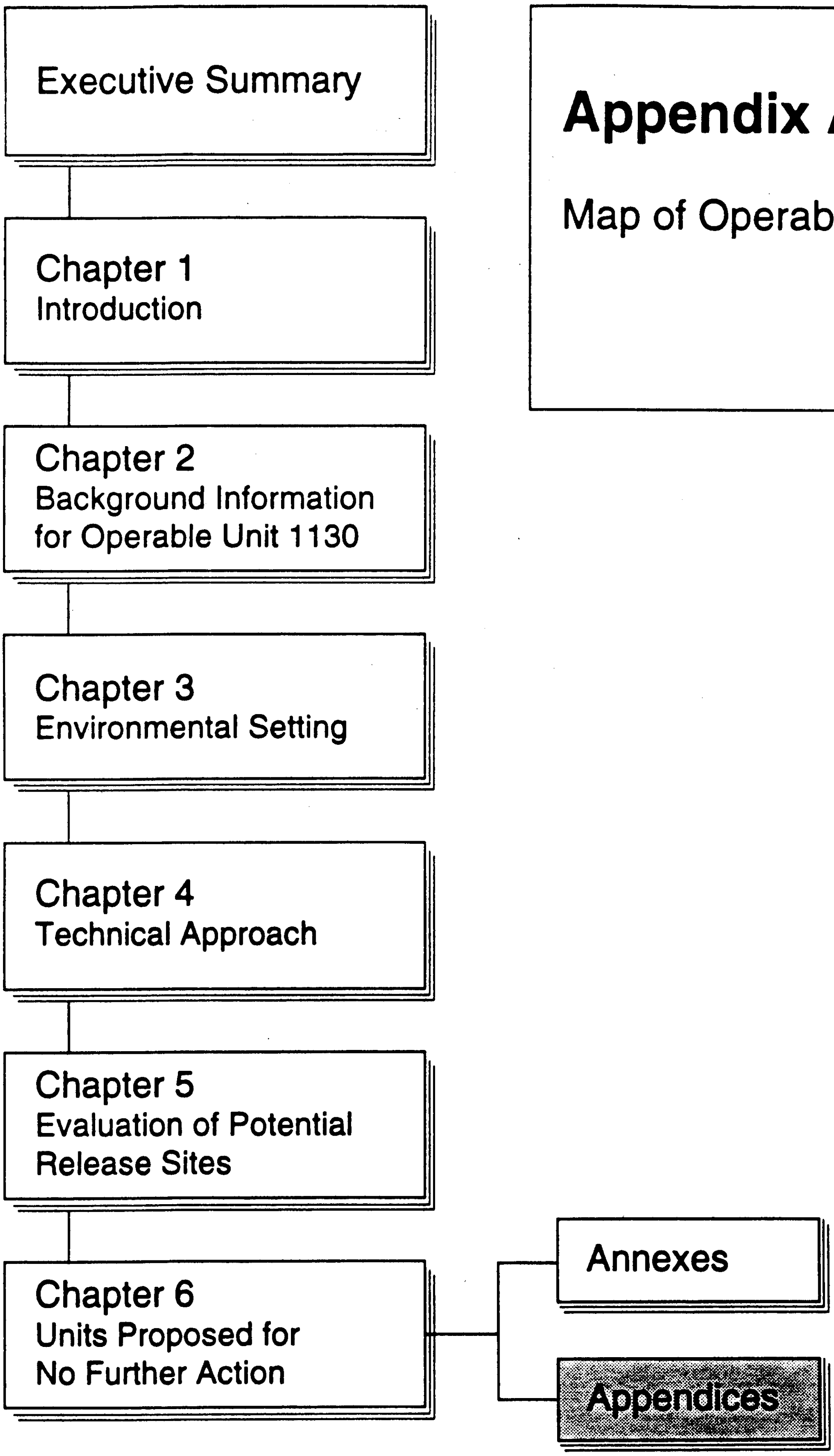
This work plan will follow the community relations program plan provided in Annex V of Revision 2 of the Installation Work Plan (LANL 1992, 0768). The ER Program's public reading room is located at 1450 Central Avenue, Suite 101, Los Alamos, New Mexico. The community relations project leader can be reached at (505) 665-5000 for additional information. (This paragraph is the complete text of Annex V.)

REFERENCES FOR ANNEX V

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-92-3795, Los Alamos, New Mexico. (LANL 1992, 0768)

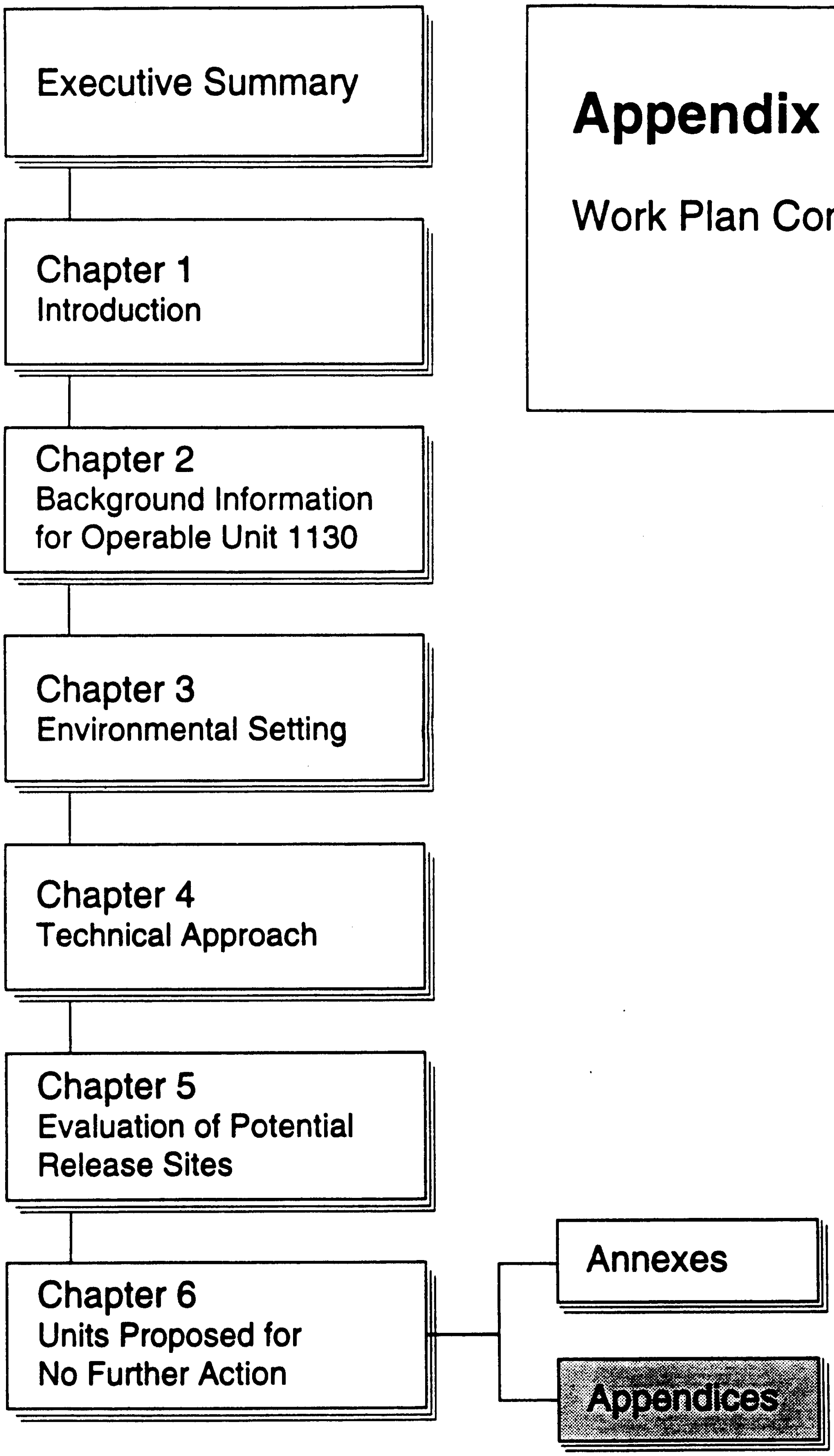
Appendix A

Map of Operable Unit 1130



Appendix B

Work Plan Contributors



APPENDIX B

LIST OF CONTRIBUTORS TO THE OU 1130 WORK PLAN

Name and Affiliation	Education and Expertise	Assignment
Jan Beck, Radian Corporation	B.A. Biology, 4 years experience in environmental risk assessment	Chapters 4 and 5
Naomi Becker, LANL, EES-3	Ph.D. Hydrology, thesis work on transport of uranium	Hydrology sections of Chapter 3, and Chapters 4 and 5
Kathy Campbell, LANL, A-1	Ph.D. Statistics/Mathematics, 13 years experience in environmental statistics	Chapters 4 and 5
Alison Dorries, LANL, HS-5	Ph.D. Chemistry, M.Ph. Public Health, 5 years experience in toxicology and risk assessment	Chapters 4 and 5
Mathew Elliott, ICF Kaiser Engineers	Research analyst, student	Archival search of entire document
Linda Fluk, ICF Kaiser Engineers	M.A. Geology, 4 years experience in environmental projects	Chapter 5
Jennifer Graham, LANL, IS-11	B.A. English, M.Ed. Counseling and Administration, 3 years experience in technical writing and editing	Archival search and technical editing of entire document
Peter Gram, ICF Kaiser Engineers	M.S. Hydrology, 2 years experience in environmental projects	Chapter 3
T.E. (Gene) Gould, LANL, MEE-4	B.A. History, 17 years experience in experimental physics, 2 years managing environmental projects	OUPL, entire document
George Guthrie, LANL, EES-1	Ph.D. Geology	Geology sections of Chapter 3 and Chapter 4
Bethanie Hooker, ICF Kaiser Engineers	B.A. Chemistry, 2 years experience in environmental projects	Chapter 4
Claudine Kasunic, ICF Kaiser Engineers	M.S. Toxicology, 14 years experience in toxicology and risk assessment	Fate and transport in Chapter 4
Sharad Kelkar, LANL, EES-4	M.S. Petroleum Engineering, M.S. Physics, 14 years experience in fluid flow through porous media, 2 years managing environmental projects	Former OUPL, entire document
Lynn Kidman, ICF Kaiser Engineers	Ph.D. Soil Physics, 15 years environmental research and management	Assistant to OUPL for OU 1130
Paula Lozar, Technical Communications Services, Inc.	Ph.D. English, 14 years experience in technical writing and editing	Archival search and technical editing of entire document

Charles Randall Mynard, LANL, MEE-4	B.A. Zoology, 16 years experience in technical illustration, photography, and computer graphics, 10 years experience as a safety representative	Entire document
Tonya Neal, LANL, MEE-4	B.S. Economics, UGS experience in ES&H quality assurance, graduate student	Administrative research for entire document
Kristie Neslen, ICF Kaiser Engineers	B.A. Humanities, 11 years experience in technical writing and editing	Archival search and technical editing of entire document
Steve Snelgrove, LANL, EES-4	B.S. Geophysics, 12 years as an exploration geophysicist	Chapters 5 and 6
Philip Stauffer, LANL, EES-4	B.S. Physics, graduate student	Archival search, and Chapters 5 and 6
Denise Tillery, ICF Kaiser Engineers	M.A. English, 3 years experience in technical writing and editing	Technical editing of entire document
Patricia Tillery, ICF Kaiser Engineers	B.S. Civil Engineering, 8 years experience in environmental projects	Executive Summary, Chapters 1, 2, and 5
Andrea Trujillo, ICF Kaiser Engineers	B.S. Mechanical Engineering, experience in environmental projects	Research of entire document
Merlin Wheeler, ICF Kaiser Engineers	Ph.D. Hydrology, 20 years experience in waste management and environmental projects	Entire document
Wilette Wehner, ICF Kaiser Engineers	B.A. Journalism, 21 years experience in writing and editing	Technical editing of entire document

Appendix C

Field Investigation Approach and Methods

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Appendices

Field Investigation Approach and Methods

1.0 GENERAL

This appendix describe the conduct of field investigations at all Operable Unit (OU) 1130 Potential Release Sites (PRSs or PRS aggregates). This information is provided in a single discussion to present the sampling information in Chapter 4 of the RFI Work Plan for Operable Unit 1130 in a concise document and reduce the repetition in Chapter 4.

Several general concepts apply to all of the field investigations presented in Chapters 4 and 5 of this work plan. These are the following:

- All PRSs have potential for metals, explosives, volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs).

- Potential radioactive contamination from uranium is a common characteristic of the active firing sites and other PRSs.

- The active firing sites are contaminated with metals, explosive residue, and depleted uranium; however, the firing sites will not be characterized during this field investigation.

- Field surveys and field screening of samples can be used to identify contamination areas, to confirm or adjust sampling plans, and to implement the health and safety plan.

1.1 Field Operations

Standard activities that will be used to support the field operations for this OU include:

- preliminary activities and support plans and procedures,

- sampling, sample handling, and laboratory coordination procedures,
- equipment decontamination procedures,
- management of wastes generated by sampling activities, and
- records and data management.

1.2 Investigation Methods

The primary focus of this appendix is on field investigation methods. It is tiered to the field sampling methods section of the Laboratory's Installation Work Plan for Environmental Restoration (IWP), as presented in Section 4.4 of that document (LANL 1992, 0768). This appendix refers to the Laboratory's Environmental Restoration (ER) Program Standard Operating Procedures (SOPs) (LANL 1992, 0688). For each of the brief method descriptions given here, refer to the applicable SOPs for detailed methodology.

The methods described in this appendix include:

- field survey methods to identify radioactive contamination and geophysical anomalies along the grids,
- sampling methods,
- field sample screening methods to be used at the point of sample collection for health and safety reasons, and
- analytical laboratory methods.

The method descriptions here are simple and brief and provide some information on application; however, the SOPs (LANL 1992, 0688) will be used for actual work. Grid locations for the radiological and geophysical surveys are provided in Section 3.0 below. Table C-1 provides an overview of potential contaminants at each PRS and the sampling techniques that will be used.

Table C-1

Suspected Contaminants and Sample Types

SWMU	Description	Potential Chemical Contaminants	Potential Radiological Contaminants	Sample Type
36-001	Material disposal area AA	Metals Explosives	depleted uranium	
36-002	Sump, Bldg. 49	Metals VOCs[1] SVOCs[2] explosives	depleted uranium	
36-003(a)	Septic system, Bldg. 1	cyanide metals VOCs SVOCs		
36-003(b)		explosives metals VOCs SVOCs	depleted uranium	
36-003(c)	Septic system, Bldg. 69	None		NFA[3]
36-003(d)	Septic system, Bldg. 84	None		NFA
36-004(a)	Eenie firing site	explosives metals VOCs SVOCs	depleted uranium	deferred investigation
36-004(b)	Meenie firing site	explosives metals VOCs SVOCs	depleted uranium	deferred investigation
36-004(c)	Minie firing site	explosives metals VOCs SVOCs	depleted uranium	deferred investigation
36-004(d)	Lower Slobbovia firing site	explosives metals VOCs SVOCs	depleted uranium	deferred investigation

Table C-1
(cont'd)

Suspected Contaminants and Sample Types

36-004(e)	I-J firing sites	explosives metals VOCs SVOCs	depleted uranium	deferred investigation
36-004(f)	Moe, magazine			NFA
36-005	Boneyard	explosives metals VOCs SVOCs	depleted uranium, gamma emitters	
36-006	Surface disposal area			deferred investigation
36-007(a)	SAA[4], Bldg. 4			NFA
36-007(b)	SAA, Bldg. 5			NFA
36-007(c)	SAA, Bldg. 7			NFA
36-007(d)	SAA, Bldg. 11			NFA
36-007(e)	SAA, Bldg. 8			NFA
36-007(f)	SAA, Mimie			NFA
C36-001	Contaminated vessel near I-J			deferred investigation
C36-002	Surface disposal area			NFA
C36-003	Photo outfall, Bldg. 1	photo chemicals		
C36-006(e)	Projectile testing area	metals, cyanide, SVOCs		deferred investigation

[1] Volatile Organic Compounds

[2] Semi-Volatile Organic Compounds

[3] No Further Action

[4] Satellite Accumulation Area

2.0 FIELD OPERATIONS

In this section, several aspects that will occur as a part of all field operations are described.

2.1 Health and Safety

The site-specific health and safety plan, and the OU 1130 Annex III health and safety plan, will be used for all field activities within OU 1130. These plans give PRS-specific information regarding known or suspected contaminants and personnel protection required for different activities. Samples acquired as part of this work plan will be screened at the point of collection to identify the presence of gross contamination or conditions that may pose a threat to the health and safety of field personnel.

2.2 Site Control

Access, staging, and sample storage areas will be designated by the Field Team Leader (FTL). To maintain sample integrity and sample documentation, all sampling sites will be included in one or more exclusion zones. Exclusion zones will be delineated by the FTL with the concurrence of the Site Safety Officer (SSO).

The boundary of an exclusion zone will be defined based on the nature, magnitude, and extent of confirmed or possible contamination; the potential for contaminant migration; hazards at the site, such as the use of mechanical equipment; the presence of electrical lines or other utilities, structures, tanks, pits, or trenches; and the presence of steep banks or cliffs. The FTL may determine whether changes in the boundaries of exclusion zones are necessary, and will make appropriate changes with the concurrence of the SSO.

In order to assure sample integrity, to maintain control over sampling waste, and to avoid contamination of the site office, decontamination will be required for personnel, equipment, tools, and vehicles moving from one zone to another. Therefore, a contamination reduction zone (CRZ) will be established surrounding the exclusion zone(s). A contamination reduction corridor through the contamination reduction zone will be established, based on information from the site weather station. The size of the CRZ will depend on the number of stations required for decontamination activities.

Decontamination stations will be set up to reduce contamination as personnel move towards the end of the contamination reduction corridor. A system will be set up to wash and rinse all sample containers, waste containers, protective equipment, tools, and other equipment. Sequential doffing of protective equipment will be conducted, starting with the most heavily contaminated items at the first station and progressing to the least heavily contaminated items at the final station. The stations will be far enough apart to minimize cross-contamination.

All decontamination materials will be stored in drums with proper labels and identifying information. Efforts will be made to keep the volume of decontamination materials to a minimum. Persons involved in performing the actual decontamination will generally be dressed in protective clothing one level below what the exclusion zone workers are required to wear. All personnel and equipment will be monitored for radioactive contamination prior to leaving an exclusion zone or central decontamination area. Personnel entering an exclusion zone in which personnel decontamination is required must follow specified decontamination procedures.

2.3 Site Monitoring

Entry to and egress from sites will be controlled for monitoring purposes. All personnel entering the sites must use appropriate radiation monitoring badges. Locations for drinking water, rest room facilities, etc., will be well marked. Protective clothing requirements will be determined by the SSO assigned to the project, and all involved personnel will be notified of these requirements.

Field measurements for wind-borne contaminants shall be made and documented prior to, during, and after surface sampling activities. Qualified health and safety personnel (or their designees) are responsible for this monitoring. Results of monitoring will be used to evaluate possible hazards existing at the site in order to evaluate current conditions and specify personal protective equipment. All personnel will visually monitor for extreme weather conditions, lightning, or other physical or environmental hazards which may develop, and notify the SSO of such hazards.

2.4 Archaeological, Cultural, and Ecological Evaluations

Prior to initiation of field work, and as part of the Laboratory's Environment, Safety, and Health (ES&H) Questionnaire process, archaeological and ecological evaluations will be performed in all areas where the surface is to be disturbed, vegetation removed, or invasive sampling performed. Depending upon the results of the archaeological and ecological evaluations, a DOE environmental checklist for either categorical exclusion or an environmental assessment will be completed.

2.5 Support Services

Physical support services during the field investigation will be provided by Laboratory support groups ENG-3, ENG-5, Johnson Controls, or contractors. Existing job ticket procedures will be used. The services these groups will provide include but are not limited to backhoe and front-end loader excavations, moving pallets of drummed auger cuttings and decontamination solutions, and setting up signs and other warning notices around the perimeter of the working area.

2.6 Excavation Permits

As part of the ES&H Questionnaire process, excavation permits are required by the Laboratory prior to any excavation, drilling, or other invasive activity. Acquisition of the permits will be coordinated with the Laboratory's Safety and Risk Assessment Group (HS-3) and with Johnson Controls. Acquisition of excavation permits will be scheduled as appropriate for each phase of field work. All areas intended for excavation, drilling, or sampling deeper than 18 in. will be marked in the field for formal clearance before the work begins.

2.7 Sample Control and Documentation

Sample packaging, handling, chain of custody, and documentation procedures are provided in the following ER Program SOPs (LANL 1992, 0688):

- LANL-ER-SOP-01.01, General Instructions for Field Investigations
- LANL-ER-SOP-01.02, Sample Containers and Preservation
- LANL-ER-SOP-01.03, Handling, Packaging and Shipping of Samples
- LANL-ER-SOP-01.04, Sample Control and Field Documentation.

2.8 Sample Coordination

A sample coordination facility has been established by the ER Program in the Laboratory's Environmental Chemistry Group (EM-9) to provide consistency for all investigations. The applicable SOP is LANL-ER-SOP-01.04, Sample Control and Field Documentation (LANL 1992, 0688).

2.9 Quality Control Samples

Field quality control samples of several types are collected during the course of a field investigation. The definition of each kind of sample and the purpose it is intended to fulfill are given in Annex II of this work plan, in the Generic Quality Assurance Project Plan (QAPjP) (LANL 1991, 0412), and in LAN-ER-SOP-01.05, Field Quality Control Samples (LANL 1992, 0688). The frequency with which each type of field QA sample is to be collected is indicated in Table C-2, which is the summary of sampling and analysis for OU 1130. Tables C-3 and C-4, taken from the QAPjP (LANL 1991, 0412), indicate the recommended number and type of quality control samples to be taken.

TABLE C-2

SUMMARY OF THE SAMPLING AND ANALYSIS PLAN FOR OU 1130

Unit	Description	Sampled Media								Samples						Field Screening					Laboratory Analyses										
										Structure		Surface		Subsurface																	
		soil/tuff	water	soil	ash/debris	fill	sludge	fluid	soil/sediments	primary	duplicate	primary	duplicate	primary	duplicate	Beta-gamma	Alpha	Organic Vapor	Combustible gas/oxygen	Explosives (Spot Test)	Gross Gamma	Gamma spectroscopy	Total uranium	Isotopic uranium	Plutonium	Metals (SW 6010/7000)	Mercury	Cyanides	VOCs (SW 8260)	SVOCs (SW 8270)	Explosives (SW 8330)
PRS 36-001 MDA-AA	Trench	x												16	1	x	x	x					x	•		x					x
	Trench				x									32	2	x	x	x		y			x	•		x					x
	Trench					x						4	1			x	x	x					x	•		x					x
	Channel			x								3	1			x	x	x		x			x	•		x					x
PRS 36-002 Sump	Sump					x								3	1	x	x	x	x	x			x	•		x			x	x	x
	Sump						x							2	1	x	x	x	x	x			x	•		x			x	x	x
	Sump	x												6	1	x	x	x		x			x	•		x			x	x	x
PRS 36-003(a)	Septic Tank						x			2	1						x	x	x							x		x	x	x	
	Septic Tank							x		2	1						x	x	x							x		x	x	x	
	Leach field					x								6	1		x	x		y						x		x	x	x	
	Leach field					x								6	1		x	x								x		x	x	x	
	Leach field	x												6	1		x	x								x		x	x	x	
PRS 36-003(b)	Septic Tank						x			2	1					x	x	x	x	x			x	•		x			x	x	x
	Septic Tank							x		2	1					x	x	x	x	x			x	•		x			x	x	x
	Outfall	x															x	x		x			x	•		x			x	x	x
PRS 36-004 Firing Sites (a,b,c,d and e)	Canyons	x										12	1			x	x	x		x	x	•	x	•	y	x			x	x	x
	Canyons		x									12	1			x	x	x		x	x	•	x	•	y	x			x	x	x
	Burn Pits				x									6	1	x	x	x		x	x	•	x	•		x			x	x	x
	Burn Pits	x												6	1	x	x	x		x	x	•	x	•		x			x	x	x
PRS 36-005 Boneyard	Drainage channels								x			8	1			x	x	x		y	x	•	x	•		x			x	x	x
	Elevated rad								x			8	1			x	x	x		y	x	•	x	•		x			x	x	x
	Current/recent storage								x			8	1			x	x	x		y	x	•	x	•		x			x	x	x
	Near tracks								x			8	1			x	x	x		y	x	•	x	•		x			x	x	x
	Other								x			8	1			x	x	x		y	x	•	x	•		x			x	x	x
	Off Boneyard								x			2	1			x	x	x		y	x	•	x	•		x			x	x	x
PRS C-36-003	Outfall								x							x	x	x								x		x		x	
	Outfall		x													x	x	x								x		x		x	

2.9.1 Trip Blank

A trip blank is usually an organic-free aqueous solution that is prepared by the sample coordination facility. It is carried to the field and back to the facility without being opened. The trip blanks are maintained with the sample containers throughout the sampling event and returned unopened to the laboratory with the collected samples.

Table C-3
QC Samples for Nonradiological Samples

Sample Type	Applicable Matrix	Sample Frequency
Field Blank	Soil and Water	1 per 20 samples
Reagent Blank	Soil and Water	1 per 20 samples
Duplicate Blank	Soil	1 per 20 samples
	Water	1 per 20 samples
Rinsate Blank	Soil	1 per 20 samples
	Water	1 per 10 samples
Trip Blank	Water	1 per shipping container for VOCs only

Table C-4
QC Samples for Radiological Samples

Sample Type	Purpose of Sample	Frequency
Field Duplicate	To evaluate the reproducibility of the sampling technique	1 out of 20 samples or less
Rinsate Blank	To evaluate decontamination procedures	1 out of 20 samples or less

2.9.2 Field Blank

A field blank is usually organic-free water that is transferred from one container to another at the sampling site and preserved along with the samples. In the vicinity of the sample collection activity, a quantity of organic-free water is poured into designated sample containers. The field blanks are preserved exactly the same way as the other collected samples.

2.9.3 Duplicate Sample

Duplicate samples are collected from the same location at the same time as two separate samples. The samples are placed in separate containers, marked as unique samples, preserved, and submitted for separate sample analysis.

2.9.4 Equipment (Rinsate) Blank

After equipment has been decontaminated and rinsed, the equipment is rinsed again with organic-free water, making sure that all surfaces are rinsed. The rinse water is collected and sent for analysis.

2.10 Equipment Decontamination

Decontamination is performed to prevent the spread of contamination and as a safety precaution. It prevents cross- contamination among samples, and helps maintain a clean working environment for personnel safety. Sampling tools are decontaminated by washing, rinsing, and drying. The effectiveness of the decontamination process is documented through rinsate blanks submitted for laboratory analysis. Steam cleaning is used for large machinery, vehicles, auger flights, and coring tools used in borehole sampling. Decontamination water from surface sampling activities may be disposed of on the site of the PRS, if the state of New Mexico approves of the plan. However, decontamination water from drilling activities will be collected and sampled according to the site- specific waste management plan.

2.11 Waste Management

This discussion is based on the guidance provided in Appendix B of the IWP (LANL 1992, 0768). Wastes produced during sampling activities consist of decontamination wash and rinse water and disposable materials such as wipes, protective clothing, and sample bottles. Because of the possible contaminants in OU 1130, sampling waste may include hazardous waste, low-level radioactive waste, transuranic waste, and mixed waste (either low-level or transuranic mixed waste). Requirements for segregating, containing, characterizing, treating, and disposing of each type and category of waste are provided in accordance with LANL-ER-SOP-01.06, Management of RFI-Generated Waste (LANL 1992, 0688).

2.11.1 Waste Minimization

Every effort has been made to minimize hazardous and radioactive wastes on site and derived from the site investigation. These efforts include:

- Using washable "firemen's" boots instead of disposable booties.
- Using only minimal water for the day's decontamination activities to minimize the liquid that must be disposed of.
- Using stainless steel utensils to minimize disposable wastes and organics from plastic utensils or chrome from chrome-plated utensils. The stainless steel utensils are easy to decontaminate for future use.
- Performing decontamination with deionized water, rather than with solvents or alcohols, which could pose additional waste problems.

See the Waste Management Plan for OU 1130 for more information on waste minimization during site characterization activities.

3.0 FIELD SURVEYS

Field surveys consist of walking scans of the land surface following the grids presented below, using direct reading or recording instruments at the indicated locations. Field survey data are used to determine radioactivity or the presence of structures or other geophysical anomalies in the field. While negative results from field surveys are not conclusive evidence of the absence of contaminants, positive results obtained at an early stage can allow for timely redirection of a sampling plan.

3.1 Radiological Surveys

3.1.1 Boneyard (PRS 36-005)

A radiological field survey for gross alpha, gross beta, and gross gamma will be conducted to locate and map the extent of radiological contamination. Portable field instruments for detecting alpha-, beta-, and gamma-emitters will be used. The 50-ft grid will be based on these coordinates:

Corner	East	North
Southwest	491750	1756550
Northwest	491750	1756950
Northeast	492150	1756950
Southeast	492150	1756550

3.1.2 Burn Pits [Within PRS 36-004(d)]

A radiological field survey for gross alpha, gross beta, and gross gamma will also be conducted to locate radiological contamination from the area of the burn pits, although the burn pits may not have processed any radiological material. Positive information from this and/or the geophysics survey may identify the exact location of the burn pits. The area of the burn pits is not known, but it has been surmised from an early aerial photograph which places the burn pits between Bldgs. 12 and 13. The radiological survey will be conducted on a 10-ft grid based on these coordinates:

Corner	East	North
Southwest	498900	1756100
Northwest	498900	1756300
Northeast	499100	1756300
Southeast	499100	1756100

3.1.3 Instrumentation for Radiological Surveys

3.1.3.1 Gross Gamma Survey

Several instruments are available that are suitable for these surveys: microR meters, Sodium-Iodide (NaI) detectors of various sizes with rate meters or scalars, and Geiger-Mueller detectors. The preferred instruments are microR meters with the ability to measure to 5 µR/hr, and 2-in. by 2-in. NaI detectors with a rate meter capable of displaying 100 counts per minute (cpm). Some discrete-measurement or continuous-measurement recording instruments are also available using the same detectors. Surveys are conducted by carrying the instrument at waist height at a slow walking pace, and observing and recording the rate meter response. Measurements may also be made at the ground surface to aid in identifying the presence of localized contamination. Quantification of the response is difficult, so it is best interpreted as a gross indicator of potential contamination.

3.1.3.2 Gross Alpha Radiological Screening

Field screening of samples for gross alpha radioactivity is conducted using a hand-held alpha scintillation detector and a rate meter. The detector is held close to contact with the sample or core, and is capable of detecting approximately 100-200 pCi/g for a damp soil sample. The instrument cannot identify specific radionuclides.

3.1.3.3 Gross Beta Radiological Screening

Field screening of samples for gross beta radioactivity is conducted using a hand-held detector. A typical beta detector consists of a Geiger-Mueller tube with a thin mica window protected by a sturdy wire screen. The mica window thickness may vary from 1.4 to 2 mg/cm^2. The detector is held close to contact with the sample or core, and is capable of detecting gross beta activity down to 40 keV. The gamma sensitivity of such a detector is approximately 3,600 cpm/mR/h, and the beta efficiency with screen in place is 45% ^{90}Sr and 10% ^{14}C. Screen removal will increase efficiency by 45%. The efficiencies are determined as a percentage of the emission rate from a 1 in. diameter source. This beta detector is alpha-sensitive above
3 MeV.

3.2 Geophysical Surveys

Electromagnetic and magnetic surveys will be conducted according to protocols established in LANL-ER-SOP-03.02, General Surface Geophysics (LANL 1993, in review).

3.2.1 MDA AA (PRS 36-001)

The exact number of trenches used for burning explosive testing debris is not known and could not be determined from archival information and photographs. Therefore, a geophysical survey will be conducted to locate the trenches. The survey will cover an area of approximately 75,000 sq ft on a 10-ft grid using electromagnetic and magnetic methods. The survey will be conducted on these coordinates:

Corner	**East**	**North**
Southwest	498700	1755800
Northwest	498700	1756100
Northeast	498950	1756100
Southeast	498950	1755800

3.2.2 Septic System at IJ Firing Site [PRS 36-003(b)]

A geophysical survey will be conducted to determine the exact location of the outfall of the septic system, as the location has not been determined by other means. The survey will be conducted on a 10-ft grid based on these coordinates:

Corner	East	North
Southwest	487900	1759750
Northwest	487900	1759950
Northeast	487700	1759950
Southeast	487700	1759750

3.2.3 Burn Pits [Within PRS 36-004(d)]

A geophysical survey will be conducted along the same 10-ft grid described in Section 3.1.2. The location of the burn pits should be determined from this survey. If the location of the pits cannot be determined, the grid will be expanded.

4.0 FIELD SCREENING

Health and safety field screening will be conducted during the sampling process. Consult the site-specific health and safety plan for detailed information, because the following information is general and not intended to replace the health and safety plan. The field screening readings are taken from the headspace at the point of sample collection, in borehole headspace, along the length of the core, and in excavations, to measure the presence of certain contaminants or determine other properties. The instruments indicated below will be calibrated and used according to the manufacturer's instructions in the instruments' manuals.

4.1 Screening for Volatile Organics

Organic vapor detectors will be used to monitor breathing zones for personnel safety in sample collection and handling areas at OU 1130 sites. The following instruments will be used:

- Flame Ionization Detector (FID), Century OVA Model 128
- Photo Ionization Detector (HNu Systems), Model PI101.

4.2 Screening for Level of O_2 and Combustible Gas

There will be monitoring for oxygen level and the presence of combustible gases by a Mine Safety Appliances Company, model MD 261 Combustible Gas Indicator.

4.3 Screening for Particulate Aerosol Dust

Dusts and other particulates will be monitored by the Aerosol Dust Monitor, MIE Miniram PDM-3.

4.4 Screening for Metals and Radioactivity

An SKC Universal Constant Flow Sampler will be used to monitor for metals and radioactivity.

4.5 Screening for Wind Direction and Speed

Wind speed and direction will be measured using the weather station Campbell Scientific, Inc., Measurement and Control Module w/CR10WP w/ .OS10 - 0.1 Prom Model # CR10. Information from the weather station will help determine where to locate the contamination reduction zone. Also, high-volume air samplers will be placed upwind and downwind of drilling based on the weather station information.

5.0 SAMPLING METHODS

For the field sampling plans used in this work plan, a suite of specific sampling methods has been selected, and the details of their use and application in the field have been carefully defined. For example, a "surface soil sample" in this document is specifically defined as representing a 5 to 10 cm layer of soil collected by a hand scoop (see Section 5.1.1). A "vertical borehole core sample" is specifically defined as a 5-ft core interval taken with a particular length and diameter of split-barrel sampler (see Section 5.2.2).

Setting these common definitions and using them uniformly in all of the field sampling plans provides several benefits: consistency of field operations, comparability of sample analysis results from location to location in OU 1130, and the ability to have each sampling plan refer to a method definition in this chapter without reproducing the information in each plan. For each method identified below, the specifically defined portion is detailed. However, for a complete description of the method, refer to the applicable SOP or field sampling plan (e.g., nominal or target depth for a borehole).

5.1 Soil Sampling

5.1.1 Surface Soil

Surface soil samples are defined as samples taken from the upper 2 to 6 in. of soil. This type of soil sample will be gathered using a stainless steel scoop. Care will be used to take the sample to a full 6-in. depth and to cut the sides of the hole vertically to ensure that equal volumes of soil are taken over the full 6-in. depth. The applicable SOP is LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples (LANL 1992, 0688).

5.1.2 Manual Shallow Core

Small volume soil samples can be recovered from depths approaching 10 ft with a hand auger or with a thin-wall tube sampler. The thin-wall tube sampler provides a less disturbed sample than that obtained with a hand auger. However, it may not be possible to force the thin-wall tube sampler through some soils or through tuff, and sampling with the hand auger may be the more viable alternative. It is usually not practical to use a hand auger or thin-wall sampler at depths below 10 ft. The applicable SOP is LANL-ER-SOP-06.10, Hand Auger and Thin-Wall Tube Sampler (LANL 1992, 0688).

5.1.3 Shallow Boreholes

A number of the sampling plans call for core samples to be collected from limited depths to investigate subsurface migration of contaminants where little potential for deep migration exists. This shallow borehole method is intended for boreholes of limited depth; for instance, 30 ft is a reasonable maximum depth for shallow boreholes. Because these boreholes are used primarily for areas where minimal penetration of contaminants into the soil is expected, a major feature of this method is the specification of a 2.5 ft core interval as a sample. For ease of setup and rapid drilling, use of the light-weight drilling rig may be preferred for all shallow boreholes, regardless of site access. The applicable SOP is LANL-ER-SOP-04.01, Drilling Methods and Drill Site Management (LANL 1992, 0688).

5.1.4 Sample Collection from Split Spoon or Shelby Tube Samplers

After the split-spoon or Shelby tube is brought to the surface, it is opened and the core is separated from the sampler. If VOCs are to be collected, the ends of the sampler are sealed immediately, and the log indicates the material taken for the sample. Samples may be discrete or composite, and rational and sample locations will be documented in the daily log. After the samples are taken, the sample containers are decontaminated and placed in the ice chest with the appropriate labeling and paperwork completed. See LANL-ER-SOP-06.24, Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers (LANL 1992, 0688), for more details.

5.2 Liquid Sampling Methods

5.2.1 Surface Water

For collecting samples of standing or running water, the most efficient method is to use a transfer device that collects the water and transfers the sample to the sample container. This keeps the outside of the sample container from contamination. The correct type of transfer device must be selected to avoid incompatibility problems. The methods described in LANL-ER-SOP-06.13, Surface Water Sampling (LANL 1992, 0688), will be followed.

5.2.2 Coliwasa for Liquids or Slurries

For collecting samples in containers such as drums or septic tanks, be sure to use the type of coliwasa that is compatible with the sample to be taken. After the coliwasa is assembled, it is slowly inserted into the open container and the sample is obtained. The sample is transferred from the coliwasa to the sample container. The coliwasa must be decontaminated before reuse. The method described in LANL-ER-SOP-06.15, Coliwasa Liquid Waste Sampler for Liquids and Slurries (LANL 1992, 0688), will be used.

6.0 SAMPLE LOCATIONS

The required quality control samples are included in the sampling table, Table C-2, and the field identifiers with corresponding PRS numbers are in Table C-5.

6.1 MDA-AA (PRS 36-001)

After the trench locations have been verified by the geophysical survey, four boreholes will be drilled in each trench, one borehole per quadrant, and the exact location will be randomized. The boreholes will be drilled as continuous core to a depth of approximately 2 ft below the bottom of the trench, approximately 8 to 14 ft below grade. The cores will be examined, and data such as depth, color, and grain size will be recorded for each layer. Approximate sampling locations are shown in Figure C-1.

Three or four samples will be collected from each of the drilled holes: one sample from the overlying fill layer (only one per trench), two samples from the ash and debris layer, and one from the undisturbed layer below the trench. If there is evidence of runoff erosion, a field decision will be made to take surface samples from the sediment traps using the thin-wall sampler or the spade-and scoop-method. Table C-2 shows an estimate of three samples for erosion. Numbers of samples in this table are based on four trenches.

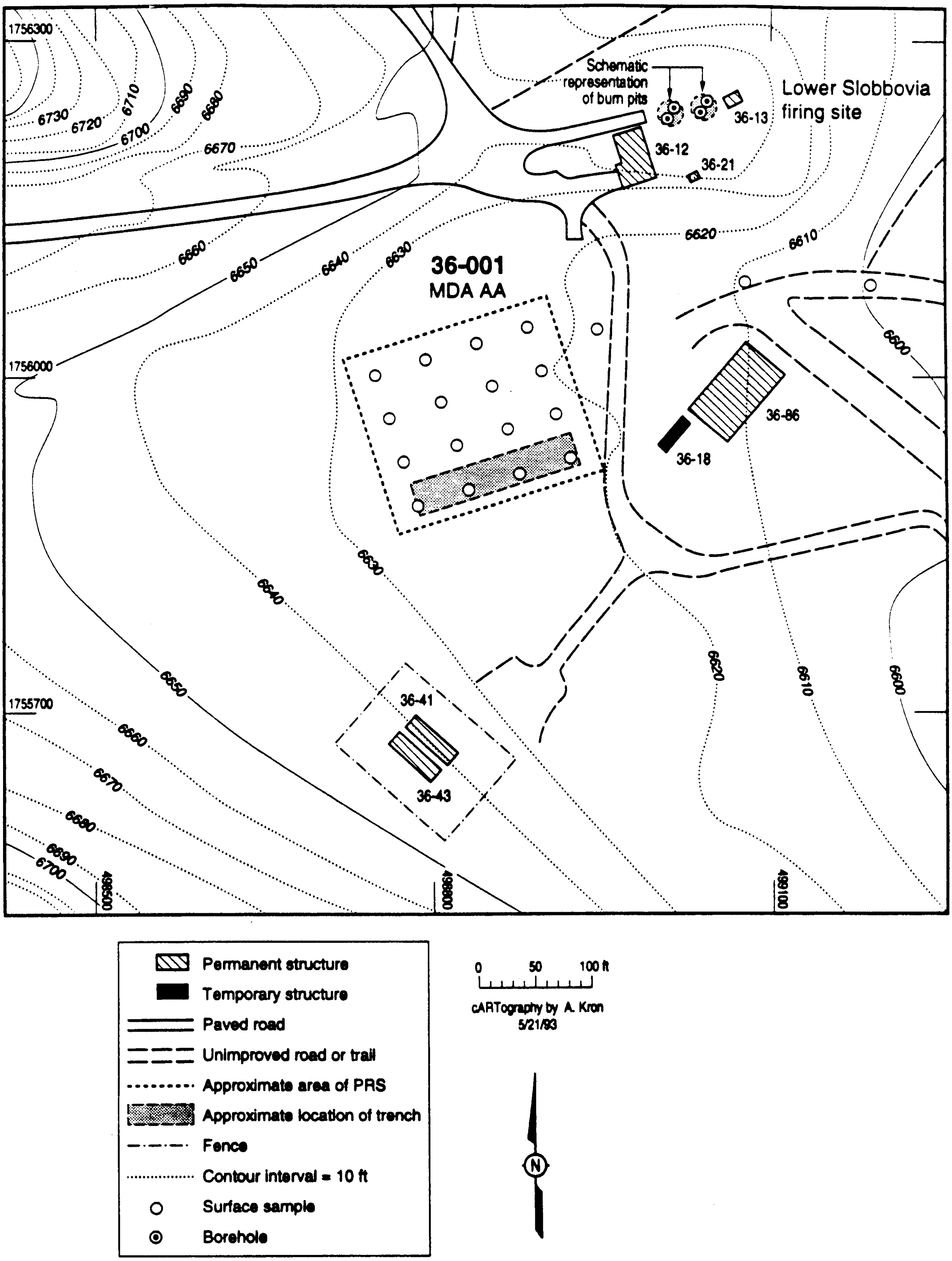

Figure C-1. Approximate sampling locations at MDA-AA and the Burn Pits.

Table C-5

Correlation of SWMUs and Sample Numbers

SWMU NUMBER	SAMPLE NUMBER		
36-001	001-001	through	001-060
36-002	002-001	through	002-007
36-003(a)	003a-001	through	003a-027
36-003(b)	003b-001	through	003b-011
36-004	004-001	through	004-040
36-005	005-001	through	005-039
C-36-003	003C-001	through	003C-009

6.2 The Sump (PRS 36-002)

A backhoe will be used to remove the rock fill from the sump, and samples of the rocks will be collected at three depths below the discharge point of the pipe entering the sump. As the sump is excavated, sampling intervals will be based on visual inspection and field screening results. Samples will be collected by the spade-and- scoop method. The excavated rock fill will be piled or containerized in accordance with LANL-ER-SOP-01-06, Management of RFI-Generated Waste (LANL 1992, 0688).

Two liquid sludge samples will be collected from the near-bottom of the sump by the coliwasa method. If there is no sludge, the spade and scoop method will be used. Approximate sampling locations are shown in Figure C-2.

If contaminants are present, three boreholes will be drilled within the 4-ft diameter sump and three will be drilled outside the sump. The boreholes will be drilled at least 5 ft deep, unless visual inspections indicate that contamination extends deeper. The continuous core will be field screened for volatile organic compounds, gross alpha, beta, gamma, and explosives. A minimum of two samples will be collected from each borehole, one from the top 1 ft of each hole and the other from approximately 2 ft below the bottom of the sump. Core and sample collection will be conducted using the thin-wall sampler and following proper collection procedures. These samples are not included in Table C-2.

6.3 Septic System [PRS 36-003(a)]

Two fluid and two sludge samples will be collected from the interior of the tank using the coliwasa sampling procedure.

Six boreholes will be drilled at random locations across the leach field using the hollow-stem auger drilling rig. Continuous cores will be collected from each of the six boreholes, and three samples will be taken from each core for a total of 18 samples: one from the depth of the tiles, one from the fill/tuff interface, and one from the underlying tuff. Core and sample collection will be conducted using the

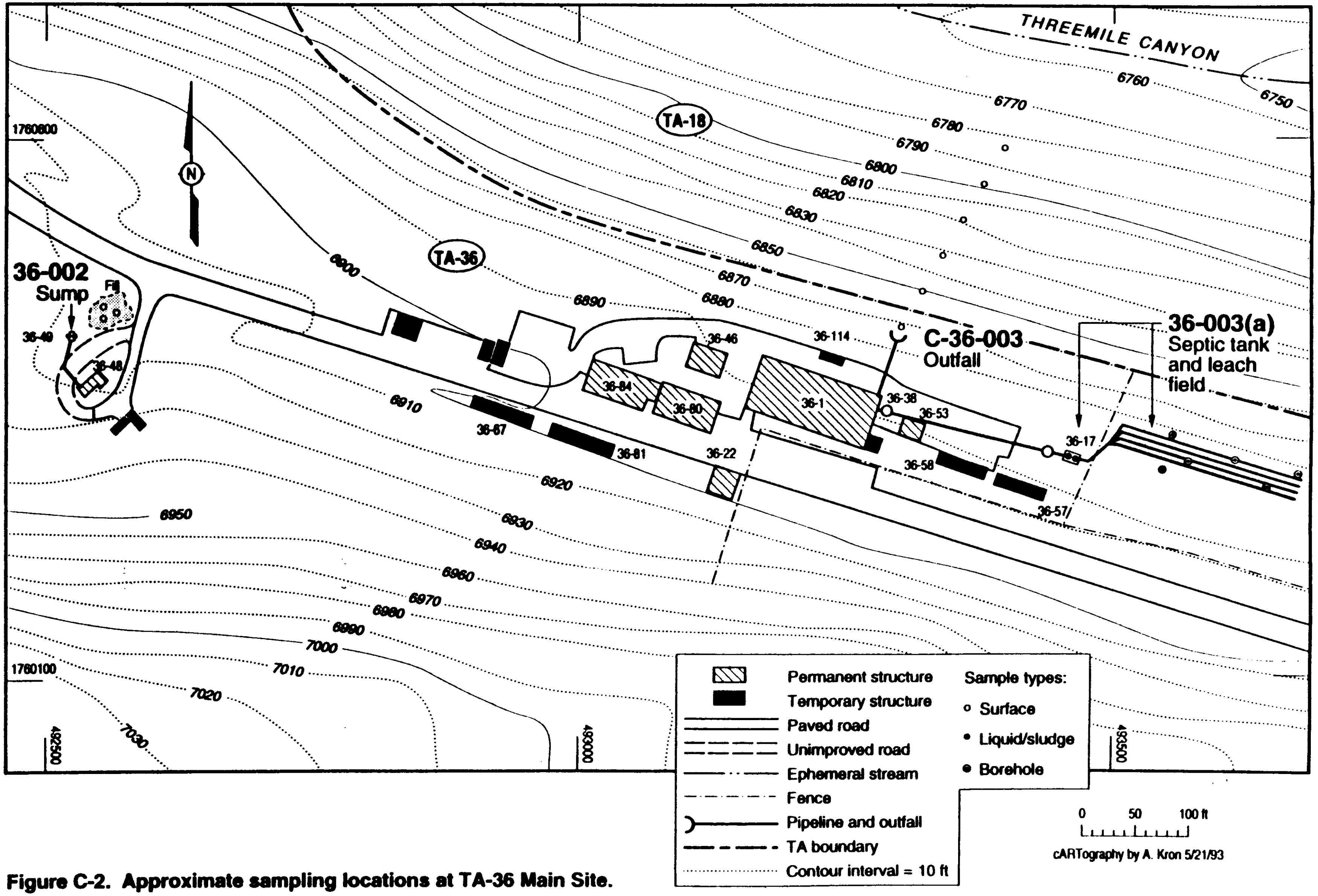

Figure C-2. Approximate sampling locations at TA-36 Main Site.

hand auger/thin-wall and split-spoon/Shelby tube procedures. Approximate sample locations are shown in Figure C-2.

6.4 Septic System [PRS 36-003(b)]

Two fluid and two sludge samples will be collected from the interior of the tank using the coliwasa sampling procedure.

Soil samples will be taken. The depth and method will depend on the depth of the end of the pipe. One sample will be collected at the end of the pipe, and another approximately 1 ft away and 6 in below the previous sample. Samples will be taken using the hand auger/thin-wall and split-spoon/Shelby tube procedures.

If the pipe discharges to the surface, one sample will be taken near the end of the pipe. Three other samples will be collected along the likely migration pathway determined from the geomorphic survey. Samples will be collected using the spade and scoop procedure. Approximate sample locations are shown in Figure C-3.

6.5 Aggregate Firing Sites [PRSs 36-004 (a, b, c, d, e)]

Water, Fence, and Potrillo Canyons will be sampled outside the hazard circles of the firing sites to determine whether contaminants have been transported by surface water runoff. The catchment areas will be determined by the geomorphic study conducted using LANL-ER-SOP-03.08, Geomorphic Characterization (LANL 1993, in review), and one water and one soil sample will be taken in each of those areas. Water samples will be taken during periods of runoff from snow melt or rain, and soil samples will be taken when there is no water running. A minimum of four samples will be taken from each canyon. The soil samples will be taken using the spade and scoop procedure, and the water sample will use the surface water sampling procedure. Approximate sample locations are shown in Figure C-4.

The Burn Pits in the area of Lower Slobbovia will have two boreholes drilled in each pit, one from each half of the pit, unless visual inspection or field screening

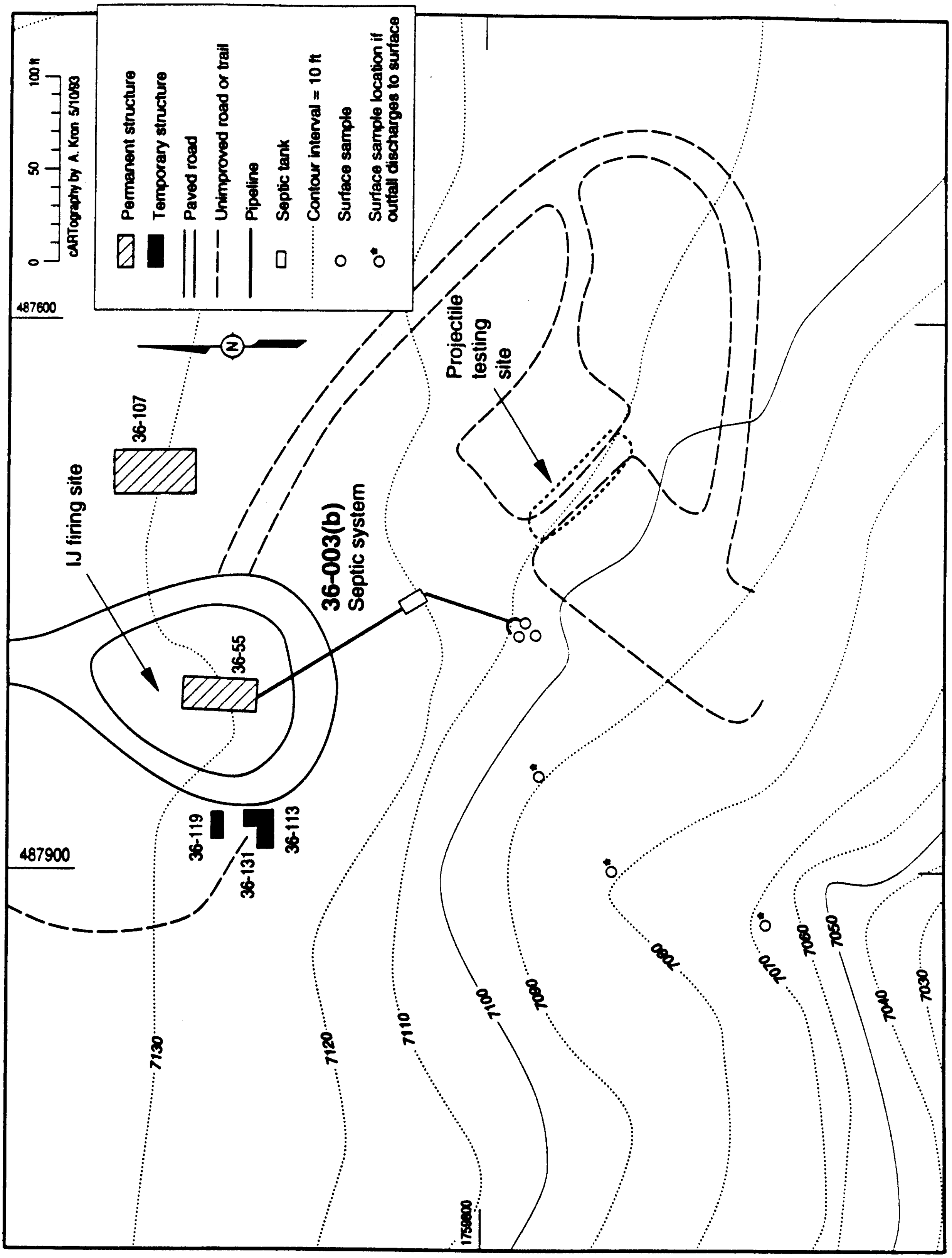

Figure C-3. Approximate sampling locations for PRS 36-003(b), septic system.

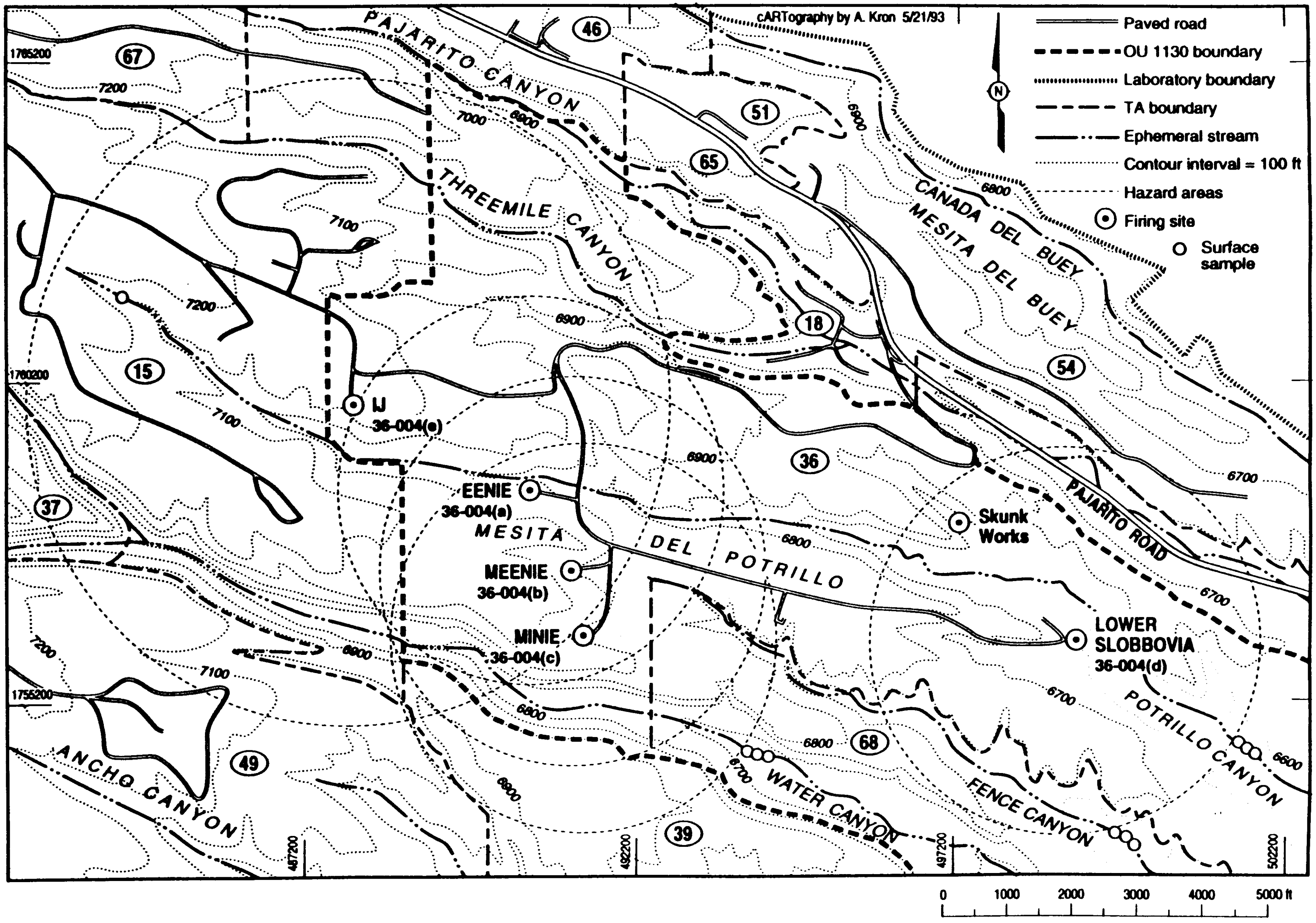

Figure C-4. Approximate sampling locations in catchment areas of Water, Fence, and Potrillo canyons outside hazardous radii of the firing sites. (Exact locations to be determined in the field).

indicates other locations that should be sampled. The total number of boreholes drilled will depend on the number of pits that are located during the surveys. The depth of the borehole will be 2 ft below the bottom of the pits into the undisturbed soil or tuff. Continuous cores will be taken, and data such as depth, thickness, color, and grain size of each layer will be examined and recorded. Approximate sample locations are shown in Figure C-1.

Two samples will be collected from each of the cores. One sample will be collected from the ash and debris layer, and one will be collected from the undisturbed layer below the pit. Core and sample collection will use the hand auger/thin-wall and split-spoon/Shelby tube procedures.

6.6 Boneyard (PRS 36-005)

Eight surface samples will be taken from each of the four identified strata, using information from the field surveys and visual inspection. The strata are as follows:

- drainage channels that carry surface runoff during snow melt or heavy rainstorms;
- areas with elevated radioactivity (two or more times the background average);
- areas currently used for storage or showing signs of recent use, including areas with stained soil; and
- the remainder of the site.

Two additional surface samples will be collected from the area outside the location of observed contamination in the boneyard, but within the hazard radii of Meenie and Minie firing sites. The samples will be collected using the spade and scoop method. Approximate sample locations are shown in Figure C-5.

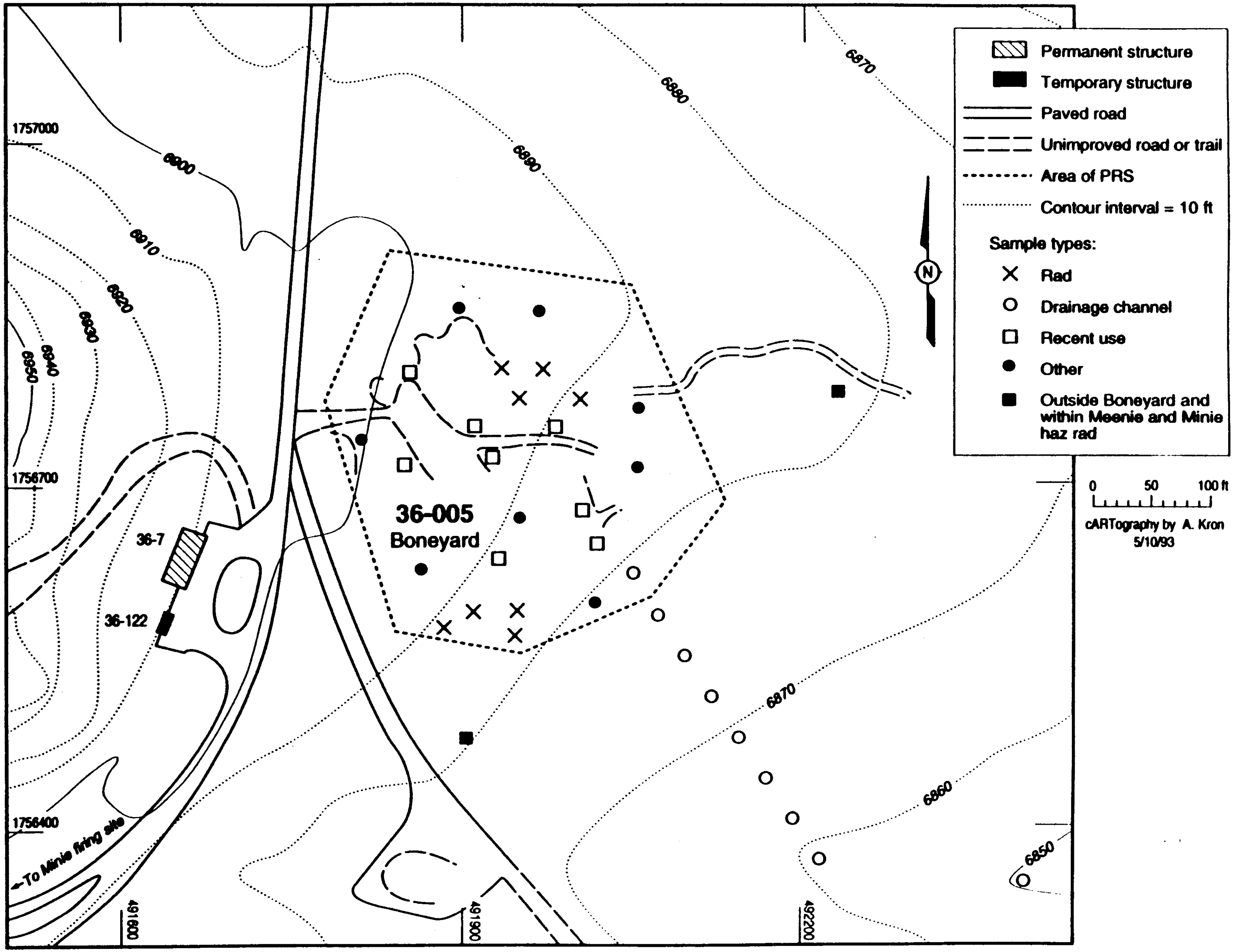

Figure C-5. Approximate sampling locations at PRS 36-005, the Boneyard.

6.7 Photo Outfall (C-36-003)

Six surface and sediment samples will be collected downstream within approximately 200 ft of the outfall. The exact sampling locations will be determined in the field on the basis of geomorphic study, which will locate the sediment locations. In addition, one sample of the outfall water will be collected if possible. The spade- and-scoop and surface-water sampling methods will be followed. Approximate sampling locations are shown in Figure C-2.

7.0 LABORATORY ANALYSIS

Laboratory analyses will be conducted according to the data requirements of this work plan. Level III is intended to be the highest quality level of data acquired. As described in Section 2.0 of this appendix, samples to be submitted to an analytical laboratory will be coordinated, handled, and tracked by the ER Program Sample Coordination Facility.

The following list provides references for methods and analytical levels for the parameters which appear in the screening and analysis tables.

Gamma Spectroscopy. Quantification of radionuclides by measurement of photon emissions. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Explosives. U.S. Army Toxic and Hazardous Materials Agency standard method for explosive analysis. The standard list of analytes and quantitation limits is given in LANL-ER-QAPjP, Table V.10 (LANL 1991, 0412).

Volatile Organic Compounds (SW-846 Method 8240). EPA standard method for quantification of volatile organic compounds. The standard list of analytes and quantitation limits is given in LANL-ER-QAPjP, Table V.3 (LANL 1991, 0412).

Semivolatile Organic Compounds (SW-846 Method 8270). EPA standard method for quantification of semivolatile organic compounds. The standard list of analytes and quantitation limits is given in LANL-ER-QAPjP, Table V.4 (LANL 1991, 0412).

Isotopic Plutonium. Radiochemical separation of plutonium soil is followed by alpha spectrometry to quantify each isotope of plutonium. Quantitation limits are given in LANL-ER-QAPjP, Table V.3 (LANL 1991, 0412).

Isotopic Uranium. Radiochemical separation of uranium from soil is followed by alpha spectrometry to quantify each isotope of uranium. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Tritium. Measurement of tritium in soil moisture. Soil moisture is distilled from soil, and the low energy beta emission from tritium is measured by liquid scintillation techniques. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Total Metals Inductive Coupled Plasma Method. This method is applicable to a large number of metals and wastes.
All matrices, including ground water, aqueous samples, EP extracts, industrial wastes, soils, sludges, sediments, and other solid wastes, require digestion prior to analysis (EPA 1986, 0291).

8.0 FIELD FORMS

The following are the ER field forms for all EM-13 field investigations. EM-13 supplies the necessary forms, except for the Chain of Custody/Request for Analysis form, which will be provided upon request by EM-9. The first column indicates the ER SOP that describes use and requirements for completion of the form.

1.01, R0	SOP Training Documentation Check List

1.01, R0	Readiness Review Meeting Attendance Form
1.04, R1	Daily Activity Log
1.04, R1	Sample Labels
1.04, R1	Sample Collection Log
1.04, R1	Master Collection Log (Optional)
1.04, R1	Chain of Custody/Request for Analysis
4.01, R0	Daily Drilling Summary

All completed forms will be collected by the FTL and submitted to the ER records processing facility in accordance with LANL-ER-AP-2.01, Procedure for Environmental Restoration Records Management (LANL 1992, 0814).

REFERENCES

EPA (Environmental Protection Agency), November 1986. "Test Methods for Evaluating Solid Waste Volume IA: Laboratory Manual, Physical/Chemical Methods," SW-846, Revision 0, third edition, Washington, DC. (EPA 1986, 0291)

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan," Rev. 0, Environmental Restoration Program, Los Alamos, New Mexico. (LANL 1991, 0412)

LANL (Los Alamos National Laboratory), March 16, 1992. "Environmental Restoration Standard Operating Procedures," Vols. I and II, Los Alamos, New Mexico. (LANL 1992, 0688)

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-92-3795, Los Alamos, New Mexico. (LANL 1992, 0768)

LANL (Los Alamos National Laboratory), 1993. "Environmental Restoration Standard Operating Procedures," Los Alamos, New Mexico. (LANL 1993, in review)