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Environmental Surveillance at Los Alamos during 1995





Los Alamos
NATIONAL LABORATORY

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Edited by Louisa Lujan-Pacheco, Group CIC-1

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The following four Laboratory organizations in the Environmental, Safety, and Health (ESH) Division perform surveillance and provide environmental data for this report:

Air Quality, ESH-17;
Water Quality and Hydrology, ESH-18;
Hazardous and Solid Waste, ESH-19; and
Ecology, ESH-20.

The beginning of each chapter credits all contributing authors.

Julie Johnston (ESH-20) and Louisa Lujan-Pacheco (CIC-1) compiled this report with contributions from members of ESH Division. Louisa Lujan-Pacheco edited the report. Belinda Gutierrez (ESH-20) assembled this report and completed its layout. Karen Lyncoln (ESH-19) provided technical review of the document.

Preface

"Environmental Surveillance at Los Alamos" reports are prepared annually by the Los Alamos National Laboratory (the Laboratory) as required by US Department of Energy Order 5400.1, entitled "General Environmental Protection Program."

These annual reports summarize environmental data that characterize the Laboratory's compliance with applicable federal, state, and local environmental laws and regulations, executive orders, and departmental policies. Additional data, beyond the minimum required, is also gathered and reported as part of the Laboratory's efforts to ensure public safety and to monitor environmental quality at and near the Laboratory.

These annual reports are written to be useful to the many individuals, organizations, and governmental entities interested in environmental monitoring at the Laboratory. Significant environmental efforts, special studies, and environmental quality trends of interest are highlighted. This year's report contains improved maps and new graphs designed to further clarify important issues. A glossary of terms, a listing of report contributors, and other supplementary information are included to aid the reader. Comments on how to improve the annual reports are encouraged.

This report is prepared by the Los Alamos National Laboratory, Environment, Safety, and Health Division, for the US Department of Energy.

Inquires or comments regarding these annual reports may be directed to the US Department of Energy, Office of Environment and Projects, 528 35th Street, Los Alamos, NM, 87544, or to the Los Alamos National Laboratory, Environment, Safety, and Health Division, P.O. Box 1663, MS K491, Los Alamos, NM, 87545.

Environmental Surveillance at Los Alamos during 1995 is organized differently than past environmental site reports. The reorganization was based on audience feedback received from the reports published in 1993 and 1994. This report is designed to better meet the needs of our varied audience. We have tried to make information accessible to all without compromising its scientific integrity.

Chapter 1 provides an overview of the Laboratory and highlights the major environmental programs. Chapter 2 reports the Laboratory's compliance status for 1995. Chapter 3 provides a summary of the maximum radiological dose a member of the public could have potentially received from Laboratory operations. Chapters 4–6 discuss the environmental surveillance for each media: air, water, and foodstuffs. A glossary and a list of acronyms and abbreviations in the back of the report define relevant terms and acronyms. Appendix A explains the standards for environmental contaminants, Appendix B explains the units of measurements used in this report, and Appendix C describes the Laboratory's technical areas and their associated programs.

We've also enclosed a summary booklet that briefly explains important concepts, such as radiation, and provides a summary of the monitoring results and regulatory compliance explained at length in the report.

We hope to continue to improve this report based on our audience feedback. For further information about this report, contact the Los Alamos National Laboratory's Environmental Reports Team:

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This report is also available on the Internet at ***http://lib-www.lanl.gov./pubs/la.htm***.

1. Introduction

authors:

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Abstract

This report describes the environmental surveillance program at Los Alamos National Laboratory (LANL or the Laboratory) during 1995. The Laboratory routinely monitors for radiation and for radioactive and nonradioactive materials at (or on) Laboratory sites as well as in the surrounding region. LANL uses the monitoring result to determine compliance with appropriate standards and to identify potentially undesirable trends. Data were collected in 1995 to assess external penetrating radiation; quantities of airborne emissions and liquid effluents; concentrations of chemicals and radionuclides in ambient air, surface waters and groundwaters, municipal water supply, soils and sediments, and foodstuffs; and environmental compliance. Using comparisons with standards, regulations, and background levels, this report concludes that environmental effects from Laboratory operations are small and do not pose a demonstrable threat to the public, Laboratory employees, or the environment.

A. Laboratory Overview

1. Introduction to Los Alamos National Laboratory

In March 1943, a small group of scientists came to Los Alamos, located on a remote mesa high above the Rio Grande, northwest of Santa Fe for Project Y of the Manhattan Project. Their goal was to develop the world's first nuclear weapon. Although planners originally expected that the task would be completed by a hundred scientists, by 1945, when the first nuclear bomb was tested at Trinity Site in southern New Mexico, more than 3,000 civilian and military personnel were working at Los Alamos Laboratory. In 1947, Los Alamos Laboratory became Los Alamos Scientific Laboratory, which in turn became Los Alamos National Laboratory (LANL or the Laboratory) in 1981.

The Laboratory's original mission to design, develop, and test nuclear weapons has broadened and evolved as technologies, US priorities, and the world community have changed. Los Alamos is a multiprogram laboratory with the central mission of reducing the nuclear danger. The central mission at the Laboratory has evolved beyond the nuclear weapons research, development, and testing role to now include five major elements to reduce the nuclear danger:

- stockpile stewardship activities ensure that we keep safe, secure, and reliable those weapons that the nation needs;
- stockpile support projects provide capabilities ranging from the dismantlement to the recertification of existing nuclear weapons;
- nuclear materials management requires that we ensure the availability or safe disposition of plutonium, highly enriched uranium, and tritium;
- effective nonproliferation and counterproliferation technologies will help us keep nuclear weapons, nuclear materials, and nuclear weapons knowledge out of the wrong hands; and
- cleaning up the legacy of 50 years of weapons production focuses our capabilities derived from nuclear weapons development in a new direction.

The Laboratory will continue its role in defense, particularly in nuclear weapons technology, and will increasingly use its multidisciplinary capabilities to solve import civilian problems (including initiatives in the areas of health, national infrastructure, energy, education, and the environment). The research and technology programs that address civilian issues, nonnuclear defense, and industrial partnerships are crucial to the support of our central mission (LANL 1995).

1. Introduction

The operating cost of the Laboratory for fiscal year (FY) 1995 was $1,007 million, with an additional $43 million for capital equipment and $5 million for construction. In FY95, $884 million of the operating cost was spent on Department of Energy (DOE) programs, including $388 million on defense programs, $209 million on Environmental Restoration and Waste Management, and $86 million on Nonproliferation and International Security. Approximately $181 million was spent on work for others, including $78 million on Department of Defense projects.

In 1995, the Laboratory employed approximately 7,000 people in permanent positions; approximately 39% of these employees are technical staff members, 7% are managers, 12% are support staff members, 26% are technicians, and 16% are either office or general support. The Laboratory also employed another 3,000 people in special programs such as work-study programs, graduate research positions, and limited-term employees. In addition, more than 2,500 people are employed by contractors providing support services, protective force services, and specialized scientific and technical services.

The Laboratory contract is administered through the DOE Los Alamos Area Office and the Albuquerque Operations Office. The Laboratory Director is ultimately responsible for all Laboratory activities. However, technical and administrative responsibility and authority have been delegated to directorates and technical and support offices. The Director is supported by a Deputy Director; both the Director and the Deputy Director are supported by Special Assistants. In 1995, the Laboratory management structure consisted of 17 division offices, 10 program offices, and 6 institutional offices. The directors of all programs and divisions form the Laboratory Leadership Council.

2. Geographic Setting

The Laboratory and the associated residential areas of Los Alamos and White Rock are located in Los Alamos County, in north central New Mexico, approximately 100 km (60 mi) north-northeast of Albuquerque and 40 m (25 mi) northwest of Santa Fe (Figure 1-1). The 111-km^2 (43-mi^2) Laboratory site is situated on the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep east-to-west oriented canyons cut by intermittent streams (Figure 1-2). Mesa tops range in elevation from approximately 2,400 m (7,800 ft) on the flanks of the Jemez Mountains to about 1,900 m (6,200 ft) at their eastern termination above the Rio Grande Canyon.

Most Laboratory and community developments are confined to mesa tops. The surrounding land is largely undeveloped, and large tracts of land north, west, and south of the Laboratory site are held by the Santa Fe National Forest, Bureau of Land Management, Bandelier National Monument, General Services Administration, and Los Alamos County. The Pueblo of San Ildefonso borders the Laboratory to the east.

The Laboratory is divided into technical areas (TAs) that are used for building sites, experimental areas, waste disposal locations, roads, and utility rights-of-way (see Figure 1-3 and Appendix C). However, these uses account for only a small part of the total land area. Most land provides buffer areas for security and safety and is held in reserve for future use.

DOE controls the area within Laboratory boundaries and has the option to completely restrict access. The public is allowed limited access to certain areas of the Laboratory. An area north of Ancho Canyon (see Figure 1-4) between the Rio Grande and State Road 4 is open to hikers, rafters, and hunters, but woodcutting and vehicles are prohibited. Portions of Mortandad, Los Alamos, and Pueblo Canyons are also open to the public. Archaeological sites at Otowi Tract, northwest of State Road 502 near White Rock and in Mortandad Canyon, are open to the public, subject to restrictions protecting cultural resources.

3. Geology and Hydrology

Most of the finger-like mesas in the Los Alamos area are formed from Bandelier Tuff, which includes ash fall, ash fall pumice, and rhyolite tuff (Figure 1-5). The tuff, ranging from nonwelded to welded, is more than 300 m (1,000 ft) thick in the western part of the plateau and thins to about 80 m (260 ft) eastward above the Rio Grande. It was deposited as a result of major eruptions in the Jemez Mountains' volcanic center about 1.2 to 1.6 million years ago.

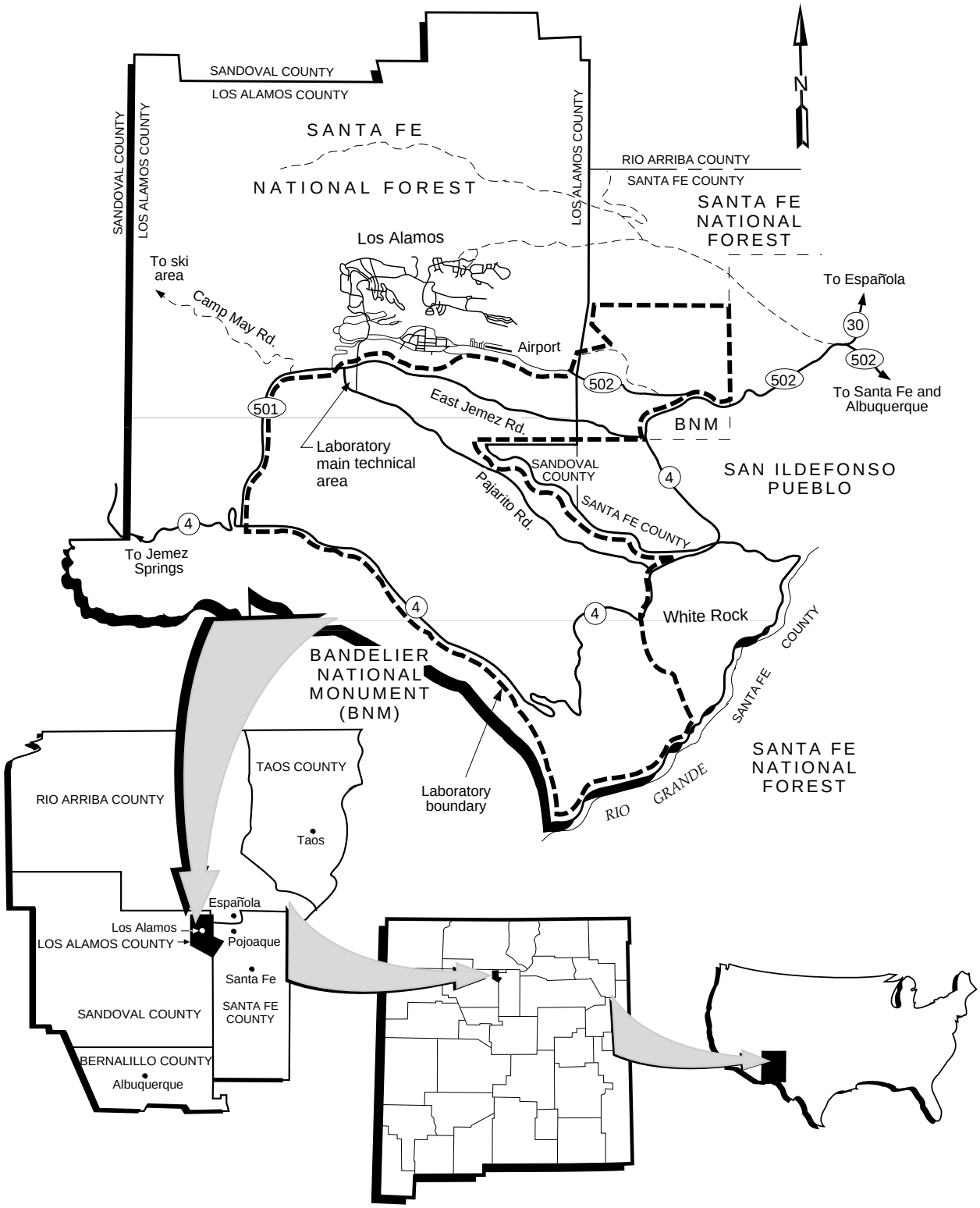

Figure 1-1. Regional location of Los Alamos National Laboratory.

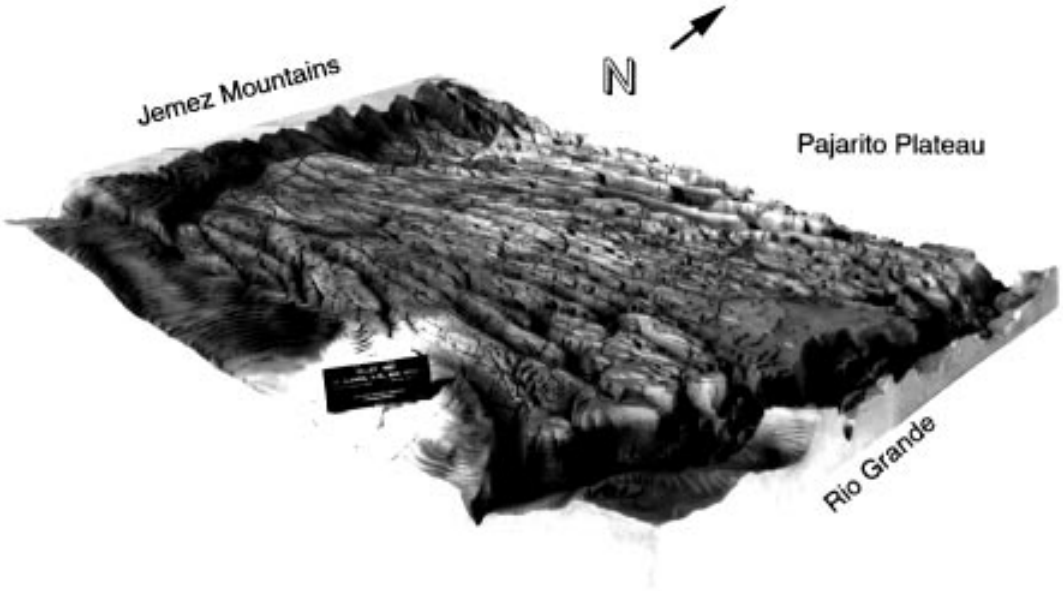

Figure 1-2. Topography of the Los Alamos area.

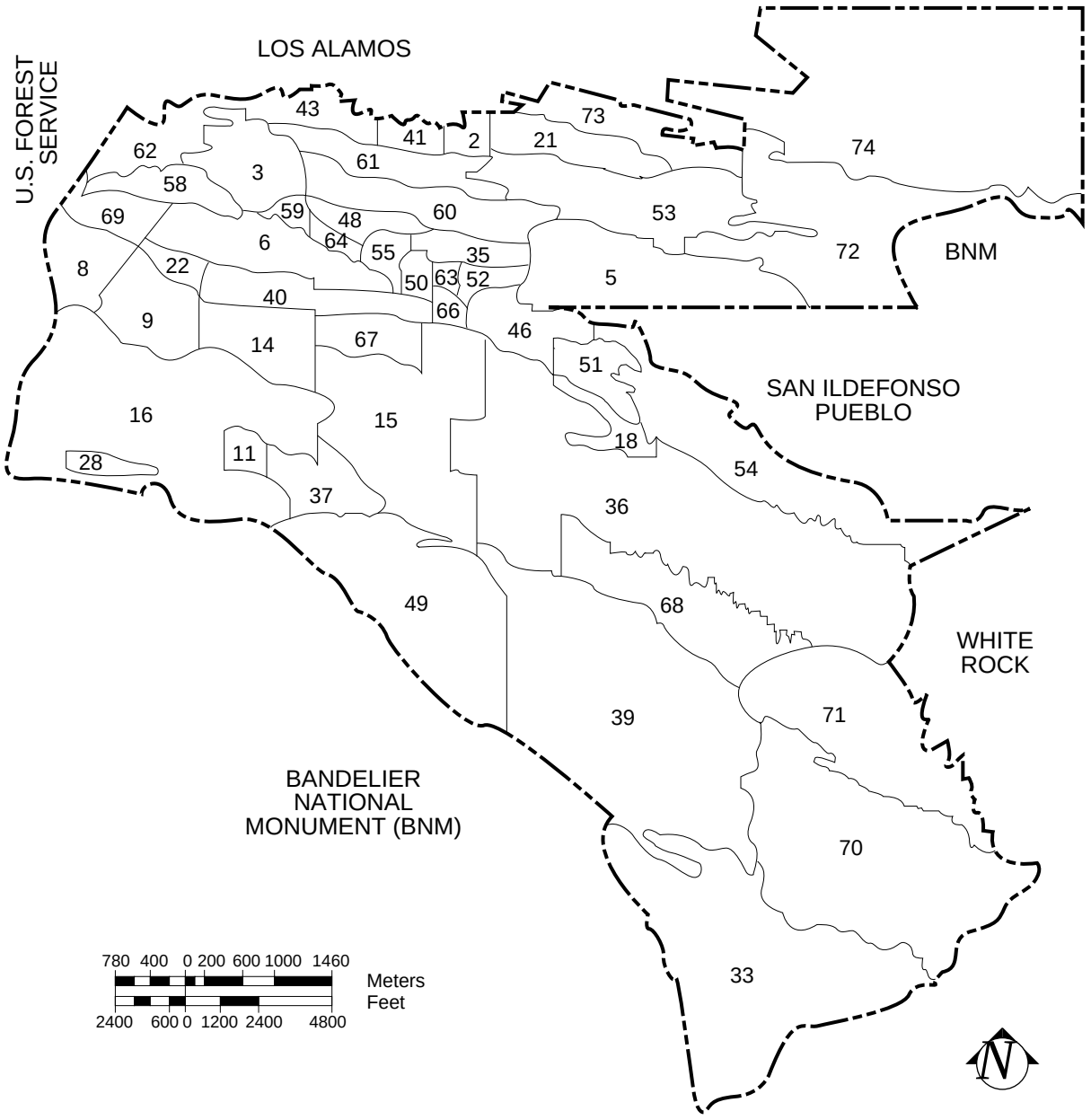

Figure 1-3. Technical areas of Los Alamos National Laboratory in relation to surrounding landholdings.

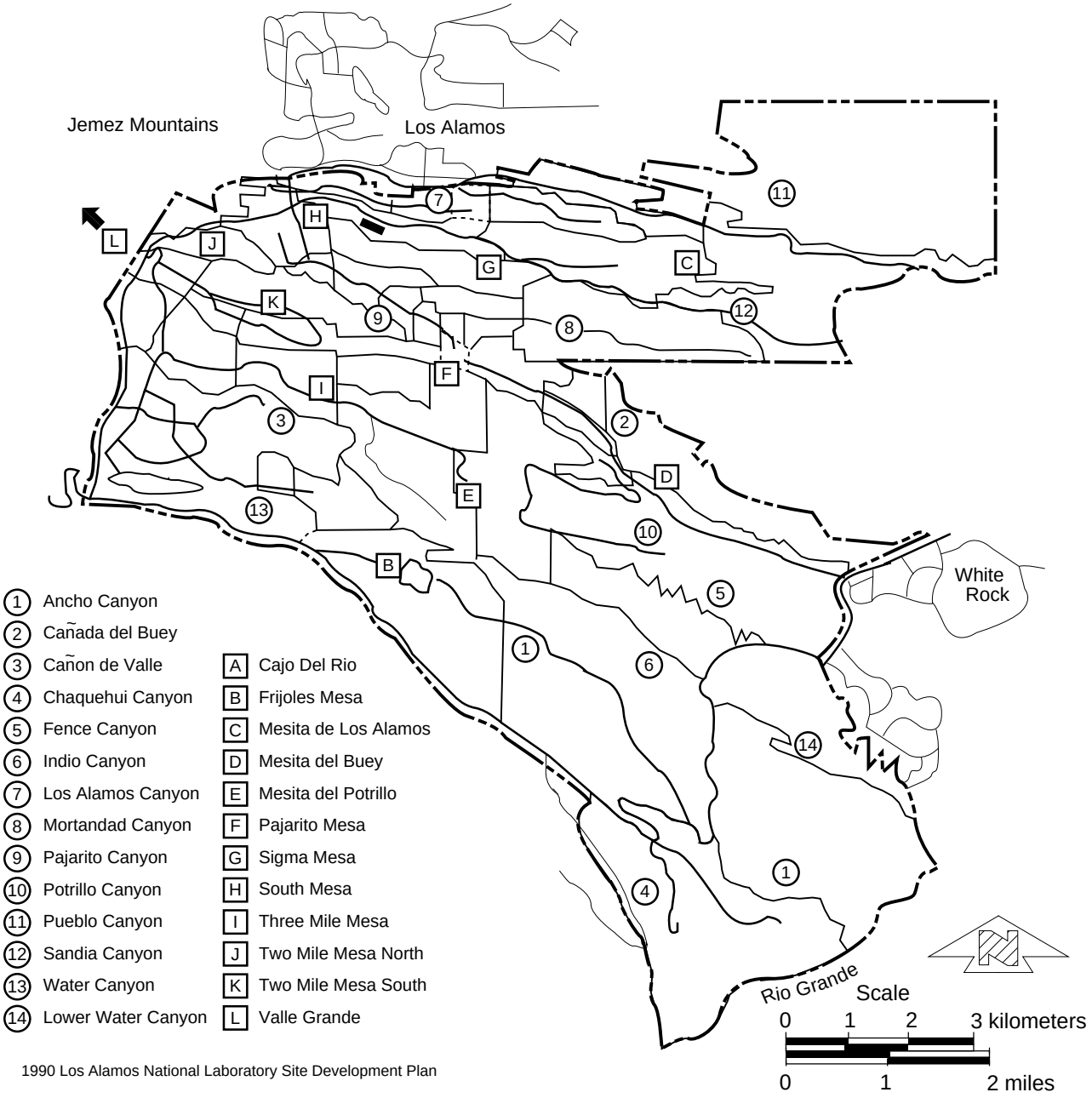

Figure 1-4. Major canyons and mesas.

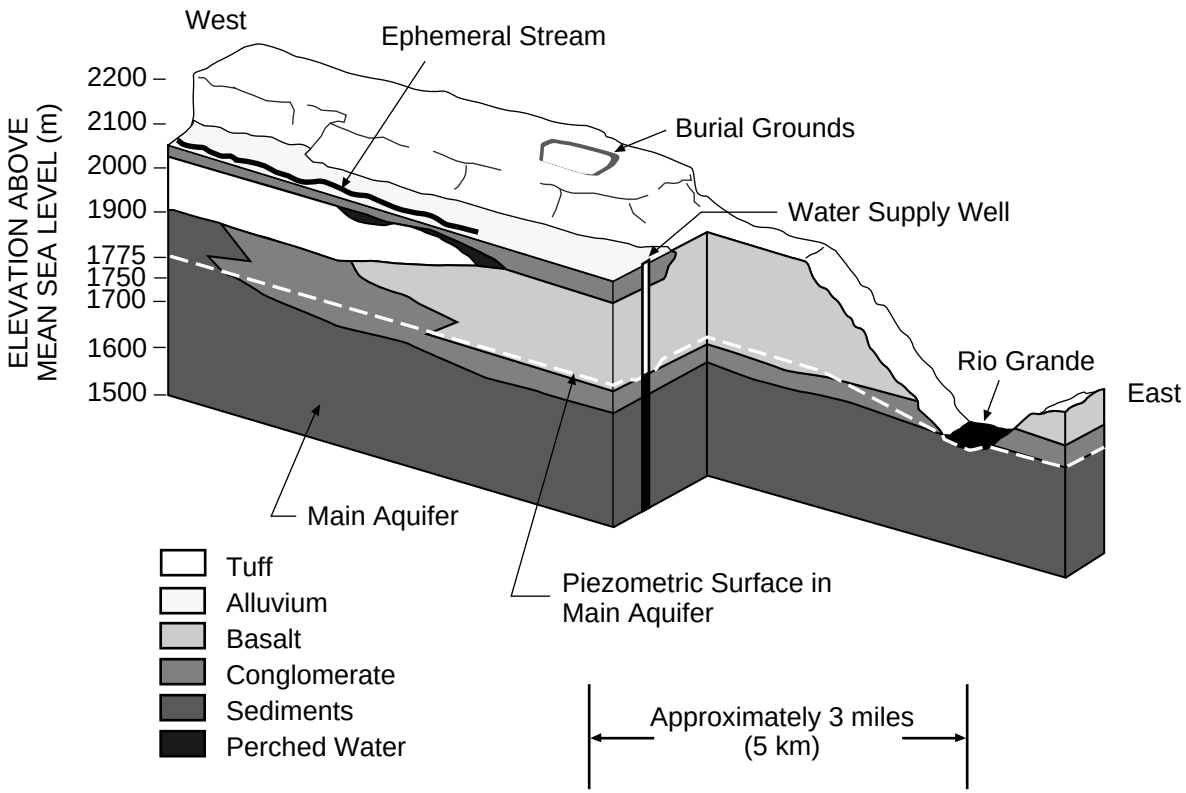

Figure 1-5. Conceptual illustration of geologic and hydrologic relationship in Los Alamos area.

On the western part of the Pajarito Plateau, the Bandelier Tuff overlaps onto the Tschicoma Formation, which consists of older volcanics that form the Jemez Mountains. The tuff is underlain by the conglomerate of the Puye Formation (Figure 1-5) in the central plateau and near the Rio Grande. Chino Mesa basalts interfinger with the conglomerate along the river. These formations overlay the sediments of the Santa Fe Group, which extend across the Rio Grande Valley and are more than 1,000 m (3,300 ft) thick. The Laboratory is bordered on the east by the Rio Grande, within the Rio Grande Rift. Because the rift is slowly widening, the area experiences frequent but minor seismic disturbances.

Surface water in the Los Alamos area occurs primarily as short-lived or intermittent reaches of streams. Perennial springs on the flanks of the Jemez Mountains supply base flow into upper reaches of some canyons, but the volume is insufficient to maintain surface flows across the Laboratory site before they are depleted by evaporation, transpiration, and infiltration. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande several times a year in some drainages. Effluents from sanitary sewage, industrial waste treatment plants, and cooling-tower blowdown enter some canyons at rates sufficient to maintain surface flows for varying distances.

Groundwater in the Los Alamos area occurs in three modes: (1) water in shallow alluvium in canyons, (2) perched water (a body of groundwater above a less permeable layer that is separated from the underlying main body of groundwater by an unsaturated zone), and (3) the main aquifer of the Los Alamos area.

Ephemeral and interrupted streams have filled some parts of canyon bottoms with alluvium that ranges from less than 1 m (3 ft) to as much as 30 m (100 ft) in thickness. Runoff in canyon streams percolates through the alluvium until its downward movement is impeded by layers of weathered tuff and volcanic sediment that are less permeable than the alluvium. This creates shallow bodies of perched groundwater that move down gradient within the alluvium. As water in the alluvium moves down the canyon, it is depleted by evapotranspiration and movement into underlying volcanics (Purtymun 1977). The chemical quality of the perched alluvial groundwaters show the effects of discharges from the Laboratory.

In portions of Pueblo, Los Alamos, and Sandia Canyons, perched groundwater occurs beneath the alluvium at intermediate depths within the lower part of the Bandelier Tuff and within the underlying conglomerates and basalts. Perched groundwater has been found at depths of about 37 m (120 ft) in the midreach of Pueblo Canyon, to about 137 m (450 ft) in Sandia Canyon near the eastern boundary of the Laboratory. This intermediate-depth perched water discharges at several springs in the area of Basalt Spring in Los Alamos Canyon. These intermediate-depth groundwaters are formed in part by recharge from the overlying perched alluvial groundwaters and show the effects of radioactive and inorganic contamination from Laboratory operations.

Perched water may also occur within the Bandelier Tuff in the western portion of the Laboratory just east of the Jemez Mountains. The source of this perched water might be infiltration from streams discharging from the mouths of canyons along the mountain front and underflow of recharge from the Jemez Mountains. Industrial discharges from Laboratory operations may also contribute to perched groundwater in the western portion of the Laboratory. Perched groundwater in the Tschicoma Formation is the source of water supply for the ski area located just west of the Laboratory boundary in the Jemez Mountains.

The main aquifer of the Los Alamos area is the only aquifer in the area capable of serving as a municipal water supply. The surface of the aquifer rises westward from the Rio Grande within the Tesuque Formation (part of the Santa Fe Group) into the lower part of the Puye Formation beneath the central and western part of the plateau. Depth to the main aquifer is about 300 m (1,000 ft) beneath the mesa tops in the central part of the plateau. The main aquifer is separated from alluvial and perched waters by about 110 to 190 m (350 to 620 ft) of tuff and volcanic sediments with low (less than 10%) moisture content.

Water in the main aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande (Purtymun 1974). The source of recharge to the aquifer is presently uncertain. Early research studies concluded that major recharge to the main aquifer is probably from the Jemez Mountains to the west, because the piezometric surface slopes downward to the east, suggesting easterly groundwater flow beneath the Pajarito Plateau. The small amount of recharge available from the Jemez Mountains relative to water supply pumping quantities, along with differences in isotopic and trace element composition, appear to rule this out. Further, isotopic and chemical composition of some waters from wells near the Rio Grande suggest that the source of water underlying the eastern part of the Pajarito Plateau may be the Sangre de Cristo Mountains (Blake 1995). Groundwater flow along the Rio Grande rift from the north is another possible recharge source. The main aquifer

discharges into the Rio Grande through springs in White Rock Canyon. The 18.5-km (11.5-mi) reach of the river in White Rock Canyon between Otowi Bridge and the mouth of Rito de los Frijoles receives an estimated 5.3 to 6.8×10^6 m^3 (4,300 to 5,500 ac-ft) annually from the aquifer.

4. Ecology and Cultural Resources

a. Ecology. The Pajarito Plateau is considered a biologically diverse area. The diversity of ecosystems in the Los Alamos area is due partly to the dramatic 1,500-m (5,000-ft) elevation gradient from the Rio Grande on the east, to the Jemez Mountains 20 km (12 mi) to the west, and partly to the many steep canyons that dissect the area. Six major vegetative community types are found in Los Alamos County: juniper-grassland, piñon-juniper, ponderosa pine, mixed conifer, spruce-fir, and subalpine grassland. The juniper-grassland community is found along the Rio Grande on the eastern border of the plateau and extends upward on the south-facing sides of canyons, at elevations between 1,700 and 1,900 m (5,600 to 6,200 ft). The piñon-juniper community, generally in the 1,900- to 2,100-m (6,200- to 6,900-ft) elevation range, covers large portions of the mesa tops and north-facing slopes at the lower elevations. Ponderosa pines are found in the western portion of the plateau in the 2,100- to 2,300-m (6,900- to 7,500-ft) elevation range. These three communities predominate, each occupying roughly one-third of the Laboratory site. The mixed conifer community, at an elevation of 2,300 to 2,900 m (7,500 to 9,500 ft), overlaps the ponderosa pine community in the deeper canyons and on north slopes and extends from the higher mesas onto the slopes of the Jemez Mountains. The subalpine grassland community is mixed with the spruce-fir communities at higher elevations of 2,900 to 3,200 m (9,500 to 10,500 ft). Twenty-seven wetlands and several riparian areas enrich the diversity of plant and animals found on LANL lands.

The plant and animals found on or near LANL property include approximately 500 plant species, 29 mammals, 200 birds, 19 reptiles, 8 amphibians, and hundreds of insects. Roughly 20 of these are designated as a threatened species, an endangered species, or a species of concern at the federal and/or state level.

b. Cultural Resources. Approximately 67.5% of DOE land in Los Alamos County has been surveyed for prehistoric and historic cultural resources, and close to 1,500 sites have been recorded. More than 85% of the ruins date from the 14th and 15th centuries. Most of the sites are found in the piñon-juniper vegetation zone, with 80% lying between 1,760 and 2,150 m (5,800 and 7,100 ft) in elevation. Almost three-quarters of all ruins are found on mesa tops.

5. Climatology

Los Alamos has a temperate, semiarid mountain climate. However, its climate is strongly influenced by elevation, and large temperature and precipitation differences are observed in the area due to the topography.

Los Alamos has four distinct seasons. Winters are generally mild, but occasionally winter storms dump large snows and cause below-freezing temperatures. Spring is the windiest season of the year. Summer is the rainy season in Los Alamos, when afternoon thunderstorms and associated hail and lightning are common. Fall marks the end of the rainy season and a return to drier, cooler, and calmer weather. The climate statistics given below summarize analyses given in Bowen (1990 and 1992).

Several factors influence the temperature in Los Alamos. An elevation of 7,400 ft helps to counter its southerly location, making for milder summers than nearby locations with lower elevations. The sloping nature of the Pajarito Plateau causes cold-air drainage, making the coolest air settle into the valley. Also, the Sangre de Cristo Mountains to the east act as a barrier to arctic air masses affecting the central and eastern United States. The temperature does occasionally drop well below freezing, however. Another factor affecting the temperature in Los Alamos is the lack of moisture in the atmosphere. With less moisture there is less cloud cover, which allows a significant amount of solar heating during the daytime and radiative cooling during the nighttime. This heating and cooling often causes a wide range of daily temperature.

Winter temperatures range from –1°C to 10°C (30°F to 50°F) during the daytime, to –9°C to –4°C (15°F to 25°F) during the nighttime. The record low temperature recorded in Los Alamos is –28°C (–18°F). Winter is usually not particularly windy, so extreme wind chills are uncommon at Los Alamos.

Summer temperatures range from 21°C to 31°C (70°F to 88°F) during the daytime, to 10°C to 15°C (50°F to 59°F) during the nighttime. Temperatures occasionally will break 32°C (90°F). The highest temperature ever recorded in Los Alamos is 35°C (95°F).

The average annual precipitation (including both rain and the water equivalent of frozen precipitation) in Los Alamos is 47.57 cm (18.73 in.). The average snowfall for a year is 149.6 cm (58.9 in.). Freezing rain and sleet are rare at Los Alamos. Winter precipitation in Los Alamos is often caused by storms entering the United States from the Pacific Ocean, or by cyclones forming or intensifying in the lee of the Rocky Mountains. When these storms cause upslope flow over Los Alamos, large snowfalls can occur. The record snowfall for one day at Los Alamos is 56 cm (22 in.), and the record snowfall in one season is 389 cm (153 in.). The snow is usually a dry, fluffy powder, with an average equivalent water-to-snowfall ratio of 1:20.

The summer rainy season accounts for 48% of the annual precipitation. During the July–September period, afternoon thunderstorms form because of the monsoonal flow of moist air from the Gulf of Mexico and the Pacific Ocean and because of convection and the orographic uplift as air flows up the sides of the Jemez Mountains. These thunderstorms can bring large downpours, but sometimes they only cause strong winds and dangerous lightning. Hail frequently occurs from these rainy-season thunderstorms.

Winds in Los Alamos are also affected by the complex topography, particularly in the absence of a large-scale disturbance affecting the area. Often a distinct daily cycle of the winds around Los Alamos is evident. During the daytime, upslope flow sometimes exists on the Pajarito Plateau, causing an southeasterly component to the winds on the plateau (see Figure 4-16). During the nighttime, as the mountain slopes and plateau cool, the flow becomes downslope, causing light westerly and northwesterly flow (see Figure 4-17). Cyclones moving through the area disturb and override the cycle. Flow within the canyons of the Pajarito Plateau can be quite varied and complex.

B. Major Environmental Programs

1. Environmental Protection Program

a. Purpose and Objectives. The Environment, Safety, and Health (ESH) Division is in charge of performing environmental measurements and activities to help ensure that Laboratory operations do not adversely affect public health or the environment and that the Laboratory conforms with applicable environmental regulatory requirements as required by DOE Orders 5400.1 (DOE 1988) and 5400.5 (DOE 1990).

Although the Laboratory Director has primary responsibility for ESH management, ESH Division provides line managers with assistance in preparing and completing environmental documentation such as reports required by the National Environmental Policy Act (NEPA) of 1969 and the federal Resource Conservation and Recovery Act (RCRA) and its state counterpart, the New Mexico Hazardous Waste Act (NMHWA). With assistance from the Laboratory Counsel, ESH Division helps to define and recommend Laboratory policies with regard to applicable federal and state environmental regulations and laws and DOE orders and directives. The ESH Division is responsible for communicating environmental policies to Laboratory employees and ensuring that appropriate environmental training programs are available.

Several committees provide environmental reviews for Laboratory operations. The Laboratory's ESH Identification Process, which in 1994 replaced the Environmental, Safety, and Health Questionnaire Review Committee, provides reviews of proposed projects to ensure that appropriate environmental, as well as health and safety, issues are properly addressed. The Laboratory Environmental Review Committee reviews NEPA documentation for projects before submitting the documents to DOE. The Environmental, Safety, and Health Council provides senior management level oversight of environmental activities and policy development.

The Emergency Management Office is responsible for the Laboratory's Emergency Management Plan, which is designed for prompt mitigation of all incidents, including those with environmental impact, and provides the means for coordinating all Laboratory resources in the mitigation effort.

b. Environmental Surveillance. Four groups in ESH Division (Air Quality [ESH-17], Water Quality & Hydrology [ESH-18], Hazardous & Solid Waste [ESH-19], and Environmental Assessments & Resource Evaluations [ESH-20]) initiate and promote Laboratory programs for environmental protection and are responsible for environmental surveillance and regulatory compliance. Personnel in the LANL environmental protection programs prepare permits, interpret regulations, provide technical advice, and conduct cultural and biological investigations across the site. They are responsible for environmental monitoring: collecting, analyzing, and interpreting samples of air, water, soil, sediments, food, and hazardous materials. Data are also gathered from

measurements of natural radiation and LANL radiation sources. Weather conditions are monitored to assess the transport of airborne contaminants to the environment. The results of these analyses help identify impacts of LANL operations on the environment.

Monitoring and sampling locations for various types of environmental measurements are generally organized into two groups:

- Off-site locations include regional and perimeter stations.

  Regional stations are located within the five counties surrounding Los Alamos County (Figure 1-1) at distances up to 80 km (50 mi) from the Laboratory. They provide a basis for determining conditions beyond the range of potential influence from normal Laboratory operations.

  Perimeter stations are located within about 4 km (2.5 mi) of the Laboratory boundary, and many are in residential and community areas. They are used to document conditions in areas regularly occupied by the public and potentially affected by Laboratory operations.

- On-site stations are within the Laboratory boundary, and most are in areas accessible only to employees during normal working hours. They measure environmental conditions at the Laboratory where public access is limited.

More than 450 sampling locations are used for routine environmental monitoring. The general location of all monitoring stations is presented in maps in the text.

Samples of air particles and gases, water, soils, sediments, and foodstuffs are routinely collected at the monitoring stations for subsequent analyses. External penetrating radiation from cosmic, terrestrial, and Laboratory sources are also measured. Meteorological conditions are continually monitored to assess the transport of contaminants in airborne emissions to the environment and to aid in forecasting local weather conditions.

Additional samples are collected and analyzed to obtain information about particular events, such as major surface runoff events, nonroutine releases, or special studies. Each year, over 200,000 analyses for chemical and radiochemical constituents are conducted on more than 11,000 environmental samples. Data from these analyses are used for dose calculations, comparisons with standards and background levels, and interpretations of the relative risks associated with Laboratory operations, as presented in Sections 3, 4, 5, and 6 of this report. Methods and procedures for acquiring, analyzing, and recording data are presented in each resource section. Comprehensive information about environmental regulatory standards is presented in Appendix A.

c. Environmental, Safety, and Health Training. The Laboratory maintains an extensive training program of ESH courses that meet compliance requirements under the Occupational Safety and Health Administration/Act (OSHA), EPA, and Department of Transportation regulations, as well as the DOE orders and LANL's Radiological Control Manual. These courses are designed, developed, delivered, and/or coordinated by the ESH Training Group (ESH-13). In 1995, training was available in the following categories: radiation safety training, including courses for radiological workers and radiological control technicians; safety training, including courses on electrical safety, cranes, forklifts, lasers, lockout/tagout, and OSHA standards; health training, including courses on a variety of chemical hazards, first aid/cardiopulmonary resuscitation, and respirators; and environment training, including courses on waste management, spill coordination, and hazardous waste operations.

All new employees, contractors, affiliates, long-term visitors, students, and current employees working at sites governed by DOE Order 5480.20 (DOE 1991a) are required to take General Employee Training, which consists of introductory information covering Laboratory ESH topics, including OSHA Rights and Responsibilities, Industrial Hygiene, Industrial Safety, Fire Protection, Emergency Management, General Employee Radiological Training, and Occupational Medicine. All internally developed Laboratory-wide training is done in conjunction with subject matter experts who validate technical content.

2. Waste Management Program

a. Purpose and Objectives. The waste management function at the Laboratory was formed in 1948 as part of the Los Alamos Area Office of the Atomic Energy Commission. Waste management activities have been focused on minimizing the adverse effects of radioactive wastes on the environment, maintaining compliance with regulations and permits, and ensuring that wastes are managed safely. The Chemical Sciences and Technology (CST) Division at the Laboratory became responsible for waste management activities during 1994.

1. Introduction

Wastes generated at the Laboratory are divided into categories based on the radioactive and chemical content. No high-level radioactive wastes are generated at the Laboratory. Major categories of waste managed at the Laboratory are presented below:

Low-Level Radioactive Waste. The level of radioactive contamination in low-level waste (LLW) is not strictly defined. Rather, LLW is defined by what it is not. It does not include nuclear fuel rods, wastes from processing nuclear fuels, transuranic (TRU) waste, or uranium mill tailings.

LLW at the Laboratory includes solid waste contaminated with radioactive materials, including plutonium, americium, uranium, or tritium from weapons design and test work; tracer and medical isotopes from scientific studies; mixed fission materials from nuclear energy work; and activation products from physics experiments. (Activation products are formed when a substance is struck by protons or neutrons. The atoms of the original substance are converted to another element that is unstable and, therefore, radioactive.)

LLW includes items such as equipment, paper, rags, radiation protective clothing, demolition debris from decontamination and decommissioning activities, and contaminated soils and debris from environmental cleanup activities. LLW handled at the Laboratory may require special handling and shielding to protect workers and the public. Most LLW generated at the Laboratory is disposed of on site in pits and shafts designed and engineered for this purpose within TA-54, Area G. Approximately 3,032 m^3 (107,074 ft^3) of LLW were managed at the Laboratory in calendar year (CY) 1995.

Transuranic Waste. TRU waste consists of rags, equipment, solidified wastewater treatment sludge, paper, and protective clothing that contain radioactive elements heavier than uranium above a designated threshold. The major radioactive contaminants at the Laboratory, plutonium and americium, both have long half-lives. Less than 95 m^3 (3,353 ft^3) of TRU waste were managed at the Laboratory during CY95.

Mixed Waste. Mixed waste contains low-level radioactive elements mixed with nonradioactive hazardous waste. Low-level mixed waste (LLMW) at the Laboratory includes gases, liquids, and solids, such as gas cylinders of hydrogen with a tracer radioactive isotope; contaminated solvents and oils; spent solutions from electroplating operations; contaminated lead shielding; or solid chemicals that react violently with water. Solid LLMW is stored at the site pending the availability of off-site commercial treatment or the development of technologies to treat those wastes that cannot be treated by the commercial sector. Liquid LLMW generated at the Laboratory is stored on site. TRU mixed wastes at the Laboratory are solids. The major hazardous component is solvent contamination or the presence of heavy metals like cadmium or lead. Approximately 52 m^3 (1,836 ft^3) of mixed waste were managed at the Laboratory in CY95.

Hazardous Waste. Hazardous special wastes are defined by regulations under RCRA and the NMHWA. Hazardous wastes at the Laboratory include gases, liquids, and solids such as compressed gas cylinders containing combustible gases; acids, bases, solvents; out-of-date laboratory chemicals; and lead bricks. At present, no disposal facility for hazardous chemical waste exists at the Laboratory. Hazardous wastes are shipped off site for further treatment and disposal to facilities designated in accordance with RCRA. Approximately 1,158,638 kg (2,554,359 lb) of RCRA hazardous waste was managed at the Laboratory in CY95.

Nonhazardous Special Waste. Nonhazardous waste is waste that does not fall under the technical definition of hazardous waste but still requires special handling. Other regulations apply to some of these wastes, such as asbestos, infectious wastes, oils, coolants, and other materials that are controlled for reasons of health, safety, or security. Approximately 1,230,578 kg (2,712,960 lb) of nonhazardous waste were managed by the Laboratory in CY95.

b. Waste Minimization and Pollution Prevention. Today, DOE and the Laboratory conduct business in an atmosphere of sharply declining budgets and increasing public scrutiny, which mandate that operations become both more cost effective and environmentally aware. Incorporation of waste minimization (WMin) methodologies into the daily conduct of operations can provide significant returns in avoided waste management costs, both for the waste generating programs and the Laboratory Waste Management (WM) Program, as well as increases in employee productivity.

The existence of a functional, proactive, pollution prevention program is necessary to comply with the Hazardous and Solid Waste Amendments (HSWA) module of the Laboratory's RCRA permit, the Federal Facility Compliance Agreement, RCRA Subtitle A, Superfund Amendments and Reauthorization Act Subtitle 313, DOE Order 5400.1, and other regulations. As such, pollution prevention is an essential element of the LANL WM Program. Additionally, due to the limited amount of waste disposal capacity remaining in current WM on-site

Table 1-1. Source Reduction and Recycling Activities Implemented in Calendar Year 1995

Sanitary	*Routine*	Site-wide recycling activities	811.45
		Johnson Controls, Inc. Environmental reuse of SM-22 Power Plant residue in sand/salt winter traction mixture	.90
	Nonroutine	Environmental Restoration recycle/reuse activities	1,406.46
		Environmental Restoration procedural changes	20.84
		Chemical reuse program	2.54
		Materials sent to redistribution and marketing for reuse	.15
		Total	**2,242.34 mt**
State-regulated	*Routine*	Site-wide recycling activities	192,267
		Johnson Controls, Inc. Environmental reclassification of cooling tower sediment as sanitary	9,090.91
	Nonroutine	Chemical reuse program	11.5
		Environmental Restoration procedural changes	377.73
		Total	**201,747.38 kg**
Resource Conservation and Recovery Act	*Routine*	Site-wide recycling activities	92,291.97
		TA-55 replacement of HCl in heavy metals recovery with common solvent; reuse of solvent	318.18
		Intervention into disposal of clean drill cuttings	150,000
		Site-wide materials substitution of tetrachloroethylene	2,655.45
		Site-wide materials substitution of trichloroethane	886.36
	Nonroutine	Chemical reuse program	1,908.41
		Federal Facility Compliance Agreement LD200 Lead Regulatory Milestone to Recycle Decontaminated Lead Bricks	47,330
		Total	**295,390.37 kg**
Toxic Substance Control Act	*Nonroutine*	Site-wide recycling/energy reuse activities	8,163.44
		Recategorization and release for recycle of suspect polychlorinated biphenyl equipment	5,840.91
		Total	**14,004.35 kg**
Low-Level Waste	*Routine*	Reuse of spent vacuum oil from foundry furnace vacuum systems to cover depleted uranium chips and turnings	.38
	Nonroutine	Environmental Restoration survey, segregation, and/or decontamination and reuse/recycle	1,082.47
		Environmental Restoration procedural changes	107.4
		Environmental Restoration volume reduction activities	125.11
		Recycle from direct generator assistance program	44.93
		Total	**1,360.29 m^3**
Mixed Low-Level Waste	*Routine*	Substitution of nonhazardous degreaser in RAD areas	.2
		Substitution of nonharzardous paint stripper in NMT Division	2.1
		Change of fluorescent lightbulbs in TA-55, PF-4 on an as-needed basis as opposed to annual changeout	4
	Nonroutine	Federal Facility Compliance Agreement LD200 Lead Regulatory Milestone to decontaminate lead bricks for recycle	8
		Environmental Restoration procedural changes	10,702.35
		Total	**10,716.65 m^3**
Transuranic	*Routine*	Sort/segregation of suspect transuranic using portable spectrometry	
	Nonroutine		16.6
		Total	**16.6 m^3**

mt = metric tonnes (2,200 lb or 1,000 kg).
kg = kilograms.
m^3 = cubic meters.

facilities, pollution prevention is a primary component in WM strategic planning. The Laboratory's Environmental Stewardship Office (ESO) (formerly the Pollution Prevention Program Office) activities provide for a comprehensive program designed to address the requirements of DOE orders as well as federal environmental regulations and executive orders.

The organization of the Laboratory pollution prevention program is modeled after the guidance provided in the DOE Pollution Prevention Crosscut Plan (DOE 1995). This plan sets forth the responsibilities of the various DOE departments and establishes what activities they are responsible for funding. Source reduction and recycling activities implemented in CY95 that resulted in quantifiable waste avoidance are listed in Table 1-1. The chart is arranged by waste type and groups waste minimization efforts by whether they affected routine or nonroutine waste generation.

ESO was also involved in activities during CY95 that cannot be quantified. The most notable among those are listed below:

- continuation of the WMin chargeback system (now called the Set-Aside Program) to provide a financial incentive for WMin/Pollution Prevention actions at the Laboratory by placing a "tax" on wastes generated, as well as to provide a pool of funding to support the accomplishment of specific waste reduction activities;
- award of cash prizes for innovative pollution prevention ideas;
- development of an ESO homepage on the Internet at http://perseus.lanl.gov; and
- coordination of an environmental stewardship forum at which representatives from more than 14 Laboratory divisions and program offices presented to an estimated audience of more than 200 people from both national and international organizations.

Research and development of new pollution prevention technologies are listed below:

- development of direct chemical analysis technologies such as the micro atmospheric measurement system and laser ablation inductively coupled plasma mass spectroscopy to minimize waste generated during sampling and analysis by allowing the analysis to be performed *in situ*;
- development of portable field screening detectors that can determine if more extensive characterization is necessary to minimize waste generated from unnecessarily performed extensive site characterizations;
- collaboration of CST Division and Faraday Technology, Inc., to develop electrochemical treatment technology to treat mixed waste without increasing the end-result volume (planned pilot-scale operation for mid-1996);
- initiation of a cooperative research and development agreement with Canberra Industries to develop a passive neutron barrel counter to permit accurate assay of plutonium in TRU and LLW without breaching the waste containers, thereby not generating any secondary waste; and
- development and on-site use of a nonintrusive zero waste generation characterization technology, ultrasonic interferometry.

3. Environmental Restoration Project

a. Purpose and Objectives. The Environmental Restoration (ER) Program within the DOE office of Environmental Restoration and Waste Management is responsible for assessing, cleaning up, decontaminating and decommissioning sites at DOE facilities and sites formerly used by DOE. The objectives of the ER Project at the Laboratory meet the goals of environmental management and augment the Laboratory's environmental surveillance program by identifying and characterizing potential threats to human health and the environment from past Laboratory operations, and by mitigating those threats through corrective actions that comply with applicable environmental regulations. The project is also responsible for decontaminating and decommissioning surplus facilities at the Laboratory. Corrective actions may include source containment to prevent contaminant migration, controls on future land use, and excavation and/or treatment of the source to remove or, at a minimum, reduce chemical and/or radiological hazards to acceptable human health and environmental levels.

The ER Project at the Laboratory responds to two primary laws: RCRA, which is the statutory basis for the ER Project at the Laboratory, and the Comprehensive Environmental Response, Compensation, and Liability Act, which provides a framework for remediating sites at the Laboratory that contain certain hazardous substances not covered by RCRA. The HSWA to RCRA mandates that certain facilities which handle hazardous wastes, including the Laboratory, operate under a formal permit system. The HSWA Module of the Laboratory's RCRA permit prescribes a specific corrective action program. The New Mexico Environment Department regulates the Laboratory's corrective action program under RCRA. The DOE has oversight for those sites not subject to RCRA and for the decommissioning program.

b. Organization. The Laboratory is divided into five contiguous field units based upon both geographical proximity and historical and present uses of the lands in question to cover corrective action activities. Characterization activities have been occurring at many potential (contaminant) release sites (PRSs) to determine the nature and extent of any contamination present. Characterization (drilling, sampling, analysis, and assessment) may lead to a decision of no further action for a particular PRS or aggregate of PRSs, or to containment or cleanup of the site. These decisions are recommended by the Laboratory to the regulatory agency, who must concur before any decision is final. The public also has the opportunity to comment on the Laboratory's recommendations. PRSs that have complete descriptions (the source of the contamination, transport potentials, risks, etc.) and quantitative health-based risk assessments which indicate a threat to human health and/or the environment are subject to corrective action which may include cleanup. A sixth field unit is responsible for decommissioning activities within the ER Project at the Laboratory.

The projection for the completion of the characterization/remediation process at the Laboratory is highly dependent on the availability of funding for the ER Project. Depending on funding, the current projection is between 2005 and 2010. The decommissioning project completion date is subject to the Laboratory's current operations. A summary of ER Project activities completed in 1995 is presented in Section 2.B.1.i.

C. Overview of Quality Assurance Programs

Quality is the extent to which an item or activity meets or exceeds requirements. Quality assurance (QA) includes all the planned and systematic actions and activities necessary to provide adequate confidence that a facility, structure, system, component, or process will perform satisfactorily. In 1995, the Quality Assurance Support Group (ESH-14) provided support for QA functions at the Laboratory. ESH-14 performs QA and quality control audits and surveillance of Laboratory and subcontractor activities in accordance with the Quality Assurance Plan (QAP) for the Laboratory and for specific activities, as requested. The Laboratory's Internal Assessment Group (AA-2) manages an independent environmental appraisal and auditing program that verifies appropriate implementation of environmental requirements. The Quality and Planning Program Office provides management and coordination of the effort to become a customer-focused, unified Laboratory. This office launched a number of initiatives in continuous improvement, including a Quality Council, quality awareness training, staff-level continuous quality improvement (CQI) teams, and management-initiated "re-engineering" teams aimed at the Laboratory's core processes.

Each monitoring activity sponsored by the ESH Division has its own QAP. QAPs are unique to activities but are guided by the need to establish policies, requirements, and guidelines for the effective implementation of regulatory requirements and to meet the requirements of DOE Orders 5400.1 (DOE 1988) and 5700.6C (DOE 1991b). Each QAP must address the criteria for management, performance, and assessments.

QAPs for each environmental monitoring program performed by groups in ESH Division have been included in the current Environmental Monitoring Plan (EMP) (EARE 1995). The EMP is reviewed every year and revised every three years. The QAPs will be revised under DOE Order 5700.6C within two years.

D. Overview of University of California/Department of Energy Performance Assessment Program

During 1996, the Laboratory will be evaluated by the University of California (UC) and DOE based on mutually negotiated performance measures that were established for January 1995 through June 1996. Future performance measure rating periods will be from July to June. The environmental aspects of these performance measures include the following categories:

- radiation protection of the public;
- release incidents;
- toxic chemical releases;
- permit exceedances;
- cited environmental violations, fines, and penalties;
- status of regulatory commitments and milestones;
- waste minimization and pollution prevention; and
- survey of regulator satisfaction.

Specific information on the metrics and the assessments (when available) can be obtained from the new Northern New Mexico University of California Office. Request the document titled "1996 Appendix F Measures for Environment, Safety, and Health."

E. Community Relations and Stakeholder Involvement

In order to develop a more open and participatory culture, as well as to comply with external directives, the Laboratory has committed itself to ensuring that stakeholders receive appropriate information on existing and planned facilities, programs, and technologies. Successful interaction and dialogue are based upon honesty and forthrightness, and enable stakeholders to understand issues important to their welfare, to participate in the decision-making process, and to interact with the Laboratory in a climate fostering trust and cooperation.

Recognizing that an increase in public involvement initiatives would require carefully planned and coordinated efforts, in November 1993, the Laboratory established the Stakeholder Involvement Office to form strong and lasting relationships with internal customers and external stakeholders that are based on mutual respect and trust. In August 1995, the Bradbury Science Museum and the Laboratory Outreach Group also became part of the office, and its name was changed to Community Involvement and Outreach (CIO).

The CIO works with the Laboratory's stakeholders including neighboring individuals and groups, local and state governments, tribal governments, special interest groups, UC, DOE, federal agencies, and Laboratory staff.

One of the primary responsibilities of the CIO was to oversee the public involvement related activities of Laboratory programs from an institutional perspective to ensure consistency and quality across programs, and to provide technical information at a level appropriate for its intended audience. Other core responsibilities in 1995 included the following:

- stakeholder involvement guidance and support to technical divisions, program offices, operational divisions, resources organizations, and for institutional efforts;
- development and implementation of Laboratory policy and vehicles for stakeholder involvement and information dissemination;
- stakeholder inreach and relationship building with DOE, LANL, and UC;
- communication and relationship building with tribal governments, local governments, and special interest groups; and
- administration of the Laboratory's Native American Program.

Public Meetings

During 1995, the CIO planned, managed, or supported 130 meetings on various topics such as Stockpile Stewardship and Management, domestic production of molybdenum-99, the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, environmental restoration, and diversity. This increased from 82 public meetings in 1994.

The CIO coordinated, managed, or supported public involvement for 37 projects, including continuing support for the Northern New Mexico Citizens' Advisory Board to DOE and LANL, the Laboratory's Diversity Strategic Plan and its Strategic Thinking Process, the Site-Wide Environmental Impact Statement (EIS), and the DARHT EIS.

The CIO will continue to collaborate with Laboratory technical programs to sponsor special public briefings and tours of waste management facilities, sampling sites for the ER Project, and facilities related to selected programmatic initiatives.

Tribal Government Liaison

Through the Tribal Government Liaison, the CIO supports the LANL/Tribal Environmental Quality Working Group and the Tribal Cooperative Agreement Implementation Team. Work during 1995 included assisting in the implementation of cooperative agreements with several neighboring pueblos.

Rio Grande Intergovernmental Council

The CIO played a key role in the establishment of the Rio Grande Intergovernmental Council, composed of government representatives from 11 municipalities and 5 counties within a 60-mi radius of the Laboratory. Monthly meetings address issues of mutual concern to local governments and the Laboratory.

Tours and Queries

The CIO is the primary Laboratory recipient of all queries from local and tribal governments and special interest groups and queries having environmental, safety, and health; technical; or programmatic content. Some vehicles for involvement include public and special meetings and specialized tours. The CIO provided tours for interested members of neighboring pueblos, special interest groups, local government officials, and community leaders of facilities or areas related to issues such as expedited cleanup, expansion of a waste disposal site, and hyrodynamic testing.

Community Reading Room

During 1995, the Los Alamos Community Reading Room received 1,281 visitors, an increase from the 1,249 visitors in 1994. The Reading Room serves as a repository for documents of interest to the public about the Laboratory's activities. Other repositories for information were established in public libraries in Santa Fe, Española, Taos, and Las Vegas.

Bradbury Science Museum

The Bradbury Science Museum is an area of the Laboratory that is open to the public and where aspects of the Laboratory's work can be viewed. During 1995, the Museum received more than 130,000 visitors, the majority of whom live out of New Mexico. In addition, the Museum hosted more than 5,000 students, ranging from elementary school students to college attendees. The co-location of the Museum and the Community Reading Room in the Los Alamos townsite encourages people to visit both locations.

Speakers' Bureau

The Laboratory supplies speakers to organizations that would like to learn more about aspects of the Laboratory and its work. In 1995, Laboratory speakers gave approximately 542 talks to an estimated audience of more than 57,000 people. Some of the topics covered were accelerator technology, DARHT, and the Laboratory's environmental programs.

Taos Outreach Office

As part of its effort to improve dialogue with surrounding communities, the CIO opened its second outreach office in 1995, in Taos. The purpose of the office is to provide residents of northern New Mexico with easy, local access to information about the Laboratory and to engage in ongoing communication between the Laboratory and residents of Taos County.

Public Information

Some primary vehicles for information dissemination include the Community Reading Room, fact sheets, special publications, quarterly reports, briefings, advertisements, and a stakeholder mail list and database. In 1995, the CIO instituted both an electronic mail address (cio@lanl.gov) and "community" pages for the Internet (http:/www.lanl.gov/Public/Community/Welcome.html), which are accessible from the Laboratory's external home page. The "community" pages on the Internet present an opportunity for the Laboratory to reach a global audience, while at the same time posing a challenge to put forth public information in a way that is timely, appropriate, and unique among other DOE national laboratories. In addition to primary telephone banks, toll-free telephone lines are maintained for receiving queries (1-800-508-4400).

The CIO is committed to using these types of communication tools to create viable access points for the public to the Laboratory and disseminating information that is accurate, complete, and timely.

F. References

Blake 1995: W.D. Blake, F. Goff, A. Adams, and D. Counce, "Environmental Geochemistry for Surface and Subsurface Waters in the Pajarito Plateau and Outlying Areas, New Mexico," Los Alamos National Laboratory report LA-12912-MS (May 1995).

Bowen 1990: B. M. Bowen, "Los Alamos Climatology," Los Alamos National Laboratory report LA-11735-MS (May 1990).

Bowen 1992: B. M. Bowen, "Los Alamos Climatology Summary," Los Alamos National Laboratory report LA-12232-MS (March 1992).

DOE 1988: US Department of Energy, "General Environmental Protection Program," US Department of Energy Order 5400.1 (November 1988).

DOE 1990: US Department of Energy, "Radiation Protection of the Public and the Environment," US Department of Energy Order 5400.5 (February 1990).

DOE 1991a: US Department of Energy, "Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Nonreactor Nuclear Facilities," US Department of Energy Order 5480.20 (February 1991).

DOE 1991b: US Department of Energy, "Quality Assurance," US Department of Energy Order 5700.6C, II (August 1991).

DOE 1995: US Department of Energy, "1995 DOE Pollution Prevention Crosscut Plan - July 1995," US Department of Energy Office of the Secretary (1995).

EARE 1995: Environmental Assessments and Resource Evaluations Group, "Environmental Monitoring Plan," Los Alamos National Laboratory document LA-UR-95-3770 (1995).

LANL 1995: "Institutional Plan FY 1996–FY 2001," Los Alamos National Laboratory report LALP-95-150 (October 1995).

Purtymun 1974: W. D. Purtymun and S. Johansen, "General Geohydrology of the Pajarito Plateau," New Mexico Geological Society Guidebook, 25th Field Conference, Ghost Ranch, New Mexico (1974).

Purtymun 1977: W. D. Purtymun, J. R. Buchholz, and T. E. Hakonson, "Chemical Quality of Effluents and the Influence on Water Quality in a Shallow Aquifer," Journal of Environmental Quality 6 (l) (1977).

2. Compliance Summary

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A. Introduction

Many Los Alamos National Laboratory (LANL or the Laboratory) activities and operations involve or produce liquids, solids, and gases that contain radioactive and/or nonradioactive hazardous materials. Laboratory policy directs its employees to protect the environment and meet compliance requirements of applicable federal and state environmental protection regulations. This policy fulfills Department of Energy (DOE) requirements to protect the public, the environment, and worker health and to comply with applicable environmental laws, regulations, and orders.

Federal and state environmental laws address handling, transport, release, and disposal of contaminants, pollutants, and wastes, as well as protection of ecological, archaeological, historic, atmospheric, and aquatic resources. Regulations provide specific requirements and standards to ensure maintenance of environmental qualities. Table 2-1 presents a list of the major environmental legislation that affects the activities of the Laboratory and serves as an outline for the first section of this chapter. The Environmental Protection Agency (EPA), DOE, the New Mexico Environment Department (NMED), and the New Mexico Environmental Improvement Board (NMEIB) are the principal authorities administering the regulations to implement these laws. The environmental permits issued by these organizations and the specific operations and/or sites affected are presented in Table 2-2.

The Compliance Summary is divided into two sections: Compliance Status and Current Issues and Actions. The Compliance Status section discusses the major environmental acts that the Laboratory operated under in 1995. The Current Issues and Actions section discusses other compliance issues that are not covered under the Compliance Status.

B. Compliance Status

1. Resource Conservation and Recovery Act

a. Introduction. The Laboratory produces a wide variety of hazardous wastes. The Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, mandates a comprehensive program to regulate hazardous wastes, from generation to ultimate disposal. The amendments emphasize reducing the volume and toxicity of hazardous waste. They require treatment of hazardous waste before land disposal. Table 2-3 lists the hazardous waste management facilities at the Laboratory.

EPA or an authorized state grants RCRA permits to specifically regulate hazardous waste and the hazardous component of radioactive mixed waste. A RCRA Part A permit application identifies (1) facility location, (2) owner and operator, (3) hazardous or mixed wastes to be managed, and (4) hazardous waste management methods and units. A facility that has submitted a RCRA Part A permit application for an existing unit is allowed to manage hazardous or mixed wastes under transitional regulations known as the Interim Status Requirements pending issuance (or denial) of a RCRA Operating Permit. (Note: The term unit as it is used in this section refers to RCRA hazardous waste management areas). The RCRA Part B permit application consists of a detailed narrative description of all facilities and procedures related to hazardous or mixed waste management. The DOE and the University of California (UC) were granted a hazardous waste facility permit on November 8, 1989.

The EPA granted base RCRA authorization to New Mexico on January 25, 1985, transferring regulatory control of hazardous wastes under RCRA to the NMED. State authority for hazardous waste regulation is set forth in the New Mexico Hazardous Waste Act (NMHWA) and Hazardous Waste Management Regulations (20 NMAC 4.1) which adopted, with a few minor exceptions, all of the federal codification for regulations in effect on July 1, 1993, concerning the generation and management of hazardous waste. On July 25, 1990, the State of New Mexico's Hazardous Waste Program was authorized by the EPA to regulate mixed waste in lieu of the federal program.

Current permitting activities center around the NMED's newly proposed approach to permitting facilities at LANL. Permits will be issued for individual technical areas (TAs). Previously there was only one umbrella permit covering all hazardous and mixed waste units at all TAs. There are approximately 12 TAs that conduct either treatment or storage of hazardous and/or mixed waste. The Laboratory is currently negotiating a schedule to submit permit applications to NMED for interim status and new units. These applications will address several categories of waste handling units. Competition for funding of these permitting activities is driven by compliance needs.

The application LANL submitted for the modification of transuranic (TRU) pads 1, 2, 4 and the addition of TRU storage domes A, B, C, and D was conditionally approved by NMED on May 11, 1994. A waste analysis plan and a schedule for further characterization of the TRU wastes on pads 1, 2, and 4 that responded to all of the state's requirements was provided to NMED on March 31, 1995. LANL had not received a response to this submittal from NMED in 1995.

LANL is developing a revised application for the units at TA-16. This application will encompass needed changes to the operations to improve combustion efficiency while reducing air emissions. Additionally, this revision will cover the eventual closure of the burn pad and the oil solvent burn tray operation while including those two operations at a newly improved adjacent location. This will address NMED concerns of the burn pad potentially recontaminating an Environmental Restoration (ER) Project site currently under remediation downgradient from the burn pad.

The development of a permit application for TA-55 is nearing completion. The Hazardous & Solid Waste Group (ESH-19) will submit the application to NMED for review in 1996. An application addressing units at TA-14, 15, 36, and 39 is in the early stages of development; submittal is anticipated for sometime in 1996. LANL submitted modification packages for storage at the Radioassay and Nondestructive Testing (RANT) facility at TA-54, West; storage at Waste Characterization, Reduction, and Repackaging Facility at TA-50; and storage at the TA-50-1 Decontamination Facility.

LANL is continuing a dialogue with NMED to establish a strategy for permitting the remaining mixed waste units at TA-54, along with the renewal of the existing permit for that TA. Inclusion of the Transuranic Waste Inspectable Storage Project (TWISP) pads and domes, as well as the RANT facility, will have to be considered in order to follow NMED's new approach for permitting TAs.

A decision to close the Controlled Air Incinerator (CAI) at TA-50 was made; a RCRA closure plan for this unit has been submitted to NMED for its approval. Additionally, a request was made to EPA Region 6 to cancel the Toxic Substances Control Act (TSCA) authorization for this unit. EPA responded and withdrew the authorization to incinerate TSCA waste on February 21, 1996. Closure activities are scheduled to be completed by the end of fiscal year (FY) 96.

In calendar year (CY) 95, LANL notified NMED of its intent to conduct five hazardous waste treatability studies. The studies treated and evaluated 48 kg (106 lb) of waste. The two Laboratory facilities that received Research, Development, and Demonstration (RD&D) permits, issued to LANL in CY94 by NMED for the treatment of hazardous waste, did not, in fact, treat any waste in CY95. During the fall of 1995, LANL submitted a modification package to NMED for its RD&D permit for the Packed Bed/Silent Discharge Plasma Unit at TA-35, which would allow the technology to be tested for its capability to destroy hazardous waste.

b. Solid Waste Disposal. The Laboratory has a commercial/special waste RCRA, Subtitle D landfill located at TA-54, Area J. This landfill is in compliance with the requirements of the New Mexico Solid Waste Management Regulations-4 (SWMR). In CY95, LANL/DOE completed the required Solid Waste Facility annual report for the previous year (CY94). In CY95, the TA-54, Area J landfill received and disposed 128 yd^3 of solid waste. Approximately 460 yd^3 of nonradioactive asbestos waste were shipped off site to an approved disposal site. On October 27, 1995, the NMED Solid Waste Bureau conducted an inspection at the Laboratory's TA-54, Area J, special waste landfill. No violations of the NM SWMR-4 were found during the inspection. Radioactive asbestos and asbestos suspected of being contaminated with radioactive material continue to be disposed in a monofill-constructed disposal cell (a cell that receives only one type of waste) at TA-54, Area G. On October 11, 1994, LANL/DOE submitted a groundwater monitoring suspension request to NMED for the TA-54, Area J landfill. The suspension request offered vadose zone (the subsurface above the main aquifer) monitoring in place of groundwater monitoring. NMED has yet to respond to the suspension request.

LANL also disposes of sanitary solid waste and rubble at the Los Alamos County landfill on East Jemez Road, which is DOE property that is operated by the county under a special use permit. Los Alamos County has day-to-

day operating responsibility for the landfill and is responsible for obtaining all related permits for this activity with the state. LANL contributed 22% (2,402,643 kg [2,649 tons]) of the total volume of trash landfilled at this site during CY95 with the remainder contributed by Los Alamos County and the City of Española. LANL also sent 5,159,923 kg (5,689 tons) of concrete/rubble, 703,832 kg (776 tons) of construction and demolition debris, 74,374 kg (82 tons) of brush for composting, and 40,815 kg (45 tons) of metal for recycling to the county landfill construction and demolition area.

Table 2-4 presents a summary of the materials recycled by Johnson Controls, Inc. (JCI), the Laboratory's support services subcontractor, in FY95. This effective waste minimization program, which continues to be expanded, conforms to RCRA, Subtitle D. (See Sections 1.B.2.b and 2.B.1.h. for more information on the Laboratory's recycling program.)

c. Resource Conservation and Recovery Act Closure Activities. Several solid waste management units (SWMUs) are subject to both the HSWA Module VIII corrective action requirements and the closure provisions of RCRA. The corrective action process occurs concurrently with the closure process, thereby satisfying both sets of regulations. NMED is the lead regulatory agency for these sites. The status of these sites is given below.

TA-35, Surface Impoundments. Closure plans for the two surface impoundments for waste oil that are associated with Buildings 85 and 125 at TA-35 were first submitted in October 1988, and the state subsequently gave oral approval to proceed with closure activities. All contents of the impoundments and underlying contaminated soil were removed and disposed of as hazardous waste. Sampling to verify the removal of contaminants from the area was completed in October 1989. Preliminary results of the sampling effort revealed that the criteria for clean closure had been met. The impoundments were backfilled and revegetated at that time. Upon receipt of the final analytical results, it was found that the allowed sample holding times had been exceeded; consequently, the data could not be verified. The closure plan was modified to reflect the events of the field work that occurred and to include bore sampling to be used as the final verification of clean closure. Bore sampling performed in December 1990 determined that the levels of contamination found to remain after this cleanup effort did not exceed the EPA's health-based, risk-based cleanup levels. By achieving these cleanup levels, the Laboratory could still achieve clean closure status for these two units and no post-closure care would be necessary.

The initial closure report and closure certification letters for the TA-35-125 surface impoundments were completed as of July 31, 1991, and were submitted to NMED in August 1991. The NMED sent a Notice of Deficiency (NOD) to DOE in July 1992 and denied approval of clean closure for the TA-35-125 unit. An amended closure plan was submitted to the state on September 4, 1992. The Laboratory received final regulatory approval from NMED in September 1993 on the TA-35-125 amended closure report. No further action is required for this surface impoundment.

The initial closure report and closure certification letters for TA-35-85 were submitted by the Laboratory on December 20, 1991. An amended closure plan for TA-35-85 was submitted to NMED for approval on November 1, 1993. On March 31, 1995, NMED issued an amended closure plan that had not been finalized by the end of the year, although a final closure plan is expected to be approved by NMED in early 1996. The Laboratory expects that additional field work will be required to support the closure.

TA-40, Scrap Detonation Site. On September 13, 1991, NMED notified the Laboratory that the closure plan for the TA-40 Scrap Detonation Site had been approved. The start date of the closure plan was September 30, 1991. This closure is proceeding behind schedule because the original closure plan did not anticipate contamination, which was detected above action levels at several different locations during the sampling phase. The closure plan modification and clean closure equivalency demonstration included risk assessments for the areas where contamination was detected above action levels and was submitted to NMED in May 1993. The Notice of Intent (NOI) to close the site and terminate interim status was issued by NMED on November 1, 1993, which started a 30-day period for receiving comments from the public. An amendment to the closure plan was submitted to NMED in February 1993. The NMED approved the amended closure plan on May 2, 1994. A final closure report was submitted to NMED on March 27, 1995, and approved by NMED on August 23, 1995.

TA-54, Waste Oil Storage Tanks. After discovering hazardous waste in six aboveground waste oil storage tanks, the Laboratory pumped and disposed of the contents as hazardous waste. The tanks were moved to TA-54, Area G to make room for needed facilities at TA-54, Area L. In April 1990, the Laboratory elected to proceed with the closure of these vessels in anticipation of receiving an approved storage plan. After the tanks had been cleaned several times, the final decontamination was completed in August 1990. A final closure plan/report that reflected

the actual closure process of these units was submitted in June 1991. An addendum to the final closure plan was submitted in July 1992. NMED approved the plan in August 1992. Soil sampling at TA-54, Area L to demonstrate clean closure will be performed in conjunction with the HSWA permit corrective activities scheduled during 1999.

TA-16, Landfill at Material Disposal Area P. Closure and post-closure-care plans for the Area P landfill were submitted on November 25, 1985. This area has not been used since 1984. In late 1987, these plans were modified to incorporate standards that this unit would be subject to once the Laboratory received its RCRA permit. Since that time, the ER Project, which oversees closures, has been established. The Laboratory requested an extension of the closure deadlines for this and other units that appear within the HSWA Module of the RCRA permit. An extension of the closure window would allow the ER Project to incorporate the results of the RCRA facility investigation (RFI)/Corrective Actions Study into the closure process. The NMED rejected this approach and requested a revised closure plan by September 1993. NMED indicated that it would allow an extension for evaluation of the outstanding issues.

The Laboratory submitted an amended closure plan on August 31, 1993, proposing additional sampling around the landfill to verify that there is no potential for migration of contaminants during snowmelt or storm events. Pending NMED approval, an asphalt lined surface water diversion channel around the landfill was constructed in November 1993. A NOD for the August 1993 closure plan was received in June 1994. Responses to the NOD, as well as a request for a 120-day extension to address groundwater issues, was submitted to NMED. NMED issued a public notice in early August 1994 that LANL intended to close TA-16, Material Disposal Area P, per the 1993 closure plan. During this time, LANL conducted a cost/benefit study on clean closing versus capping TA-16, Area P. The study concluded that clean closing the landfill would be the most cost effective and environmentally sound option. Therefore, LANL withdrew the August 1993 closure plan. A new closure plan was submitted to NMED in early February 1995 and identifies TA-16, Area P as a waste pile to allow for clean closure under 40 Code of Federal Regulations (CFR) 265.250. The closure plan was under review by NMED at the end of 1995.

TA-53, Surface Impoundments. A closure plan for two of the three surface impoundments located at TA-53 was submitted to NMED in February 1993. This plan was submitted as an alternative to permitting the impoundments as mixed waste units. NMED's comments on the Laboratory closure plan proposing clean closure for the two TA-53 surface impoundments were addressed by the Laboratory in a January 14, 1994, submittal. A revised closure plan for the two surface impoundments was submitted to NMED in early September 1994. A NOD on this closure plan was received by LANL in late October 1994. A response to the NOD was submitted to NMED in mid-December 1994. Additional clarifying information on the closure plan was submitted to NMED in early March 1995; an NOD on this closure plan was received by LANL in late July 1995. The Laboratory responded to the NOD in mid-August 1995. No response from NMED had been received by the end of 1995.

d. Underground Storage Tanks. The Laboratory's underground storage tanks (USTs) are regulated under the New Mexico Underground Storage Tank Regulations. At the end of CY95, the Laboratory had 13 regulated USTs. Of those 13, 11 USTs and their ancillary equipment must be upgraded or taken out of service by the end of CY98.

One UST was removed in CY95. This UST, TA-0-6th Street, was discovered by LANL's ER Project and is suspected to have been abandoned in the late 1960s. When found, the UST held 13,462 L (3,500 gal.) of a water and heating-fuel oil mixture. Upon removal, the UST was found to be leaking. LANL initiated corrective actions and received a letter from NMED in January 1996 stating that no further action was required for this former UST site.

UST TA-18-PL30 contained 2,154 L (560 gal.) of diesel fuel and was removed in September 1993. The site underwent extensive groundwater monitoring due to site contamination from petroleum releases associated with the UST. The groundwater data show concentrations of benzo-a-pyrene and naphthalenes below the concentration listed in Part 3 of the New Mexico Water Quality Control Commission (NMWQCC) regulations. On November 17, 1995, LANL received a letter from NMED stating that no further action was required on this former UST site.

In July 1994, the top of UST TA-16-1456 (containing 38,462 L [10,000 gal.] of unleaded gasoline) was excavated to conduct cathodic protection repairs on the tank. During the excavation, light soil staining and a faint odor of gasoline in the soil near the UST's fuel inlet pipe and vent line were noted. On August 3, 1994, NMED was notified regarding gasoline release from UST TA-6-1456. Several sources were determined to have contributed to the gasoline contamination, but the primary sources were determined to be two other former USTs that had resided in the same area as UST TA-16-1456 in the 1980s prior to their removal. One of these two former

USTs was UST TA-16-196, which was removed in 1987. This UST formerly held 15,385 L (4,000 gal.) of leaded gasoline. Upon removal, it was observed that the UST was extensively corroded and was leaking. Remediation actions involved the removal of several truck loads of contaminated soil from the site, but removal of all the soil was unsuccessful. Currently, the UST site is still under investigation to determine the extent of the former UST TA-16-196 gasoline contamination.

A UST inspection was conducted on January 23 and 24, 1995, by the NMED. From this inspection, DOE received two field Notices of Violation (NOVs) on January 27, 1995. The NOVs cited the absence of a drop tube in UST TA-3-MP-1, located at TA-60, and the lack of monthly fuel inventory reconciliations at UST TA-3-36-2. On February 24, 1995, Certification of Compliance documents were sent to NMED with $200 for the fines associated with the NOVs. There was no petroleum release associated with these NOV findings.

e. Other Resource Conservation and Recovery Act Activities. TA-54, Area L, located on Mesita del Buey, was used for disposal of hazardous waste since before the time such disposal became regulated under RCRA/NMHWA until 1985. Area L is now used for storage of hazardous waste and some mixed waste. Small amounts of new RCRA regulated waste were once placed in TA-54, Area G prior to the effective date of RCRA. Area G was also used for the disposal of mixed waste until 1985; Area G is currently being used for storage of mixed wastes. Information on a groundwater monitoring waiver for both Areas L and G has been submitted to NMED. Vadose zone monitoring is being conducted quarterly throughout Areas L and G to identify any releases from the disposal units. This type of monitoring is used to detect the presence of organic vapor in the vadose zone.

ESH-19 conducts a RCRA Self-Assessment Program designed to assist the Waste Management Coordinators (WMCs) and waste generators in proper storage of hazardous and mixed waste according to environmental, safety, and health requirements and policies. This self-assessment program utilizes personnel from the operating organization, ESH-19, and others, where appropriate. Its goals are to maintain regulatory compliance, to apply regulations and Laboratory policy consistently, and to improve the Laboratory's regulatory compliance performance. The self-assessment program is a formal procedure that follows written guidelines designed to be easily understood and achievable. The program includes an established process to correct deficiencies found during the self-assessment. The WMC has 30 days to respond to ESH-19 indicating what corrective actions were taken, if needed, or the status of any corrective actions that may take longer than the 30 day time limit. ESH-19 maintains a database to track all the observations and whether or not corrective actions were taken. The ESH-19 RCRA Self-Assessment Program is under development and subject to modifications, as needed. This program is an attempt to recognize and resolve specific needs of waste generators in maintaining regulatory compliance and was developed in coordination with the Waste Management Coordinator Program. The program was developed during 1995, and self assessments began in late 1995.

f. Resource Conservation and Recovery Act Compliance Inspection. NMED conducted its annual hazardous waste compliance inspection September 12–18, 1995 (Table 2-5). NMED inspectors visited hazardous waste satellite accumulation, storage, and treatment facilities located throughout the Laboratory.

g. Resource Conservation and Recovery Act Training. During 1995 the ESH Training Group (ESH-13), in conjunction with ESH-19, updated the Laboratory's RCRA training program. RCRA personnel training, a five-hour introductory course, was held for treatment, storage, and disposal (TSD) and less-than-90-day storage area workers. RCRA personnel must take refresher training courses annually. During 1995, 106 workers were trained in RCRA personnel training, 306 received the RCRA refresher training course, and 650 workers were trained in Waste Generation Overview, instruction for hazardous and mixed waste generators.

RCRA TSD personnel who must take Hazardous Waste Operations (HAZWOPER) training have been doing so at LANL for the last several years. In October 1994, ESH-13 developed a HAZWOPER refresher course specific to TSD workers. The course meets the regulatory requirements for both HAZWOPER and RCRA refresher training and is offered monthly throughout the year. During 1995, 202 persons completed the HAZWOPER refresher for TSD Workers.

The RCRA training program, as described in the RCRA permit, is complete and only experienced modifications and revisions in 1995 that reflect regulatory, organizational, and/or programmatic changes. The training courses that were developed in CY95 includethe following:

Waste Management Coordinator Training

Spill Prevention Control and Countermeasures (SPCC) Plan Training

HAZWOPER Refresher for TSD Workers
HAZWOPER Refresher for Environmental Restoration Workers
HAZWOPER - First Responder at the Awareness Level
Storm Water Pollution Prevention Plan Training

A class on Radioactive Materials Management Area training was developed and delivered during 1995. The class is being revised during 1996 to reflect changes in the Laboratory's requirements for handling radioactive waste.

h. Waste Minimization. Section 1003 of RCRA cites the minimization of the generation and land disposal of hazardous wastes as a national objective and policy. All hazardous waste must be handled in ways that minimize the present and future threat to human health and the environment. The act promotes process substitution, materials recovery, and properly conducted recycling, reuse, and treatment as alternatives to land disposal of hazardous waste.

The generation rates for total, routine, and nonroutine RCRA-hazardous and mixed low-level waste generation for CY93, CY94, and CY95 are provided in the list below:

	RCRA-hazardous (kg)			Mixed low-level (m^3)		
	1993	**1994**	**1995**	**1993**	**1994**	**1995**
Routine	75,570	58,147	25,725	29.47	21.12	6.29
Nonroutine	600	126,960	1,132,740	2.42	42.43	80.56
Total	76,170	185,107	1,159,465	31.89	63.55	86.85

DOE defines routine waste generation as

> "waste produced from any type of production operation, analytical and/or R&D laboratory operations; TSD operations, 'work for others', or any other periodic and recurring work that is considered ongoing in nature" (DOE 1995).

Routine/normal waste generation at LANL includes those activities that occur regularly and generate a waste stream of a predictable quantity and characterization. Routine activities constitute the waste generation baseline for that area which can be trended over an extended time period, provided the mission of the area did not change to the extent that it altered the waste generating activities of that area.

DOE defines nonroutine waste generation as

> "wastes produced from environmental restoration program activities, including primary and secondary wastes associated with retrieval and remediation operations; 'legacy wastes'; and D&D/Transition operations…" including one-time operations waste, facility upgrades, PCB and/or asbestos abatement and removal operations" (DOE 1995).

Nonroutine/off-normal waste generation at LANL can be identified as those waste generating activities that occur on an unscheduled basis and/or that produce a waste stream of unpredictable quantity and/or characterization. Because of the unpredictable schedule and/or characterization of the waste, generation from nonroutine/off-normal activities cannot be trended over an extended time period.

As evidenced in the waste generation list above, LANL continues to minimize its routinely generated hazardous and mixed low-level waste generation. Nonroutine waste generation has steadily increased, however, for both waste types due in large part to the increase in environmental restoration/decontamination and decommissioning activities occurring at LANL. Increased total mixed low-level waste generation in 1995 can also be explained by the moratorium on mixed low-level waste generation from May 8, 1992, to March 15, 1994. A full description of the moratorium is found in "Environmental Surveillance at Los Alamos during 1994" (EG 1996).

i. Hazardous and Solid Waste Amendments Compliance Activities. In 1995, the ER Project remained in compliance with Module VIII of the RCRA permit; however, NMED notified the Laboratory that its groundwater

monitoring and characterization are not sufficient to meet the requirements of the special conditions of the permit. Two Class 3 permit modification proposals were submitted in March and April 1995, requesting removal of 148 SWMUs from the HSWA Module list and recommending no further action for 428 areas of concern that are not on the HSWA Module list. EPA has not yet approved these proposals.

During 1995, an additional 356 sites were proposed for no further action in 19 field investigation reports submitted to EPA. The ER Project also cleaned up 45 sites, including areas in the Los Alamos townsite. The work plan for Los Alamos and Pueblo Canyons' investigation was submitted in November 1995, but other canyon work plans have been delayed because of funding constraints.

It was determined that the ER Project would not generate as much mixed waste as originally thought. Therefore, it was decided during 1995 to terminate work on the design for the mixed waste disposal facility. Work on the facility may resume in the future if need for it once again becomes apparent.

In 1995, the ER Project began negotiations on a Document of Understanding (DOU) among the Laboratory, Sandia National Laboratory, DOE, EPA, and NMED. This DOU is intended to facilitate timely and cost-effective implementation of ER programs at the Laboratory and Sandia. It provides a basis for standardization in planning and execution of both programs. The DOU should be finalized in 1996.

2. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 mandates actions for certain releases of hazardous substances into the environment. LANL is not listed on the EPA's National Priority List but is subject to the CERCLA guidelines for remediating ER Project sites that contain certain hazardous substances not covered by RCRA.

3. Emergency Planning and Community Right-to-Know Act

a. Introduction. Title III, Section 313, of the Emergency Planning and Community Right-to-Know Act (EPCRA) requires facilities meeting certain standard industrial classification (SIC) code criteria to submit an annual Toxic Chemical Release Inventory (TRI) report. A report describing the use and emissions from Section 313 chemicals must be submitted to EPA and the New Mexico Emergency Management Bureau every July for the preceding calendar year.

The Laboratory does not meet the SIC code criteria for reporting but has voluntarily submitted annual TRI reports since 1987. All research operations are exempt under provisions of the regulation, and only pilot plants, production, or manufacturing operations at the Laboratory are reported. In previous years, this has limited the Laboratory's release reporting to regulated chemical use at the Plutonium Processing Facility at TA-55.

On August 3, 1993, the President of the United States issued Executive Order (EO) 12856 requiring all federal facilities, regardless of SIC code to report under Title III, Section 313 of EPCRA. Research operations remain exempt. This requirement was effective for the July 1995 report that covered the preceding CY94. The Laboratory, along with DOE, elected to begin reporting under the new guidelines for the 1994 report. The 1995 report included two chemicals, chlorine for water treatment and sulfuric acid used to deionize water at the Laboratory's main power plant (TA-3-22); the 1995 report covers the releases of chlorine and sulfuric acid during 1994. Approximately 7,636 kg (16,799 lb) of chlorine were used in water purification operations involving noncontact cooling water, sewage treatment, and drinking water resulting in air emissions of 368 kg (810 lb) of chloroform and 1.8 kg (4 lb) of chlorine. An estimated 1,447 kg (3,184 lb) of chlorine were released with the discharged water. In addition, 13,960 kg (30,711 lb) of sulfuric acid used to deionize water at the Laboratory's main power plant were reported. Sulfuric acid use at the power plant was substantially decreased (10,470 kg [23,034 lb] less than that used in 1993) due to the installation of newer, more efficient ionization beds. Sulfuric acid operations resulted in less than a half kg (less than a lb) of air emissions. All spent sulfuric acid was completely neutralized before discharge to the environment.

Nitric acid used in 1994 for plutonium processing at TA-55 did not meet the threshold reporting limit of 4,546 kg (10,000 lb) due to operational shutdowns at the facility.

b. Emergency Planning and Community Right-to-Know Act Summary. The Laboratory submits four reports each year in compliance with DOE guidance for EPCRA:

		Reporting Required		
Statute		**Yes**	**No**	**Not Required**
EPCRA 302-303:	Planning Notification	×		
EPCRA 304:	Extremely Hazardous Substances Release Notification	×		
EPCRA 311-312:	Material Data Safety Sheet/ Chemical Inventory	×		
EPCRA 313:	TRI Reporting	×		

c. Emergency Planning. In accordance with DOE orders in the 5500 series, it is the Laboratory's policy to develop and maintain an emergency management system that includes emergency planning, emergency preparedness, and effective response capabilities for responding to and mitigating the consequences of an emergency. The Laboratory's Emergency Management Plan is a document that describes the entire process of planning, responding to, and mitigating the potential consequences of an emergency. The most recent revision of the plan was completed in September 1994; future revisions will be distributed on an as-needed basis.

4. Toxic Substances Control Act

Unlike other statutes which regulate chemicals and their risk after they have been introduced into the environment, TSCA was intended to require testing and risk assessment before a chemical is introduced into commerce. TSCA also establishes record keeping and reporting requirements for new information regarding adverse health and environmental effects of chemicals; governs the manufacture, use, storage, handling, and disposal of polychlorinated biphenyls (PCBs); and sets standards for PCB spill clean ups. Because the Laboratory's activities are in the realm of research and development and do not involve introducing chemicals into commerce, the PCB regulations (40 CFR 761) have been the Laboratory's main concern under TSCA. Substances that are governed by the PCB regulations include but are not limited to dielectric fluids, contaminated solvents, oils, waste oils, heat transfer fluids, hydraulic fluids, slurries, soils, and materials contaminated as a result of spills. Most of the provisions of the regulations apply to transformers, capacitors, and other PCB items with concentrations above a specified level. For example, the regulations regarding storage and disposal of PCBs generally apply to items with PCB concentrations of 50 ppm or greater.

In 1995, the last seven high concentration (>500 ppm PCBs) PCB transformers were replaced with non-PCB transformers. The Laboratory still operates 18 PCB-contaminated (between 50 and 500 ppm PCBs) transformers which will be replaced as funding becomes available. The Laboratory, through JCI, is conducting a PCB survey which is scheduled to be completed in 1996. PCB items identified during the survey are added to the Laboratory's PCB inventory. The inventory is continually updated as items are disposed of and new items are discovered during the survey. During 1995, 1,195 structures were inspected, 1,490 potential PCB items were inspected, 202 samples of potential PCB items were collected and analyzed, and 88 PCB items were identified. The types of items inventoried by the survey include transformers, various pumps, oil-filled switches, light ballasts, generators, small transformers, and capacitors. Most items are scheduled for disposal as soon as they are discovered. The survey involves visual inspection, manufacturers' data, record searches, sample collection, and laboratory analytical testing.

Analytical testing for PCBs is also performed for other TSCA compliance activities such as waste characterizations and transformer concentration verifications. A total of 257 samples was analyzed for PCBs at the Laboratory in 1995. Analytical results are attached to waste tracking forms, and the item tested is appropriately marked. Once identified, inventoried, and marked, waste materials with 50 ppm PCBs or greater which do not contain radioactive constituents are transported off site for treatment and disposal in accordance with TSCA.

In 1995, the Laboratory had 10 off-site shipments of PCB waste. The total weight of PCBs in those shipments was 1,420,073 kg (3,130,692 lb). PCB wastes are sent to EPA-permitted disposal and treatment facilities. The quantities of waste types disposed were 80 capacitors, 23 drums of light ballasts, 7 transformers, 1 drum of water, 10,933 kg (24,105 lb) of PCB oil, and 1,272,392 kg (2,805,115 lb) of PCB contaminated soil. All wastes are tracked from the point of generation to final disposal. Documentation, such as waste manifests and verification of

shipment receipts, is kept on file. Certificates of Destruction for each waste are sent to the Laboratory by all treatment or disposal facilities.

Liquids containing greater than 50 ppm PCBs and radioactive constituents are stored at the TA-54, Area L TSCA storage facility. Many of these items have exceeded TSCA's one year storage limit. A total of 51 drums of PCB and radioactively contaminated wastes are stored awaiting completion of a national storage agreement involving DOE and EPA. These wastes must be stored due to the lack of any EPA-approved disposal facility for this type of waste. This noncompliance issue is well documented and numerous communications have been taking place between EPA Region 6 and LANL/DOE representatives. Nonliquid wastes containing greater than 50 ppm PCBs and radioactive constituents are disposed at the Laboratory's EPA-authorized TSCA landfill located at TA-54, Area G.

The Laboratory's TSCA disposal facility at TA-54, Area G disposed 16 kg (35 lb) of radioactively contaminated PCB waste during 1995. Although the volumes of this type of waste were expected to be minimal over the next several years, environmental restoration cleanups may generate more significant volumes of waste to be disposed on site if suitable off-site options are not identified. LANL has therefore requested renewal of the 1980 EPA authorization for on-site PCB waste disposal. Representatives of the Laboratory have actively discussed renewal conditions with EPA since 1991. New authorization is expected to be final in 1996.

Compliance documents pertaining to the above activities are compiled and written on a routine basis. The two primary compliance documents are the Annual PCB Document (LANL 1996) (includes the annual inventory log and disposal records required by 40 CFR 760.180) and a semiannual PCB letter (required by Condition 6 of the EPA Approval for LANL to Operate a PCB Landfill). EPA did not conduct an audit of the Laboratory's PCB management program during 1995.

5. Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates the manufacturing of pesticides, with requirements on registration, labeling, packaging, record keeping, distribution, worker protection, certification, experimental use, and tolerances in foods and feeds. Sections of this act that are applicable to the Laboratory include recommended procedures for storage and disposal, and requirements for certification of workers who apply pesticides. The Laboratory is also regulated by the New Mexico Pest Control Act, administered by the New Mexico Department of Agriculture (NMDA), which regulates pesticide use, storage, and certification. NMDA conducts annual inspections of JCI's compliance with the act. The application, storage, disposal, and certification of these chemicals is conducted in compliance with these regulations. JCI certified applicators apply pesticides at the direction of the Laboratory's Pest Control Program Administrator. The Laboratory Pest Control Management Plan, which includes programs for vegetation, insects, and small animals, was established in 1984 and is revised as needed by the Pest Control Oversight Committee, a committee established to review and recommend policy changes in the overall pest management program at the Laboratory. NMDA did not conduct an annual inspection of the Laboratory's pesticide application program and certified application equipment during 1995.

6. Federal Clean Air Act

a. Federal Regulations. The Laboratory is subject to a number of federal air quality regulations. These include

- National Emission Standards for Hazardous Air Pollutants (NESHAP);
- National Ambient Air Quality Standards;
- New Source Performance Standards (NSPS);
- Stratospheric Ozone Protection (SOP); and
- Operating Permit Program.

All of the above requirements that are applicable to LANL, except the NESHAP for radionuclides and provisions relating to SOP, have been adopted by the State of New Mexico as part of its State Implementation Plan.

Therefore, all of these regulations, except the radionuclide NESHAP and SOP, are discussed in Section 7, New Mexico Air Quality Control Act.

In addition to the existing federal programs, the 1990 amendments to the Clean Air Act (CAA) mandate new programs that may affect the Laboratory. The new requirements include control technology for hazardous air pollutants, enhanced monitoring, prevention of accidental releases, and chlorofluorocarbon replacement. The Laboratory will track new regulations written to implement the act, determine their effects on Laboratory operations, and implement programs as needed.

b. Compliance Activities.

Radionuclide NESHAP. Under 40 CFR 61, Subpart H, the EPA limits the effective dose equivalent to any member of the public from radioactive airborne releases from DOE facilities, including LANL, to 10 mrem/yr. The 1995 effective dose equivalent (as calculated using EPA-approved methods which do not allow the use of shielding factors) was 5.05 mrem/yr, primarily from the Los Alamos Neutron Science Center (LANSCE) operations. LANSCE was formerly called the Los Alamos Meson Physics Facility. Any construction or modifications undertaken at LANL that will increase airborne radioactive emissions require preconstruction approval from EPA. In 1995, 169 such projects were received by Air Quality (ESH-17) for Laboratory review; only one of these was determined to require preconstruction approval**.**

A detailed description of the NESHAP Federal Facility Compliance Agreement (FFCA) is in Section 2.C.1.d.

Stratospheric Ozone Protection. Effective July 1, 1992, Section 608 (National Emission Reduction Program) of the Clean Air Act Amendments (CAAA) of 1990 prohibits individuals from knowingly venting ozone depleting substances (ODS) used as refrigerants into the atmosphere while maintaining, servicing, repairing, or disposing of air conditioning or refrigeration equipment. JCI recovers and recycles all ODS during servicing and repair of all refrigeration equipment at the Laboratory and does not vent ODS to the atmosphere. Final regulations concerning the type of recovery/recycling equipment to be used and the procedures for using this equipment became effective on July 13, 1993.

Section 609 (Servicing of Motor Vehicle Air Conditioners) of the CAAA established standards and requirements related to recycling equipment used in the servicing of motor vehicle air conditioners, and training and certification of technicians providing such services. JCI, in full compliance with these regulations, provides all servicing and maintenance relating to automotive air conditioning equipment at the Laboratory.

Section 611 (Labeling of Products Using ODS) of the CAAA established requirements that no product containing Class I or II ODS or any product containing Class I ODS may be shipped across state lines unless it bears an appropriate warning label. This regulation came into effect on November 11, 1993. ESH-17 worked with groups that ship ODS products and ODS-containing waste off site to ensure that the proper labeling requirements were met.

7. New Mexico Air Quality Control Act

a. State Regulations. The NMEIB, as provided by the New Mexico Air Quality Control Act, regulates air quality through a series of air quality control regulations in the New Mexico Administrative Code (NMAC). These regulations are administered by NMED. The NMACs (formerly called Air Quality Control Regulations) relevant to Laboratory operations are discussed below.

b. Compliance Activities.

20 NMAC 2.60-Regulation to Control Open Burning. Provisions of 20 NMAC 2.60 regulate the open burning of materials. Under this regulation, open burning of explosive materials is permitted when transport of these materials to other facilities may be dangerous. Provisions of this regulation allow DOE and the Laboratory to burn waste explosives. Research projects require open burning permits. In 1995, the Laboratory had five open burning permits: one for the open burning of jet fuel and wood for ordnance testing at TA-11, K Site; one for the open burning of explosive-contaminated materials at TA-14; one for the open burning of explosive-contaminated materials at TA-16; one for burning explosive-contaminated wood at TA-36; and one for open burning of explosive-contaminated materials TA-39 (Table 2-2).

20 NMAC 2.61-Regulations to Control Smoke and Visible Emissions. Provisions of 20 NMAC 2.61 limit the visible emissions allowed from the Laboratory boilers to less than 20% opacity. Opacity is the degree to which emissions reduce the transmission of light and obscure the view of a background object. Because the

Laboratory boilers are fueled by clean-burning natural gas, exceeding this standard is unlikely. It may, however, occur during start-up with oil, the backup fuel for the boilers. Although oil is used infrequently, the boilers must be periodically switched to oil to ensure that the backup system is operating properly. Opacity is read during these switches. Only one exceedance of the opacity standard occurred in 1995; it occurred at the TA-16 steam plant. Notification procedures, as required by 20 NMAC 2.07, were followed.

20 NMAC 2.11-Asphalt Process Equipment. Provisions of 20 NMAC 2.11 set emission standards according to process rate and require the control of emissions from asphalt-processing equipment. The asphalt concrete plant operated by JCI is subject to this regulation. The plant, which has a 68,162 kg/h (75 ton/h) capacity, is required to meet an emission limit of 15 kg (33 lb) of particulate matter per hour. A stack test of the asphalt plant in August 1992 indicated an average emission rate of 1.9 kg/h (4.2 lb/h) and a maximum rate of 2.3 kg/h (5.1 lb/h) over three tests (Kramer 1993). Although the plant is old and is not required to, it meets NSPS stack emission limits for asphalt plants.

20 NMAC 2.18-Oil Burning Equipment-Particulate Matter. This regulation applies to an oil burning unit having a rated heat capacity greater than 250 million Btu per hour. Oil burning equipment of this capacity must emit less than 0.03 lb per million Btu of particulate. Although the Laboratory boilers use oil as a backup fuel, all have maximum rated heat capacities below this level; consequently, this regulation does not apply. The TA-3 power plant operates the three highest heat capacity boilers, each of which had an observed maximum capacity of 210 million Btu/h.

20 NMAC 2.33-Gas Burning Equipment-Nitrogen Dioxide. Provisions of 20 NMAC 2.33 require gas burning equipment built before January 10, 1972, to meet an emission standard of 0.3 lb of nitrogen dioxide per million Btu when natural gas consumption exceeds 1×10^{12} Btu/yr/unit. Only the TA-3 steam plant has the capacity to operate at this level. While the TA-3 steam plant has the capacity to operate at this level, it never has and is therefore not an applicable source for this regulation. However, stack tests done in 1995 indicate that the TA-3 power plant meets the emission standard.

20 NMAC 2.31-Oil Burning Equipment-Sulfur Dioxide. This regulation applies to oil burning equipment having a heat input of greater than 1×10^{12} Btu/yr. Although the Laboratory uses oil as a backup fuel, no oil-fired equipment exceeds this threshold heat input rate. Therefore, this regulation did not apply during 1995 to the Laboratory fuel burning equipment. Should such equipment operate above the heat input limit, emissions of sulfur dioxide would be required to be less than 0.34 lb per million Btu.

20 NMAC 2.34-Oil Burning Equipment-Nitrogen Dioxide. This regulation applies to oil burning equipment having a heat input of greater than 1×10^{12} Btu/yr. Although the Laboratory uses oil as a backup fuel, no oil-fired equipment exceeds this threshold heat input rate. Therefore, this regulation did not apply during 1995 to the Laboratory fuel burning equipment. Should such equipment operate above the heat input limit, emissions of nitrogen dioxide would be required to be less than 0.3 lb per million Btu.

20 NMAC 2.72-Permits. Provisions of 20 NMAC 2.72 require permits for any new or modified source of potentially harmful emissions if they exceed threshold emission rates. More than 500 toxic air pollutants are regulated, and each chemical's threshold hourly rate is extrapolated from an occupational exposure limit. The Laboratory reviews each new and modified source and makes conservative estimates of maximum hourly chemical usage and emissions. These estimates are compared with the applicable 20 NMAC 2.72 limits to determine if additional permits are required. During 1995, over 190 source reviews were conducted. None of these sources required permits under 20 NMAC 2.72.

20 NMAC 2.74-Prevention of Significant Deterioration. These regulations have stringent requirements that must be addressed before the construction of any new, large stationary source can begin. Wilderness areas, national parks, and national monuments receive special protection under this regulation. This could impact the Laboratory due to the proximity of Bandelier National Monument's Wilderness Area. Each new or modified source at the Laboratory is reviewed to determine whether this regulation applies; however, none of the new or modified sources in 1995 have resulted in emission increases considered "significant," and they were therefore not subject to this regulation.

20 NMAC 2.78-Emission Standards for Hazardous Air Pollutants. In this regulation, NMEIB adopted by reference all of the federal NESHAP, except those for radionuclides and residential wood heaters. The impact of each applicable NESHAP is discussed below:

Asbestos. Under the NESHAP for asbestos, the Laboratory must ensure that no visible asbestos emissions to the atmosphere are produced by asbestos removal operations at the Laboratory. During 1995, no Laboratory operation

produced visible asbestos emissions.

The Laboratory is also required to notify NMED of asbestos removal activities and disposal quantities. Such activities involving less than 15 m^2 (160 ft^2) or 74 m (260 lin ft) are covered by an annual small job notification to NMED. For projects involving greater than these amounts of asbestos, separate notification to NMED is required in advance of each project. NMED is notified of asbestos wastes (both small and large jobs) on a quarterly basis, which includes any material contaminated, or potentially contaminated, with radionuclides. Radioactively contaminated material is disposed of on site in a designated radioactive asbestos burial area. Nonradioactive asbestos is transported off site to designated asbestos disposal areas.

During 1995, LANL shipped off site for disposal 52 m^3 (1,846 ft^3) of small job asbestos waste. One ER project generated an additional 66.9 m^3 (2,362 ft^2) of nonfriable asbestos waste.

A total of 107.6 m^3 (3,799 ft^3) of potentially radioactive contaminated asbestos and asbestos wastes known to have low-level contamination was disposed of on site. Small job activity accounted for 68.2 m^3 (2,407 ft^3). The large demolition job at TA-21-3 and 4 South that was started in 1993 and is not complete, accounted for 38.2 m^3 (1,349 ft^3). A small amount, 1.2 m^3 (43 ft^3) came from a large job that was scaled back and then canceled at the Chemistry and Metallurgy Research (CMR) building.

Beryllium. The beryllium NESHAP includes requirements for notification, emission limits, and stack performance testing for beryllium sources. The Laboratory has previously received four beryllium permits from NMED (Table 2-2) and has registered several additional facilities. The registered facilities do not require permits under the regulations because they existed before the adoption of the federal NESHAP. Exhaust air from each of the beryllium operations passes through air pollution control equipment before exiting from a stack. A fabric filter controls emissions from TA-3-39. The other operations use high-efficiency particle air filters to control emissions, with efficiencies of 99.95%. Source tests for the existing operations have demonstrated that all beryllium operations meet the permitted emission limits set by NMED and have a negligible impact on ambient air quality.

20 NMAC 2.70-Operating Permits. The NMED Operating Permit Program was approved by EPA in December 1994. This regulation requires major sources of air pollution to obtain an operating permit with the NMED. Because of LANL's large potential to emit regulated air pollutants (primarily from the steam plants), LANL is considered a major source. The permit specifies the operational terms and limitations required to meet all federal and state air quality regulations. During 1995, the Laboratory prepared the Operating Permit application. It was submitted to NMED in December 1995.

20 NMAC 2.71-Fees. As part of the new Operating Permit Program, the State of New Mexico will begin to charge yearly fees to sources of air pollution that are required to obtain an operating permit. Fees will depend on the amount of air pollutants described in the source's permit.

20 NMAC 2.07-Excess Emissions during Malfunction, Start-up, Shutdown, or Scheduled Maintenance. This provision allows for excess emissions from process equipment during malfunction, start-up, shutdown, or scheduled maintenance, provided the operator verbally notifies NMED either before or within 24 hours of the occurrence, followed by written notification within 10 days of the occurrence. One incidence of excess particulate emissions was recorded in 1995. This occurred at the TA-3-29 beryllium machine shop and was found during routine testing of the bag house filtration system. Notification procedures as required by 20 NMAC 2.07 were followed. New start-up and shutdown procedures were initiated in order to reduce the likelihood of excess emissions caused by the separation of the bag house filter from its housing.

One exceedance of the opacity standard occurred in 1995 at the TA-16 steam plant. Refer to Section 2.B.7.b for details.

8. Clean Water Act

a. National Pollutant Discharge Elimination System Program Overview. The primary goal of the Clean Water Act (CWA) (33 U.S.C. 446 *et seq*.) is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The Act established the National Pollutant Discharge Elimination System (NPDES) that requires permitting point-source effluent discharges to the nation's waters. The NPDES permits establish specific chemical, physical, and biological criteria that an effluent must meet before it is discharged. Although most of the Laboratory's effluent is discharged to normally dry arroyos, the Laboratory is required to meet effluent limitations under the NPDES permit program.

In 1995, LANL had 10 NPDES permits; 1 covering the effluent discharges at Los Alamos, 1 covering the hot dry rock geothermal facility located 50 km (30 mi) west of Los Alamos at Fenton Hill, and 8 covering storm water discharges (Tables 2-2 and 2-6). The UC and DOE are co-owners on the permits covering Los Alamos. The permits are issued and enforced by EPA Region 6 in Dallas, Texas. However, NMED performs some compliance evaluation inspections and monitoring for EPA through a Section 106 water quality grant.

In January 1995, the Laboratory's NPDES outfall permit for Los Alamos included 2 sanitary wastewater treatment facilities and 122 industrial outfalls. By the end of 1995, the Laboratory had eliminated 27 permitted industrial outfalls in the NPDES permit. A summary of these outfalls is included in Table 2-7. The NPDES permit for the geothermal facility at Fenton Hill includes only one industrial outfall. This outfall did not discharge during 1995. Under the Laboratory's existing NPDES permit for Los Alamos, samples are collected for analysis on a weekly basis, and results are reported to EPA and NMED at the end of the monitoring period for each respective outfall category. During 1995, effluent limits were not exceeded in any of the 166 samples collected from the sanitary wastewater facilities. Effluent limits were exceeded 22 times in the 1,751 samples collected from the industrial outfalls. Overall compliance for the sanitary and industrial waste discharges during 1995 was 100% and 98.7%, respectively. Tables 2-7 through 2-11 present monitoring standards and Laboratory exceedances from those standards.

b. Business Plan for National Pollutant Discharge Elimination System Permit Compliance and Outfall Reduction. The Water Quality and Hydrology Group (ESH-18) in coordination with DOE/Los Alamos Area Office (LAAO) developed a business plan for NPDES permit compliance and outfall reduction as a result of the Administrative Order (AO) Docket No. VI-94-10-59 received in 1994 for noncompliances. A primary function of the business plan is to establish cross-functional teams to address and improve operational, technical, and regulatory facets of the Laboratory's NPDES compliance record. The business plan enhances the Laboratory's existing plan to ensure compliance with regulations and outlines the program necessary to achieve 100% compliance, improve environmental awareness across the Laboratory, and establish ownership for compliance. It also instills accountability within the Laboratory, sets aggressive goals for employees and divisions, and improves root cause analysis of occurrences.

The business plan was finalized by LANL and approved by DOE/LAAO on October 12, 1995. After DOE's approval of the plan, ESH-18 established working groups for each of five major outfall categories contained in LANL's NPDES permit. These categories include sanitary wastewater treatment plant effluent, heating and cooling system releases, high explosives wastewater discharges, radioactive liquid waste treatment facility effluent, and photographic rinse water. These working groups are composed of individuals from DOE, ESH-18, LANL operating groups, and, in some cases, NMED.

Charters outlining the goals and objectives of each working group were developed and submitted to affected management for signature. Several of the working groups have been very involved in the identification and elimination of unnecessary outfalls from LANL's NPDES permit. This has contributed to the successful elimination of 27 outfalls from the Laboratory's permit during 1995. Other efforts of the working groups have emphasized the resolution of specific effluent violations, clearly defining the root causes of these violations, and the development of proactive strategies to achieve and maintain compliance with applicable federal and state laws.

c. Waste Stream Characterization Program and Corrections Project. ESH-18 implemented the Waste Stream Corrections Project to correct Laboratory-wide noncomplying waste streams and potential unpermitted outfalls that discharge to the environment, as identified by the Waste Stream Characterization (WSC) survey conducted from 1991 to 1994.

Waste stream deficiencies identified by the WSC survey were compiled into 83 reports that were finalized and distributed to the responsible division directors for facilities under their management in March 1994. Correction of waste stream deficiencies is required in compliance with the CWA NPDES permit regulations and with the schedule requirements set forth by EPA AO Docket No. VI-94-1242. AO Docket No. VI-94-1242 requires the Laboratory to complete 25% of the corrective actions that were recommended by the WSC survey by September 30, 1994, and 50% by September 30, 1995. These requirements have been met. The Laboratory must be in 100% compliance by October 1, 1996, pursuant to the AO.

The Laboratory has secured institutional funding of approximately $3 million to perform the corrective actions needed to bring Laboratory facilities into compliance with the NPDES permit program. ESH-18 is managing this funding for the Laboratory and utilizing maintenance and construction expertise of the Facilities Project Delivery

Group (FSS-6) to complete the projects before the October 1, 1996, deadline. Facility Managers (FMs) and operating groups are directly responsible for completing corrective actions in their facilities and for securing any additional funding and other resources as necessary for successful completion of the project.

d. National Pollution Discharge Elimination System Storm Water Program. On November 16, 1990, the EPA promulgated the final rule for NPDES Regulations for Storm Water Discharges and modified 40 CFR 122, 123, and 124. This rule was required to implement Section 402(p) of the CWA (added by Section 405 of the Water Quality Act of 1987).

On September 9, 1992, EPA published the final general permits for storm water discharges associated with industrial and construction activity. The Laboratory chose to apply for coverage under the General Permit. Currently the Laboratory has eight NPDES General Permits for its storm water discharges (Table 2-6). One permit is for the Laboratory site and includes the following industrial activities: hazardous TSD facilities operating under interim status or a permit under Subtitle C of RCRA, (this category includes SWMUs); landfills, land application sites, and open dumps including those that are subject to regulation under Subtitle D of RCRA; and steam electric power generating facilities. One permit is for the remediation of an ER site off of DOE property. The other six permits are for construction activities disturbing more than five acres.

The conditions of the General Permit require the development and implementation of a Storm Water Pollution Prevention (SWPP) Plan. During 1995, the Laboratory has developed and implemented 55 SWPP Plans for activities regulated under the NPDES General Permit for storm water discharges.

Under the General Permit, monitoring activities are required at Section 313 of EPCRA facilities and land disposal units/incinerators. In 1995 monitoring was conducted at TA-54, Areas G and J and at TA-50. This analytical data must be submitted annually to EPA in the form of a Discharge Monitoring Report (DMR). The Laboratory submitted its 1995 DMR to EPA on October 27, 1995.

As part of the NPDES Storm Water Program, in 1994 the US Geological Survey (USGS) installed and began operating stream monitoring stations on the canyons entering and leaving the Laboratory. In 1994, there were a total of 17 stations on the various watercourses at the Laboratory. Information gathered by the USGS will be published in the New Mexico Water Resources Data, Water Year 1994. In 1995, 17 stations on the various watercourses at the Laboratory were operated, and 2 additional stations were constructed in Mortandad Canyon to be operated in 1996. Information gathered by ESH-18 will be published in a separate report. See Table 2-12 for a summary of flows from these stations for the Water Year 1995.

e. National Pollutant Discharge Elimination System Compliance Inspection. An inspection, scheduled for October 1995, was canceled; no NPDES compliance inspection was conducted during 1995.

f. Spill Prevention Control and Countermeasures Program. The Laboratory's Spill Prevention Control and Countermeasures (SPCC) Plan is a comprehensive plan developed to meet the regulatory requirements of the EPA and NMED that regulate water pollution from oil and hazardous chemical spills. The SPCC Plan, as required by the CWA, was developed in accordance with 40 CFR 112. The purpose of the SPCC Plan is to ensure that adequate prevention and response measures are provided to prevent oil spills from reaching a water course. Prevention measures include maintenance and inspections of facilities to ensure the integrity of the oil and chemical handling equipment, and proper operator training. Because of the wide variety of operating conditions at the Laboratory, the SPCC Plan has also diversified coverage with the implementation of a Group SPCC Implementation Plan (GSIP) approach.

The location of the 120 SPCC characterized sites and areas, including 47 aboveground storage tanks for petroleum fuel and oils and 18 aboveground storage tanks for chemicals, which are grouped into 17 major GSIPs (some plans contain multiple sites), are listed below:

TA-3-22	Power Plant
TA-15/36	Dynamic Experimentation Division
TA-3-316	Marx Generator
TA-16	Steam Plant
TA-21	Radioactive Liquid Waste Treatment Facility
TA-35	Chemical Science and Technology Division
TA-50	Waste Treatment Facilities

TA-53	Accelerator Operations
TA-55	Plutonium Facility
TA-3-37	Asphalt Batch Plant
TA-3	Computing, Information, and Communications Division
TA-21	Steam Plant
TA-35	Physics Division
TA-53	Liquid Scintillator
TA-54	Area L
TA-57	Fenton Hill
TA-60	Fuel Yard

In keeping with the site-specific GSIP approach, the operating conditions for each location are addressed, and as these change, only the individual GSIP will be revised. In addition to requiring secondary containment provisions for all aboveground storage tanks, the plan also provides for spill control on drum and container storage, transfer, and loading/unloading areas. Training is provided for the operating group's designated Spill Coordinator on the requirements of the SPCC Plan. The Spill Coordinator plays the major role in implementation of the SPCC Plan at the group level. Revision 3 of the SPCC Plan was completed in September 1993; a training course for Spill Coordinators was presented in 1994 and is offered quarterly through the ESH-13.

g. Sanitary Sewage Sludge Management Program. In December 1992, the EPA promulgated 40 CFR Part 503: The Standards for Use or Disposal of Sewage Sludge. The purpose of these regulations is to establish numerical, management, and operational standards for the beneficial use or disposal of sewage sludge through land application or surface disposal. Under the Part 503 regulations, the Laboratory is required to collect representative samples of sewage sludge in order to demonstrate that it is not a hazardous waste and that it meets the minimum federal standards for pollutant concentrations. In addition, sewage sludge is monitored for radioactivity in order to demonstrate that it meets the standards set forth in the Laboratory's Administrative Requirement 3-5. During 1995, approximately 38 dry tons of sewage sludge was generated at the TA-46 Sanitary Wastewater System Consolidation (SWSC) Plant as part of routine wastewater treatment operations; analytical monitoring of this sludge in 1995 demonstrated 100% compliance with the minimum federal and Laboratory standards for land application.

Also during 1995, approximately 83 dry tons of sewage sludge generated at the SWSC plant in 1993, 1994, and 1995 were land applied along the TA-61/53 gas pipeline utility easement as a soil additive to promote revegetation. In 1995, the Laboratory submitted a groundwater discharge plan application to the Ground Water Protection and Remediation Bureau of NMED for the land application of dried sanitary sludge from the TA-46 SWSC plant. On June 30, 1995, the NMED approved the groundwater discharge plan application for a period of five years.

9. Safe Drinking Water Act Program

a. Introduction. This program includes sampling from various points in the Laboratory, Los Alamos County, and Bandelier National Monument's water distribution systems and from the water supply well heads to ensure compliance with the Safe Drinking Water Act (SDWA) (40 CFR 141). The DOE provides drinking water to Los Alamos County and Bandelier National Monument. The EPA has established maximum contaminant levels (MCLs) for microbiological organisms, organic and inorganic constituents, and radioactivity in drinking water. These standards have been adopted by the state and are included in the New Mexico Drinking Water Regulations (NMEIB 1995). The NMED has been given authority by EPA to administer and enforce federal drinking water regulations and standards in New Mexico.

Compliance samples are analyzed at two state certified laboratories: New Mexico Health Department's Scientific Laboratory Division (SLD) in Albuquerque for volatile organic compounds (VOCs), synthetic organic compounds (SOCs), inorganic constituents, and radioactivity; and Triangle Laboratories in Durham, North Carolina, for dioxin. The SLD reports its analytical results directly to NMED. Triangle Laboratories reports its analytical results to ESH-18, who, in turn, transmits the results to NMED. The JCI Environmental (JENV) laboratory also collects samples from the Laboratory, Los Alamos County, and Bandelier National Monument's distribution systems and tests them for microbiological contamination, as required under the SDWA. The JENV laboratory is certified by NMED for microbiological testing of drinking water.

b. Compliance Activities. During 1995, all chemical, radiological, and microbiological parameters regulated under the SDWA were in compliance with the MCLs established by regulation. The analytical results for SDWA compliance sampling in 1995 are presented in the following tables: total trihalomethanes (Table 5-25), radioactivity (Table 5-26), radon (Table 5-27), inorganic constituents (Table 5-31), lead and copper (Table 5-32), VOCs (Table 5-33), SOCs (Table 5-34), and bacteria (Table 5-35).

Radon sampling was performed at well heads and points of entry of water from the two well fields into the distribution system. This sampling was done to collect information prior to the issuance of a final EPA regulation governing radon in drinking water. The sampling indicates that radon treatment may be required if EPA finalizes the radon standard with the same 300 pCi/L limit contained in the proposed rule. Depending on the final rule's provisions, waters from some well fields may need radon treatment by extended storage to allow radioactive decay or adsorption removal.

Each month during 1995, an average of 46 microbiological samples was collected at designated sample taps in the Laboratory, county, and Bandelier National Monument's water distribution systems. The microbiological samples are analyzed for free chlorine residual and the presence or absence of total coliform, fecal coliform, and noncoliform bacteria. Sample collection and analysis were performed by personnel from the JENV laboratory. During 1995, of the 555 samples analyzed, only 2 indicated the presence of total coliforms, and only 1 indicated the presence of fecal coliforms. This was not an SDWA violation because the fecal coliform positive sample was not repeated during follow-up sampling. Noncoliforms were present in 14 of the microbiological samples. Monthly data for 1995 is presented in Table 5-35. Noncoliform bacteria are not regulated, but their presence in repeated samples may serve as indicators of biofilm growth in water pipes.

Coliforms are the standard indicators of sewage pollution because they inhabit the intestinal tract of humans and other animals and therefore may indicate the presence of sewage or animal waste in the water. They are generally easier and safer to culture than specific pathogens. Fecal coliforms are defined as a subclass of coliforms that can be cultured on specific media at an elevated temperature (44.5°C). The fecal coliform test methods are intended to select for bacteria that originate in the intestines of warm-blooded animals. Biofilms are colonies of bacteria that are normally present in drinking water pipes and that may include coliforms and noncoliforms, as well as other types of bacteria.

10. Groundwater

a. Groundwater Protection Compliance Issues. Groundwater monitoring and protection efforts at the Laboratory have evolved from the early programs initiated by the USGS to present efforts. The major regulations, orders, and policies pertaining to groundwater are as follows.

DOE Order 5400.1. DOE Order 5400.1 requires the Laboratory to prepare a Groundwater Protection Management Program Plan (GWPMPP). The program was required by the order to (1) document the groundwater regime with respect to quantity and quality; (2) design and implement a groundwater monitoring program to support resource management and comply with applicable environmental laws and regulations; (3) establish a management program for groundwater protection and remediation, including specific SDWA, RCRA and CERCLA actions; (4) summarize and identify areas that may be contaminated with hazardous substances; (5) develop strategies for controlling sources of these contaminants; (6) establish a remedial action program that is part of the site CERCLA program required by DOE Order 5400.4; and (7) have in place decontamination and decommissioning, and other remedial programs contained in DOE directives.

The Laboratory completed a major revision of the draft GWPMPP in 1994 and continued in 1995 to refine the document to address review comments of DOE and the NMED/Agreement in Principle (AIP) Oversight and Monitoring Program. The GWPMPP focuses on protection of groundwater resources in and around the Los Alamos area and ensures that all groundwater-related activities comply with the applicable federal and state regulations.

The GWPMPP also fulfills the requirements of Chapter IV, Section 9 of DOE Order 5400.1. This section requires development of a Groundwater Monitoring Plan (GMP) as a specific element of the GWPMPP. The GMP identifies all DOE requirements and regulations applicable to groundwater protection and includes monitoring strategies for sampling, analysis, and data management. The general requirements outlined in Section 9b for the GWPMPP include: (1) determination of baseline groundwater quality and quantity conditions; (2) demonstration of compliance with, and implementation of, all applicable regulations and DOE orders; (3) data that will allow early detection of groundwater pollution or contamination; (4) a reporting mechanism for detection of groundwater

pollution or contamination; (5) identification of existing and potential groundwater contamination sources and maintaining surveillance of these sources; and (6) data upon which decisions can be made concerning land disposal practices and the management and protection of groundwater resources.

The GWPMPP contains a business plan in which a prioritized list of activities and studies addresses the above requirements. The business plan also shows the suggested organization for accomplishing the tasks, the proposed funding sources, and a preliminary cost estimate.

Section 9c of Chapter IV of the DOE Order 5400.1 requires that groundwater monitoring needs be determined by site-specific characteristics and, where appropriate, groundwater monitoring programs be designed and implemented in accordance with 40 CFR Part 264, Subpart F, or 40 CFR Part 265, Subpart F. The section also requires that monitoring for radionuclides be in accordance with DOE orders in the 5400 series dealing with radiation protection of the public and the environment.

RCRA Permit/HSWA Module. Module VIII of the RCRA permit, i.e. the HSWA Module, Task III, requires the Laboratory to collect information to supplement and verify existing information on the environmental setting at the facility and collect analytical data on groundwater contamination. Under Task III, Section A.1, the Laboratory is required to conduct a program to evaluate hydrogeologic conditions. Under Task III, Section C.1, the Laboratory is required to conduct a groundwater investigation to characterize any plumes of contamination at the facility.

Historically, the groundwater monitoring requirements of RCRA (40 CFR 264 Subpart F) were not applied to the Laboratory's regulated units because DOE and LANL had submitted groundwater monitoring waiver demonstrations. However, as of May 30, 1995, the NMED denied the DOE/LANL groundwater monitoring waiver demonstrations, and groundwater monitoring program plans were requested for DOE/LANL to be in compliance with RCRA. In the denial letter, NMED recommended the development of a comprehensive groundwater monitoring program plan which addresses both site-specific and Laboratory-wide groundwater monitoring objectives.

New Mexico Water Quality Control Commission Regulations. NMWQCC regulations control liquid discharges onto or below ground surface to protect all groundwater of the State of New Mexico. Under the provisions, a groundwater discharge plan must be submitted by the facility and approved by NMED or the Oil Conservation Division for energy/mineral extraction activities. Subsequent discharges must be consistent with the terms and conditions of the plan.

The NMWQCC regulations were significantly expanded in 1995 with the adoption of comprehensive abatement regulations. The purpose of the regulations is to abate both surface and subsurface contamination for designated or future uses. Of particular importance to DOE/LANL is the contamination which may be present in alluvial groundwater.

The Laboratory has three approved groundwater discharge plans to meet NMWQCC regulations. One for TA-57 (Fenton Hill); one for the TA-46 Sanitary Wastewater Treatment Plant, which is the location for the SWSC project; and one for the land application of dried sanitary sewage sludge from the TA-46 SWSC plant.

The Laboratory has three existing general NOIs for discharges of water from the Laboratory's water distribution system, line disinfection activities, and steam distribution system. The Laboratory tracks all discharges handled under the general NOIs and submits this data annually to NMED. Additionally, in 1995, there were three miscellaneous potable water discharges primarily from line leaks and fire hydrant flushing. On December 20, 1995, NMED issued a general "No Discharge Plan Required" to the Laboratory for the discharge of up to 6 gal./day of deionized water used for the purpose of rinsing soil sampling equipment. This general NOI was issued as a result of the Laboratory submitting several formal NOI applications for work of this nature in preceding years. In 1995 there were six discharges of deionized rinse water used to clean soil sampling equipment. The Laboratory is pursuing a general NOI from NMED for discharges of water in excess of 6 gal. used to rinse field sampling equipment.

Among other regulations related to groundwater protection compliance issues are the following:

(1) New Mexico Solid Waste Management Regulations,

(2) Safe Drinking Water Act, and the

(3) National Pollutant Discharge Elimination System Permit.

b. Groundwater Compliance Activities. The Laboratory continued an ongoing study of the hydrogeology and stratigraphy of the region, as required by the HSWA Module of the RCRA permit and DOE Order 5400.1. Much of the activity was centered on compiling and assessing existing information on the Laboratory collected over the previous 50 years. Studies by various Laboratory programs are integrated by the Groundwater Protection Management Program, administered by ESH-18. Some key activities are listed as follows:

(1) ESH-18 published a compilation report of borehole and well completion records (Purtymun 1995). This includes an inventory of wells and borings drilled through 1992.

(2) ESH-18 and the ER Project published an analysis of all known Laboratory hydraulic property measurements of the Bandelier Tuff (Rogers 1995). Estimates are made of the rate and direction of water movement through the tuff.

(3) New geologic mapping has been performed by the ER Project at TA-21, TA-33, TA-49, TA-54, and TA-67. The TA-21 work has been compiled to include reports on results of deep drilling in Los Alamos and DP canyons, detailed outcrop studies of the Bandelier stratigraphy and mineralogy, and preliminary evaluation of the hydrogeology (Broxton 1995).

(4) The Seismic Hazards Program has recently completed a major field investigation to delineate faulting on the Pajarito Plateau.

(5) The Waste Management Program prepared a series of reports in support of the ongoing Performance Assessment of MDA G (Hollis 1995). Critical geological, hydrological, and geochemical data have been assembled into a basic data report to formulate a conceptual hydrogeological model. Preliminary computer simulations forecast the long-term performance of the disposal area over thousands of years. The analysis includes an initial evaluation of the role of fractures on contaminant migration within the mesa.

(6) Detailed field investigations are ongoing at the major waste disposal areas.

(7) The USGS, in cooperation with the Laboratory, completed a numerical computer simulation of regional groundwater flow near Los Alamos (Frenzel 1995).

(8) LANL received notice from NMED of denial of previously submitted groundwater monitoring waiver demonstrations and a request by NMED to develop a hydrogeologic work plan to address NMED's concerns.

11. National Environmental Policy Act

a. Introduction. The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4331 *et seq*.) mandates that federal agencies consider the environmental impact of their proposed major actions and allow public input before making a final decision on what actions to take. The DOE is the sponsoring agency for most LANL activities, and it is DOE's policy to follow the letter and spirit of NEPA. DOE must comply with the regulations for implementing NEPA published by the Council on Environmental Quality at 40 CFR Parts 1500–1508 and its own NEPA Implementing Procedures as published at 10 CFR Part 1021. Under these regulations and DOE orders 5440.1D and 5440.1E, DOE reviews proposed LANL activities and determines whether the activity is categorically excluded from the requirements to prepare the following:

- an Environmental Assessment (EA), evaluating environmental impacts, leading to either a finding of no significant impact (FONSI) if the impacts are indeed found to be not significant or requiring an Environmental Impact Statement (EIS) if the impacts are significant,
- an EIS, in which impacts of proposed and alternative actions are evaluated and mitigation measures proposed. The EIS is followed by a Record of Decision (ROD) in which the agency decides if and how to proceed with a project.

If an EA or an EIS is required, the DOE is responsible for directing its preparation. In some situations, a LANL project may require an EA but, because the project is connected to a larger action requiring an EIS (e.g., the LANL Site-Wide EIS or a programmatic EIS done at the nationwide level), a regular EA is not prepared. For this type of project, DOE has determined that an analysis of the project be completed to the same level of detail as in an EA; and these EA-type documents are appended to the EIS in order for the connected actions to be considered together. No standard terminology has emerged yet for these EA-type documents.

LANL project personnel initiate NEPA reviews by completing Environment, Safety, and Health (ESH) identification documents, which form the basis of a DOE Environmental Checklist (DEC) written by the Environmental Assessments and Resource Evaluations Group (ESH-20) using the format specified by the DOE Albuquerque Field Office (DOE/AL). As part of the NEPA review process, proposed projects are evaluated for possible effects on cultural resources (archeological sites or historic buildings), in accordance with the National Historic Preservation Act (NHPA) of 1966. In addition, proposed projects are evaluated for potential impact on threatened, endangered, or sensitive species, in accordance with the Endangered Species Act, and on floodplains or wetlands, in accordance with relevant executive orders. The DEC is submitted to DOE/LAAO, which uses it to assist DOE in determining the appropriate level of NEPA documentation. In August 1995, DOE granted LANL the authority to determine if a project fell within the scope of a DEC for which a categorical exclusion had already been made by DOE. This is referred to as a "prior" determination.

b. Compliance Activities. In 1995, LANL sent 115 DECs to DOE for review. Also in 1995, DOE categorically excluded 119 actions and made a "prior" determination for 1 other action. LANL made a "prior" determination for 45 actions. DOE issued five FONSIs in 1995. An EA-type document was completed for one project to be included in the Stockpile Stewardship and Management Programmatic EIS. Twelve specific projects were scoped for possible inclusion in the Site-Wide EIS. For 2 of those 12 projects, an EA-type document was completed to be included in the Site-Wide EIS. In 1995, DOE determined that one project required an EIS.

c. Environmental Assessments. An EA presents the purpose of the proposed action, then describes the proposed action and reasonable alternatives. The EA includes a description of the affected environment and evaluates impacts to air quality (radioactive and nonradioactive emissions), water quality, waste management, and human health. The impacts to cultural and biological resources are also discussed in the EA. The DOE submits draft EAs to the NMED, potentially affected Native American tribes, and interested stakeholders for review before making a determination. After that decision (FONSI or EIS) has been made, DOE places copies of the EAs in public reading rooms in Los Alamos and Albuquerque. The depth and breadth of analysis of impacts in an EIS is greater than in an EA, and there are more opportunities for public input.

Table 2-13 presents the status of the Laboratory's major NEPA documentation as of December 1995. Project descriptions follow which are listed in the same order as in Table 2-13.

Atlas. The proposed action is to design, build and operate the Atlas facility at TA-35. Pulsed power experiments performed at the Atlas facility would be used to simulate certain hydrodynamic effects and radiation effects of a nuclear explosion. The Atlas facility would be used to investigate issues relating to thermonuclear secondary weapons components, as well as some issues related to primary components. The facility would also be used for basic research in physics, astrophysics, geophysics and in the study of fundamental properties of non-nuclear materials. An alternative to the proposed action would be the continued use of the Pegasus II pulsed power facility at its current energy level and current rate of experiments. Potential environmental, safety, and health issues include nonradioactive air emissions, waste management, and exposure to electrical hazards, magnetic field hazards, and x-rays.

Actinide Source-Term Waste Test Program. The Actinide Source-Term Waste Test Program is a two to five year study designed to provide data on the behavior of actinide elements (chemically similar radioactive materials with atomic numbers ranging from 89–103) in actual TRU waste immersed in brine. The proposed study is required to fulfill EPA requirements for the Waste Isolation Pilot Project (WIPP). The tests would be conducted in a controlled and enclosed environment within the basement of Wing 9 of the CMR Building in TA-3 at the Laboratory. Alternatives to the proposed action include taking no action (no testing), conducting tests at facilities outside LANL, and conducting the tests at other laboratories at LANL. Potential environmental, safety, and health issues include radioactive air emissions, radiation exposures to workers and the public, and generation and disposal of radioactive wastes. This EA received a FONSI in January 1995.

Weapons Component Testing Facility Relocation. The Weapons Component Testing Facility (WCTF) is one of the primary component instrumentation, diagnostics, and testing laboratories at LANL. The proposed action is to relocate the WCTF from Building 450 to Building 207, both at TA-16. Relocation would allow the WCTF operations to become more efficient and productive by increasing the usable space, consolidating with similar testing operations, and increasing the testing capabilities for larger components. Increased efficiency and productivity would allow the WCTF to better fulfill a LANL programmatic responsibility to maintain weapons development capability and test stored weapons components. The alternative is to keep the WCTF operations at their existing location. No changes in current operations of the WCTF are anticipated as a result of the relocation; no new waste would be generated in the operations after the relocation. The relocation would not change the quantity of sanitary effluent. This EA received a FONSI in February 1995.

High-Explosive Wastewater Treatment Facility. LANL proposes to improve its current management of wastewater contaminated with high-explosive (HE) residues and solvents. Improvements to existing wastewater management are necessary to ensure that discharges conform to LANL's NPDES permit. The proposed action would consist of minimizing the use of water in HE processes and treating all remaining HE-contaminated water at a new treatment facility. No untreated wastewater would be released to the environment. The proposed treatment facility would remove organic contaminants by passing the water through activated carbon filters. The alternative, which was not selected, would consist of constructing two treatment facilities and a system of pipes to collect HE-contaminated wastewater and deliver it to the treatment facilities. This alternative would not minimize water use in HE processes. The principal potential environmental, safety, and health issues include air and water quality, soils, wetlands, wildlife, and safety. This EA received a FONSI in September 1995.

Low-Energy Accelerator Laboratory (formerly Accelerator Prototype Laboratory). The proposed action is to erect a 100-ft by 70-ft preengineered metal building that would contain a high bay area where physicists could conduct research and development of linear particle injection systems. A linear particle injection system is the first part of a linear particle accelerator. The next generation of higher power particle accelerators must have a higher flux of subatomic particles, or beam current, supplied by an improved injection system, in order to operate. The linear particle injection systems to be developed would not create any radioactive wastes or air activation products; the energy would be dissipated in the form of heat and x-rays. Shielding inside the building would protect personnel from exposure from x-rays. Alternative actions include construction and operation at another location and not constructing nor operating the facility. Potential environmental issues include discharge of cooling water, land use, and personnel safety. This EA received a FONSI in April 1995.

Radioactive Source Recovery Program. The proposed action is to receive and recover (reprocess) unwanted and excess plutonium-beryllium (plutonium-238-beryllium) and americium-beryllium (americium-241-beryllium) sealed neutron sources now being held by commercial and other federal entities. This proposed program would enhance the DOE's and the US Nuclear Regulatory Commission's joint capabilities in the safe management of commercially held radioactive source materials. Currently there are no federal or commercial options for the recovery, storage, or disposal of sealed neutron sources. About 1 kg (2.2 lb) of plutonium and 3 kg (6.6 lb) of americium would be recovered over a 15 year project. The process would take place at TA-3 in the hot cells of the CMR Building, Wing 9 and at TA-55 in PF-4. Recovery reduces the neutron emissions from the source material and refers to a process by which: (1) the stainless steel cladding is removed from the neutron source material, (2) the mixture of the radioactive material (plutonium-238 or americium-241) and beryllium that constitutes the neutron source material is chemically separated (recovered), and (3) the recovered plutonium-238 or americium-241 is converted to an oxide form. The proposed action would include placing the recovered oxidized plutonium-238 and americium-241 in interim storage in a special nuclear material vault at the LANL Plutonium Facility. Potentially affected resources identified for the proposed action are water quality, land use for waste management, worker health effects, and air quality. This EA received a FONSI in December 1995.

Medical Radioisotope Production. Molybdenum-99 and iodine-125 radioisotopes are extensively used in human medical diagnosis and treatment. Several radiopharmaceutical supply firms have asked DOE to provide a backup source of supply because only one reactor in Canada now supplies the entire needs of North America. The proposed action is for DOE to use the production technologies that are registered with the US Food and Drug Administration Master Drug File and produce these radioisotopes. During 1994, the project was rescoped. DOE proposes to produce targets at LANL. Highly enriched uranium-235 would be electroplated inside target tubes in the CMR Building at TA-3. The sealed tubes would be irradiated in the Annular Core Research Reactor at Sandia National Laboratories and the desired radioisotopes would be separated from the mixed fission products in the

adjacent hot cell facility. The molydbenum-99 and iodine isotopes would be packaged for shipment to commercial radiopharmaceutical suppliers for final purification. Alternatives considered were production at other sites and no production. Potential environmental concerns include radioactive air emissions, liquid wastes, mixed fission product and other solid radioactive waste management, worker exposure to highly radioactive material, transportation, and public exposures. This EA was completed in May 1995, and DOE determined that an EIS was required.

Expansion of TA-54, Area G. Routine activities at the Laboratory generate solid low-level radioactive wastes (LLWs) that are disposed of or stored at TA-54, Area G, which is currently a 63-acre site. For some types of waste, burial in pits or shafts is the only feasible disposal method that complies with all regulations. The proposed action is to develop Zone 4 at Area G, the 30-acre area immediately west of the active disposal area, and 40 acres west of Area L, and dispose of LLW there when the active area is filled. This acreage includes two ER exclusion zones and the easement for the proposed Public Service Company of NM Ojo Transmission Line Extension, areas which could not be used immediately. Alternatives to expanding TA-54, Area G include using the currently active disposal area until it is full, developing an alternative disposal site within the Laboratory, or transporting future solid LLW off site. Potential environmental, safety, and health issues include air quality, geology, soil, surface water, wetlands, threatened and endangered species, cultural resources, environmental restoration, transportation, human health, and land use. The Specific Project Review for this project was submitted to the Site-Wide EIS Project Office in December 1995.

Radioactive Liquid Waste Treatment Facility. The proposed action is to build and operate a new Radioactive Liquid Waste Treatment Facility (RLWTF) to replace an existing 30 year old radioactive wastewater treatment plant. The new RLWTF would be constructed at TA-63 and would use the following technologies: influent storage tank treatment, ultraviolet oxidation, chemical pretreatment, membrane separation, reverse osmosis, and evaporation. A new pretreatment facility would be constructed at TA-50 to recover and concentrate nitric and hydrochloric acid waste streams for reuse at TA-55. The alternative actions include continuing to operate the existing RLWTF and pretreatment facilities until closure is required, and privatizing the design, construction, and operation of a new RLWTF. Potential environmental, safety, and health issues include worker exposure to radiation, air quality, water quality, cumulative long-term impacts, and waste management. DOE had previously determined that an EIS is required for the proposed action. The Specific Project Review for this facility was submitted to the Site-Wide EIS Project Office in December 1995.

Chemical and Metallurgy Research Building Upgrades. The CMR Building was constructed as a major chemical research and analysis laboratory facility for radioactive materials in 1952. Despite some repairs and upgrades since that time, the CMR Building does not meet current DOE regulations governing construction of a new nonreactor nuclear facility. LANL proposes to extend the life of the building 20 years by upgrading several major systems including seismic upgrades, ventilation system replacements and confinement zone separations, acid vents and drain lines replacements, and electrical system upgrades. The alternative action is not to upgrade the facility. Potential environmental issues include worker safety while the work is performed and LLW disposal.

Hazardous Waste Treatment Unit and Mixed Waste Receiving and Storage Facility. The proposed action was to construct a new Hazardous Waste Treatment Unit (HWTU) and a Mixed Waste Receiving and Storage Facility (MWRSF) within the laboratory complex at TA-63. The construction and operation of these facilities had been identified as critical milestones in the RCRA Federal Facility Compliance Agreement (FFCAgreement) at LANL. The proposed HWTU was designed to provide a central location for use of existing hazardous and mixed waste treatment processes and a location for development of alternative treatment processes for existing and future wastes that would otherwise be stored. The proposed MWRSF would have complemented the HWTU by providing a centralized location for receiving and storing wastes identified for treatment in the HWTU. Alternatives to building the HWTU and MWRSF included transporting untreated wastes off site, developing and utilizing alternative waste treatment processes at various sites throughout the Laboratory, and continuing to manage the waste using current treatment and storage procedures. Potential environmental, safety, and health issues included radioactive and hazardous air emissions, radioactive and hazardous effluents, transportation, and cumulative, long-term impacts associated with operation of the proposed facility. These types of treatment units are no longer planned for LANL; DOE determined in December 1995 that an EA would not be required for this project.

Low-Energy Demonstration Accelerator. The proposed action is to design, build, and test critical components of a full-size prototype accelerator system for tritium production using a proton linear accelerator at LANL. The Low-Energy Demonstration Accelerator (LEDA) project would be divided into five separate stages which would develop and test an accelerator apparatus section by section over the next six years. Personnel at LANL would modify an existing proton accelerator facility at TA-53 and conduct component and prototype tests in order to verify equipment and prototype design and resolve related performance and production issues for future full scale operation. The potential environmental, safety, and health issues for LEDA include utility demands, air emissions, environmental restoration, human health, and waste management.

TRU Waste Drum Staging Building. The proposed action is designed to increase safety and minimize the volume of waste generated at the Laboratory's Plutonium Processing Facility at TA-55. This action consists of using a prefabricated, concrete-floored, metal building for temporary storage of drums of solid TRU waste that is pending certification and transport to a longer term storage area. Alternatives to the proposed action include constructing a new building or continuing operations under current conditions. Some of the potential environmental, safety, and health issues include air emissions, worker safety, on-site TRU waste management, and TRU waste transportation. The draft EA was submitted to DOE in December 1995.

12. Cultural Resources

a. Introduction. The Cultural Resources Team in ESH-20 is responsible for maintaining a database of all cultural resources found on DOE land, compliance with appropriate cultural resource legislation as listed below, and providing appropriate information to the public on cultural resource management issues. Cultural resources are defined as archaeological sites, prehistoric or historic districts, sites, buildings, structures, traditional use areas, or objects included in, or eligible for inclusion in, the National Register of Historic Places. Artifacts, records, and remains related to and located within such properties are considered cultural resources.

b. Compliance Overview. Section 110 of the NHPA of 1966 and EO 11593, Protection and Enhancement of the Cultural Environment (3 CFR 154, 16 USF 470), require federal agencies to inventory cultural (historic and prehistoric) resources on their lands and to assess their eligibility for inclusion on the National Register of Historic Places. Cultural resources may be eligible for inclusion under four criteria: Criterion A, their association with an event important in the history of the nation or a specific cultural group; Criterion B, association with a person important in the nation's history or the history of a particular cultural group; Criterion C, their unique artistic value or representative style; or Criterion D, their potential to yield information important to historical or prehistoric research.

LANL conducts field surveys to locate archaeological sites. At the end of 1995, 17,493.2 acres had been surveyed by currently accepted standards. This represents 61% of all DOE land. An additional 1,858 acres have also been surveyed to a lesser degree of reliability. Combining both levels of field survey, 19,351.2 acres, or 67.5% of the 28,637.6 acres of DOE land have been surveyed.

A total of 1,392 archaeological sites have been identified as a result of these surveys. Most of these sites (1,302) were occupied in the prehistoric period and represent the material remains of pueblos and camps that were used from 6000 B.C. to the mid-1500's A.D. These sites are tabulated in Figure 2-1 by type description.

The remaining 88 sites date to the historic period (Figure 2-2). Most of those included in this tabulation are associated with Hispanic and Anglo homesteading activities on the Pajarito Plateau during the late 19th to early 20th centuries. Some Laboratory structures over 50 years old are also included in this tabulation; however, not all Laboratory structures meeting the 50-year-age requirement for inclusion on the National Register of Historic Places have been evaluated for significance. Those not evaluated are not included in the tabulation.

Section 106 of the NHPA (implemented by 36 CFR 800, Public Law 89-665) requires agencies to evaluate the impact of all undertakings on cultural resources and to consult with the State Historic Preservation Officer (SHPO) and/or National Advisory Council on Historic Preservation concerning possible effects to identified resources. Amendments to this law in 1992 provide for greater involvement of Native American groups in the consultation process. All cultural resource survey reports are sent to the Pueblos of San Ildefonso, Cochiti, Santa Clara, and Jemez for review and comment.

The Cultural Resources Team reviews all Laboratory actions to determine if they are "undertakings" as defined in 36 CFR 800. Undertakings are activities that have the potential to affect a cultural resource and are typically activities outside buildings that disturb the ground. All undertakings must be reviewed to determine whether they affect a cultural resource. There are five ways a project can come to the attention of the Cultural Resources Team:

through the ESH Identification Process, siting studies initiated by the Facilities Safeguards and Support Division, quality assurance (QA) review, excavation permits, and direct request for information. Many projects may be reviewed by cultural resources staff through more than one pathway. During 1995, Laboratory archaeologists evaluated 888 Laboratory actions.

Once an action has been determined to be an undertaking, the archaeology staff conducts surveys to determine if a cultural resource is affected and if so, whether the effect is adverse. In 1995, 47 new field surveys were conducted to identify cultural resources.

The results of surveys are written as controlled release LANL documents (LA-CP). Copies are sent to the SHPO for concurrence in findings of effects and determinations of eligibility for National Register inclusion of any cultural resources located during the survey. Copies are also sent to the governors of the Pueblos of San Ildefonso, Santa Clara, Cochiti, and Jemez for comment and identification of any traditional cultural properties which may be affected by the undertaking. In 1995, 27 consultations with the SHPO and Native Americans were conducted, and 22 archaeological survey reports were submitted to the SHPO or land owning agency and Native American groups for review and concurrence. No adverse effects to prehistoric cultural resources were identified in 1995.

The American Indian Religious Freedom Act (AIRFA) of 1978 (Public Law 95-341) stipulates that federal undertakings should not impact the practice of traditional religions. Notification must be given to tribal groups of possible alteration of traditional and sacred places. The Native American Grave Protection and Repatriation Act (NAGPRA) of 1990 (Public Law 101-601) states that if burials or cultural objects are inadvertently disturbed by federal activities, work must stop in that location for 30 days and the closest lineal descendent must be consulted for disposition of the remains.

In 1995, meetings were held with tribal representatives from the Pueblos of San Ildefonso, Cochiti, Santa Clara, and Jemez to review LANL undertakings which had the potential to affect cultural sites identified in the Section 106 process as well as any possible impacts to traditional cultural places that fall under AIRFA or NAGPRA jurisdiction. General cultural resource issues were discussed at these meetings and field tours of cultural resources were conducted when requested by tribal representatives. Tours were given of artifacts now curated at the Museum of New Mexico, and discussions continued on repatriation issues. No new human remains requiring NAGPRA consultation were discovered in 1995.

The Archeological Resources Protection Act (ARPA) of 1979 (implemented by 43 CFR 7, Public Law 96-95, 16 USC 470) provides protection of cultural resources and sets penalties for their damage or removal from federal land without a permit. Criminal penalties can be assessed up to $20,000 and two years imprisonment for a first offense and $100,000 and five years imprisonment for a second offense; civil penalties may consist of the cost to mitigate damages plus forfeiture of all equipment and vehicles used to facilitate a violation.

One pot-hunting incident was discovered on DOE land in 1995. The site damaged, Laboratory of Anthropology 6787-A, is a low pueblo mound of approximately 10 rooms. Damage to the site consists of two holes that were dug into the roomblock: one hole is 50 cm by 50 cm wide and 10 cm deep, and the second is 70 cm by 70 cm wide and 1 m deep. Security personnel from Bandelier National Monument attempted unsuccessfully to identify any suspects.

In addition to the compliance related activities listed above, the Cultural Resources Team provides general information to the public on DOE cultural resources. In 1995, 20 presentations, tours, and interviews about cultural resources were conducted. These included tours for DOE and non-DOE professional groups, several universities, local teachers programs, and other local groups. Tours were also given to members of the four surrounding Indian tribes, which included presentations on cultural resource issues related to specific DOE undertakings as well as general overviews of the LANL cultural resource program. Interviews with the local newspaper and television station were also given.

13. Biological Resources

a. Introduction. The DOE and the Laboratory must comply with the Endangered Species Act, the Migratory Bird Treaty Act, and the Bald Eagle Protection Act. The Laboratory also considers plant and animal species listed under the New Mexico Conservation Act and the Endangered Species Act.

b. Compliance Activities. During 1995, ESH-20 reviewed 640 proposed Laboratory actions for potential impact on threatened and endangered species. Of these, 199 proposed actions were identified through the ESH Identification Process. The Ecological Studies Team (EST) of ESH-20 identified 60 projects that required reconnaissance surveys (Level I surveys). These surveys are designed to evaluate the amount of previous

development or disturbance at the site and to determine the presence of any surface water or floodplains in the site area. EST also identified nine projects that required quantitative surveys (Level II surveys) to determine if the appropriate habitat types and habitat parameters were present to support any threatened or endangered species. In addition, EST identified three projects that required an intensive survey designed to determine the presence or absence of a threatened or endangered species at the project site (Level III survey). The Laboratory adhered to protocols and permit requirements of the New Mexico State Game and Fish Department.

c. Environmental Assessments. EST identified projects requiring a survey by first reviewing a literature database that compiles all habitat requirements of federal and state endangered, threatened, and candidate species. After the surveys were completed, the habitat characteristics of the surveyed sites were compared with the habitat requirements of the species in question. Biological evaluations are being prepared for projects requiring a Level II or Level III survey, and consultation with US Fish and Wildlife for written concurrence of findings, as required under the Endangered Species Act, will be undertaken.

At one project area, the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, one federally protected species was confirmed within the proposed project site. Highly suitable habitat also exists for many of these species (e.g., goshawk, Jemez Mountains salamander, meadow jumping mouse) within other project sites.

14. Floodplain and Wetland Protection

a. Introduction. The Laboratory must comply with EO 11988, Floodplain Management, and EO 11990, Protection of Wetlands (EPA 1989) and Section 404 of the Clean Water Act.

b. Compliance Activities. During 1995, 640 proposed Laboratory actions were reviewed for impact to floodplains and wetlands. Nine proposed projects required a Floodplain and Wetland Assessment.

c. Environmental Assessments. In September of 1994, the Laboratory received notice from the Army Corps of Engineers that erosion from a road and sewer line crossing was causing damage to Sandia Canyon wetlands. This represents noncompliance with soil stabilization requirements under the NPDES permit, which authorized the construction of the road and sewer line across the Sandia Canyon wetland. Pursuant to Section 404 of the CWA, the Corps requested that the Laboratory repair the erosion and stabilize the slopes in question. The erosion control project for this area was completed in 1995.

C. Current Issues and Actions

1. Compliance Agreements

a. Mixed Waste Federal Facility Compliance Agreement. On May 14, 1992, DOE/LAAO, with support from a Laboratory team, began negotiations with EPA Region 6 for an FFCAgreement to ensure compliance with the land disposal restrictions storage prohibition for mixed waste (hazardous and radioactive waste) found in Section 3004(j) of the RCRA and 40 CFR Section 268.50. The draft FFCAgreement was released for public review and comment on July 27, 1993. The FFCAgreement was signed by DOE and EPA on March 15, 1994. The FFCAgreement provided a plan and schedule for the treatment of mixed wastes; it included some 47 specific compliance milestones, 17 of which were due in 1994 and 8 of which were due in 1995. DOE and LANL have successfully complied with all 25 milestones. The focus of certain FFCAgreement activities was redirected in 1995 in accordance with new regulatory requirements and reductions in DOE operating budgets. The DOE, and consequently LANL, are required by the Federal Facility Compliance Act of 1992 (Section 3021 [b] of RCRA), to prepare Site Treatment Plans (STPs) describing the development of treatment capacities and technologies for treating mixed waste. DOE/AL prepared the Albuquerque Mixed Waste Treatment Plan, which together with the FFCAgreement, formed the basis of LANL's proposed STP delivered to NMED in March 1995. The FFCAgreement between DOE and EPA was terminated on October 4, 1995, when the State of New Mexico issued the Federal Facility Compliance Order (FFCO) requiring DOE compliance with LANL's plan for treatment of mixed waste. To date, the Laboratory has complied with all FFCO/STP milestones.

b. New Mexico Environment Department Compliance Orders for Hazardous Waste Operations. The Laboratory received two RCRA Compliance Orders (COs) from NMED during 1995. CO NMHWA 95-03 was issued on March 22, 1995 as a result of NMED's RCRA inspection in September 1994. It alleged 28 violations, of

which 9 required corrective actions within 5, 10, or 30 working days. All corrective actions were completed on time. NMED proposed fines of $103,539; the final negotiated penalty amount was $48,329. CO NMHWA 95-08 was issued on November 30, 1995, as a result of NMED's annual hazardous waste compliance inspection of September 12–18, 1995. It alleged nine violations of the act and proposed fines totaling $14,795. The alleged violations were all of an administrative nature, including lack of decontamination equipment, lack of accumulation start dates, containers without covers, and unlabeled containers. The final negotiated penalties totaled $11,190 for seven alleged violations.

c. National Pollutant Discharge Elimination System Federal Facility Compliance Agreement and Administrative Order. AO Docket No. VI-94-1242, issued to the Laboratory on June 15, 1994, incorporated the revised HE Wastewater Treatment Facility schedule and the schedule for completion of the remaining corrective actions for the WSC project. The Laboratory met the September 30, 1995, deadline to complete 50% of the WSC corrective actions, as specified in the AO.

d. National Emission Standards for Hazardous Air Pollutants Federal Facility Compliance Agreement. In 1991 and 1992 the Laboratory received two Notices of Noncompliance (NONs) from the EPA for not meeting all provisions of 40 CFR 61, Subpart H. Specific findings of the NON included deficiencies in LANL's identification and evaluation of release sources, noncompliant stack monitoring equipment on all point release sources, incomplete quality assurance programs, and incomplete reporting. The 1992 NON stated that LANL had used a shielding factor without prior EPA approval and exceeded the 10 mrem/yr standard. As a result of the NON, the DOE is negotiating a FFCA with EPA Region 6. The FFCA will include schedules that the Laboratory will follow to come into compliance with the CAA and will continue to address the issues raised in the 1991 NON. Negotiations continued in 1995, and the FFCA is expected to be signed during CY96. The Laboratory has been actively engaged in a program to achieve compliance with the provisions of 40 CFR 61, Subpart H. Progress toward full compliance includes the following:

- A comprehensive identification of point release sources has been completed. Diffuse (nonpoint) release sources are being identified. These lists identify and describe sources of radioactive air emissions. Both inventories are continually updated as new information is received and old information is revised.
- Stack monitoring equipment at LANSCE has been upgraded to meet the requirements of 40 CFR 61, Subpart H, monitoring requirements. All tritium stacks are in physical compliance. Also, various stacks at TA-3-29, TA-48, TA-50, and TA-55 have been upgraded to meet the NESHAP requirements. The Laboratory is in the final phases of completing the QA plans necessary to achieve full compliance with this regulation.
- For monitoring radioactive air emissions at LANSCE, a QA project plan has been completed, approved by DOE, and implemented. This plan has been reviewed by DOE and found to be sufficient to meet EPA requirements. QA project plans are being developed for sampling radioactive particulate emissions and tritium emissions. In addition, an overall QA project plan has been drafted for the management of radioactive air emissions; necessary procedures have been written, approved, and updated. LANL ceased using the shielding factor for EPA compliance reporting in 1992. The LANL dose to the public has not exceeded the 10 mrem/yr standard since 1991.

2. Environmental Oversight and Monitoring Agreement

a. Introduction. The Environmental Oversight and Monitoring Agreement (known as the AIP) between DOE and the State of New Mexico provides technical and financial support by DOE for state activities in environmental oversight, environmental surveys and sampling, site visits, and document review. The AIP was originally signed in October 1990 and covers Los Alamos and Sandia national laboratories, WIPP, and the Inhalation Toxicology Research Institute. NMED is the lead state agency under the AIP.

The AIP was renewed on October 1, 1995, for an additional five-year period. There are four primary objectives of the program:

(1) to assess DOE's compliance with existing laws, including regulations, rules, and standards;

(2) to participate in DOE's prioritization of cleanup and compliance activities;

(3) to develop and implement a vigorous program of independent monitoring and oversight; and

(4) to communicate with the public to increase public knowledge of environmental matters about the facilities, including coordination with local and tribal governments.

b. Monitoring Laboratory Compliance Activities. During 1995, the NMED/AIP staff conducted oversight of several of the Laboratory's environmental programs. Highlights of these activities are presented below (NMED 1996).

Groundwater: NMED/AIP staff continued development of a conceptual hydrogeological model for the site, including modeling of the perched groundwater system in Mortandad Canyon. NMED/AIP staff participated in a series of meetings regarding the Laboratory's Groundwater Protection Management Program Plan. The plan is scheduled for completion by the summer of 1996 and will be implemented starting in 1999.

Surface Water: NMED/AIP staff collected grab samples and deployed portable storm water samplers to collect samples of the runoff from summer storm events. Samples were collected in canyons on LANL property and at the eastern Laboratory boundary along State Road 4. Preliminary data show elevated levels of mercury, uranium, strontium-90, and gross alpha and beta below several potential release sites in Los Alamos Canyon.

Spill Closures: NMED/AIP staff accompanied ESH-18 staff during unplanned liquid release cleanup verifications. Upon verification of adequate cleanup of the release sites, the NMED AIP staff administratively closed out the spills. In 1995, the NMED/AIP staff administratively closed out 18 of 29 releases.

Sampling: Extensive sampling activities were conducted at LANL in 1995. Sampling is done in coordination with the LANL environmental surveillance activities and NPDES permit program in order to obtain split or duplicate samples. Split samples are submitted to the state SLD and independent laboratories for analysis. The activities included sampling of groundwater, NPDES outfalls, springs, stream bed sediment, soils, snowmelt and storm water runoff, air, external penetrating radiation, foodstuffs, and wetlands. Oversight split or duplicate sampling of approximately 90 sites included springs, wells, streams, 50 environmental monitoring stations at LANL, 5 independent stations, and 5 stations at the Pueblo of San Ildefonso.

As part of a cooperative initiative with LANL, five real-time air radiation monitors were deployed throughout northern New Mexico as part of the Neighborhood Environmental Watch Network system (known as NEWNET). Data from these stations are accessible over the Internet. In 1995, two environmental sampling and surveillance trips in White Rock Canyon were conducted. Analytical results of sampling activity in 1995 at LANL were consistent with regional background levels.

Environmental Restoration: Oversight activities with the ER Project included technical reviews of site assessment documents, including site-wide environmental studies; RCRA Facility Investigation work plans; expedited cleanups; voluntary corrective actions; and proposals for no further action.

NMED/AIP staff provided recommendations regarding the use of best management practices to comply with the NMWQCC regulations, some of which the Laboratory has begun to implement.

Waste Management: NMED/AIP staff visited the principal facilities involved with the generation, treatment, or storage of wastes at LANL. In addition, programs that direct or influence waste management practices at the Laboratory were reviewed in order to understand policy implementation.

3. Corrective Activities

High-Explosive Wastewater Treatment Facility. This project consists of an HE Wastewater Treatment Facility. No piped collection system will be utilized; all wastewater will be trucked to the treatment facility. Title I design for the facility was completed in FY94; construction is planned for FY96. Upgrading the HE wastewater facilities is required under the Laboratory's NPDES FFCA and AO.

Water Supply and Cross Connection Controls (CCC) Survey. The CCC Survey continued in 1995. As of the end of December, 141 of the 409 Laboratory buildings with potable water service, or about 34%, had been surveyed. As of the end of December, 1,092 potential cross connections or other identifiable plumbing deficiencies had been identified by the survey; 581 corrective actions were completed, and 511 low-priority corrective actions were backlogged pending the availability of additional resources.

Drinking Water Lead Survey. This survey was initiated in 1993 by ESH-18 as a best management practice and Tiger Team Corrective Action because some drinking fountains at the Laboratory had demonstrated lead levels higher than the EPA action level of 15 ppb. In the summer of 1994, approximately 1,300 drinking water

taps at the Laboratory were sampled for lead; 62 of those taps sampled demonstrated lead levels equal to or greater than the EPA action level of 15 ppb and were resampled for confirmation purposes in the fall of 1994. Of the 62 taps resampled, 47 drinking water taps were removed in spring 1995 and disposed of in accordance with all applicable regulations.

Waste Stream Characterization Program and Corrections Project. Fifty percent of the corrective actions identified and recommended by the WSC survey were completed September 30, 1995, as required by the schedule set forth in AO Docket No. VI-94-1242. ESH-18 and Facilities, Security, and Safeguard (FSS) Division facility maintenance and construction personnel continue to work with Laboratory FMs and operating groups to complete the remaining corrective actions recommended in the 83 WSC reports.

4. Waiver or Variance Requests

Groundwater monitoring is required for all RCRA surface impoundments, landfills, waste piles, and land treatment units. This requirement may be waived if it can be demonstrated that there is little or no potential for a release from the units to migrate to the uppermost aquifer. Waiver demonstrations were provided to NMED for several units located at TA-16, 35, 53, and 54. A letter denying the waiver demonstrations was received from NMED, and negotiations are ongoing.

5. Significant Accomplishments

ESH-17 and DOE have made significant progress toward obtaining an FFCA with EPA Region 6. The draft FFCA and Compliance Plan was published by EPA in the summer of 1995 for public comment.

ESH-17 submitted the CAA Operating Permit application to NMED in December 1995. The group developed an innovative application that includes voluntary Plantwide Applicability Limits that better define the Laboratory's emissions of regulated air pollutants.

LANL was successful in obtaining formal EPA approval of representative sampling and the use of the shrouded probe as an alternative radionuclide sampling method. This new technology may be used in some of LANL's facilities to demonstrate compliance with 40 CFR 61, Subpart H "Radionuclide Emission Other than Radon from DOE Facilities."

ESH-18 continued to identify all waste streams that may potentially enter NPDES outfalls and to verify that each is included in the proper outfall category. Specific accomplishments of the Laboratory's WSC program during 1995 include

- elimination of 27 unpermitted outfalls, and
- ESH and FSS Divisions secured funding of $3 million and implemented the Waste Stream Corrections Project to correct the waste stream deficiencies that were identified by the WSC survey. Implementation of this project allowed the Laboratory to correct 50% of the waste stream deficiencies by September 30, 1995, as required to comply with the NPDES permit and AO No. VI-94-1242.

ESH-18 also installed stream monitoring stations on all of the significant canyons entering and leaving the Laboratory. This is the first year the Laboratory will know the volume of water entering and leaving its boundaries. In addition, the automated storm water monitoring network was fully implemented at TA-54, Area G. This network provides automated sampling and operator notification of monitoring events.

The ESH-18 business plan team achieved recognition for its efforts in coordinating with Laboratory operating groups, DOE, and the State of New Mexico. A DOE Quality Award was given to program participants on October 16, 1995, in recognition of their exceptional contributions and commitment to an ethic of quality performance within the DOE.

ESH-19 staff completed many activities during 1995. In addition to its routine hazardous and solid waste assignments, ESH-19 worked with NMED on successfully resolving a number of compliance orders and on the FFCAgreement; submitted the RCRA Closure Plan for the CAI, a permit modification for TA-50 and TA-54, and a permit application and revision for TA-16; and assisted Chemical Science and Technology (CST) Division and DOE with completion and approval of the STP. During fall of 1995, LANL submitted a modification package to NMED for a RCRA RD&D permit. If approved, the modifications to the permit will allow LANL to test a Packed-Bed/Silent Discharge Plasma technology for destruction of hazardous waste. In addition, ESH-19 drafted a Solid

Waste Management Plan for the Laboratory, including developing a position on the Laboratory's industrial vs. commercial solid waste generation, and authored the Roles, Responsibility, and Authority Plan for USTs.

During 1995, the Ecological Studies Team in ESH-20 submitted the Monitoring and Surveillance Planning document (Haarmann 1995) to LANL and DOE management. LANL management committed to follow through the plan to completion.

The ESH-20 Environmental Reports Team collaborated with ESH-17, ESH-18, and ESH-19 and published the LANL Environmental Monitoring Plan for 1996–1998 (EARE 1995). This plan was approved by DOE/LAAO in December 1995.

The LANL Site-Wide Environmental Impact Statement Project Office was opened in October 1994 in order to support DOE and its contractor by identifying baseline environmental, programmatic, facility and operations, project-specific, and socioeconomic data. The project office worked principally in two areas: developing and implementing a management structure for the project office staff and its interactions with other Laboratory personnel, DOE, and their EIS consultants; and delivery of technical products in support of DOE.

The baseline data summary was compiled and formally submitted to DOE and their consultants on June 30, 1995. Summary material on the Laboratory's environmental setting and DOE programs at LANL was also submitted in June 1995. The project office also established field liaisons and subject matter experts to provide additional support and information to the consultants.

The ESO reviewed two awards during CY95

- R&D 100 Award for CST Division's development of polymer filtration technology that results in separation of metal from a water solution so effectively that the resultant metal can be recycled, and the water meets all regulatory requirements for discharge; and
- R&D 100 Award for Nuclear Materials Technology Division's development of hydride-dehydride recycle process. The process is a one-step, zero-waste method of recovering metallic plutonium from the thousands of nuclear weapons built during the Cold War.

6. Significant Issues

a. Lawsuits. On November 16, 1994, two citizens' groups (the Los Alamos Study Group and the Concerned Citizens for Nuclear Safety) filed a lawsuit in the US District Court, Albuquerque, NM, to enjoin DOE from proceeding with the DARHT project until completion of an EIS and issuance of the ROD. On November 22, 1994, DOE published a Federal Register notice of its intent to prepare the DARHT EIS [59 FR 60134]. On January 27, 1995, the court issued a preliminary injunction enjoining DOE from further construction of the DARHT facility and related activities pending completion of the EIS and the related ROD. The draft DARHT EIS was issued in May 1955 and the final EIS (DOE/EIS-0228) in August 1995, and a ROD was issued on October 10, 1995. The injunction was subsequently lifted by the court on April 16, 1996.

In 1994, a citizen's group filed suit against the DOE and the Laboratory under the Clean Air Act. The lawsuit alleged noncompliance with 40 CFR 61 Subpart H. The litigation was unresolved throughout 1995.

b. Other Issues. NMED notified DOE and LANL that they did not have a waste analysis plan that would properly characterize the waste stored on the TRU pads at TA-54, Area G. LANL has prepared a new waste analysis plan that addressed the criteria identified by NMED in their NOD. That plan was submitted by March 31, 1995. No response to this submittal was received in 1995.

7. Department of Energy/Headquarters Audits and Assessments

The DOE Albuquerque Field Office conducted an on-site appraisal for the pilot oversight programs for line ESH management. The report contains results of the environmental portion of the appraisal conducted October 1–November 9, 1995. Several functional areas involving air quality were evaluated. The air quality program review focused on nonradioactive air quality programs. Performance objectives, criteria, and measures developed to analyze the air quality program were Clean Air Act Applicability, Applicable Requirements, and Verification Systems. For all three areas, ESH Division met all objectives. The Air Quality Program provided indications of excellence in strategic planning, regulatory agency relations and creative development of compliance tools. Two noteworthy practices were identified including (1) LANL's program to determine applicability of regulations and (2) having a process in place to capture chemical purchases at the Laboratory.

Table 2-1. Major Environmental Acts under which the Laboratory Operated in 1995

Legislation	Federal Regulatory Citation	Responsible Agency	Related Legislation and Regulations
Resource Conservation and Recovery Act (RCRA)	40 CFR 257, 258, 260–268, 270–272, 280, and 281	EPA/NMED	Hazardous and Solid Waste Amendments (HSWA) Federal Facilities Compliance Act Amendments NM Hazardous Waste Act (NMHWA) NM Hazardous Waste Management Regulations NM Solid Waste Act NM Solid Waste Regulations NM Groundwater Protection Act NM Underground Storage Tank Regulations
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	40 CFR 300–311	EPA	Superfund Amendments and Reauthorization Act (SARA) Designation, Reportable Quantities, and Notification NM Emergency Management Act
Emergency Planning and Community Right-to-Know Act (EPCRA)	40 CFR 350–373	EPA	Executive Order (EO) 12856
Toxic Substances Control Act (TSCA)	40 CFR 700–766	EPA	
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	40 CFR 150–189	EPA/NM Department of Agriculture	NM Pest Control Act
Clean Water Act (CWA)	40 CFR 121–136 40 CFR 400–424	EPA/NMED	National Pollutant Discharge Elimination System (NPDES)
		NMED/WQCC	NM Water Quality Control Commission (NMWQCC) Regulations NM Liquid Waste Disposal Regulations NM Water Quality Act Water Quality Standards for Interstate & Intrastate Streams
	40 CFR 503	EPA/NMED	EPA Standards for the Use or Disposal of Sewage Sludge

Table 2-1. Major Environmental Acts under which the Laboratory Operated in 1995 (Cont.)

Legislation	Federal Regulatory Citation	Responsible Agency	Related Legislation and Regulations
Safe Drinking Water Act (SDWA)	40 CFR 141–148	EPA/NMED	NM Drinking Water Regulations
Federal Clean Air Act (CAA)	40 CFR 50–99	EPA/NMED/NMEIB	National Emission Standards for Hazardous Air Pollutants (NESHAP) for Radionuclides (40 CFR 61, Subpart H) requires emission reporting, monitoring, and quality assurance and establishes a yearly public emission standard; Asbestos (40 CFR 61, Subpart M) requires abatement and rate procedures; Beryllium (40 CFR 61, Subpart C) requires notification, emission limits, and stack performance testing. Unleaded fuel (40 CFR 80, Subpart B) requires labeling and other gas pump controls. Refrigerants (40 CFR 82) require practice controls on recovery and recycling refrigerants. Ambient Air quality Standards (40 CFR 50) NM Air Quality Control Act and regulations
National Environmental Policy Act (NEPA)	40 CFR 1500–1508, 10 CFR 1021	Council on Environmental Quality/DOE	EO 12898: Federal Actions to address Environmental Justice in Minority Populations and Low Income Populations
National Historic Preservation Act (NHPA)	36 CFR 800	State Historic Preservation Officer	NM Cultural Properties Act
		National Advisory Council on Historic Preservation	EO 11593
Archaeological Resources Protection Act (ARPA)	43 CFR 7	Not Applicable	
American Indian Religious Freedom Act (AIRFA)	None	Not Applicable	

Table 2-1. Major Environmental Acts under which the Laboratory Operated in 1995 (Cont.)

Legislation	Federal Regulatory Citation	Responsible Agency	Related Legislation and Regulations
Native American Graves Protection and Repatriation Act (NAGPRA)	None	Not Applicable	
Endangered Species Act	50 CFR 402	US Fish and Wildlife/ NM Game and Fish	Fish and Wildlife Coordination Act NM Wildlife Conservation Act NM Endangered Plant Species Act
Floodplain Management	EO 11988	DOE	10 CFR 1022 Clean Water Act, Section 404, Rivers and Harbors Act
Protection of Wetlands	EO 11990	DOE	10 CFR 1022 Clean Water Act, Section 404, Rivers and Harbors Act
Atomic Energy Act		Nuclear Regulatory Commission/DOE/EPA	

Table 2-2. Environmental Permits or Approvals under which the Laboratory Operated in 1995

Category/Agency	Approved Activity	Issue Date	Expiration Date	Administering
RCRA Hazardous waste facility[a]	Hazardous waste storage, treatment, and disposal permit	November 1989	November 1999	NMED
	Postclosure care	Application submitted September 1988		NMED
	RCRA mixed waste	Part A application submitted January 1991		NMED
		Portion of Part B application submitted July 1991 (TA-53 Surface Impoundments [3])		NMED
		Revised Part A application submitted October 1993		NMED
	Two RD&D Permits for Packed Bed Reactor/Silent Discharge Plasma Treatment Unit and Hydrothermal Processing Unit	Both issued on April 21, 1994		
HSWA	RCRA Corrective Activities	March 1990	December 1999	EPA
PCBs[b]	Disposal of PCBs at TA-54, Area G	June 5, 1980	NA[c]	EPA
PCB oil (TSCA)	Incineration of PCB oils[d]	October 9, 1992	October 9, 1997	EPA
NPDES[e], Los Alamos	Discharge of industrial and sanitary liquid effluents	August 1, 1994	October 31, 1998	EPA
	Storm water associated with industrial activity	General permit August 25, 1993	October 1, 1997	EPA
NPDES, Fenton Hill	Discharge of industrial liquid effluents	October 15, 1979	June 30, 1983[f]	EPA
Groundwater discharge plan, Fenton Hill	Discharge to groundwater	June 5, 1995	June 5, 2000	NMOCD[g]
Groundwater discharge plan, TA-46 Sanitary Wastewater Treatment Plant	Discharge to groundwater	July 20, 1992	July 20, 1997	NMED
Groundwater discharge plan, Sanitary Sewage Sludge Land Application	Land application of dry sanitary sewage sludge	June 30, 1995	June 30, 2000	NMED

Table 2-2. Environmental Permits or Approvals under which the Laboratory Operated in 1995 (Cont.)

Category/Agency	Approved Activity	Issue Date	Expiration Date	Administering
NMLWD Regulations[h]	Discharge of sanitary effluents[i] from septic tank systems into soil			NMED
Air Quality (NESHAP)[j]	Construction and operation of four beryllium facilities	December 26, 1985; March 19, 1986; September 8, 1987; April 26, 1989		NMED
Open Burning (20 NMAC 2.60)	Burning of jet fuel and wood for ordnance testing, TA-11	September 22, 1995	September 22, 1996	NMED
Open Burning (20 NMAC 2.60)	Burning of HE-contaminated materials, TA-14	January 19, 1995	January 19, 1996	NMED
Open Burning (20 NMAC 2.60)	Burning of HE-contaminated materials, TA-16	January 19, 1995	January 19, 1996	NMED
Open Burning (20 NMAC 2.60)	Burning of scrap wood from experiments, TA-36	November 1995	April 1996	NMED
Open Burning (20 NMAC 2.60)	Burning of HE-contaminated materials, TA-39	August 10, 1995	August 10, 1996	NMED

[a] See Table 2-3 for specific permitted activities.
[b] Polychlorinated biphenyls.
[c] NA = Permit does not have an expiration date.
[d] No incineration occurred during 1995 even though the activity was permitted.
[e] National Pollutant Discharge Elimination System.
[f] Permit administratively extended.
[g] New Mexico Oil Conservation Division.
[h] New Mexico Liquid Waste Disposal Regulations.
[i] Dates vary depending on individual permits.
[j] National Emission Standards for Hazardous Air Pollutants.

Table 2-3. Hazardous Waste Management Facilities at Los Alamos National Laboratory

Technical Area Building	Facility Type	Included in RCRA Permit or Interim Status[a]
3-29[b]	Container (3 Units)	Interim S[c]
3-102-118A	Container	Closed
14-35	OB/OD[d] (2 Units)	Interim T[c]
15-184[b]	OD	Interim T[c]
16, Area P	Landfill	Closure in Progress
16	OB (6 Units)	Interim T[c]
16-88[b]	Container	Interim S[c]
16-1409	Incinerator	Permitted T[e]
21-61[b]	Container	Interim S[c]
22-24	Container	Closed
35-125	Surface Impoundment	Closed
36-8[b]	OB/OD	Interim T[c]
39-6	OB/OD	Interim T[c]
39-57	OB/OD	Interim T[c]
40-2	Container	Closed
50-1	Container	Permitted S[e]
50-1-60A[b]	Container	Interim TS[c]
50-1-60D[b]	Container	Interim S[c]
50-1-BWTP[f]	Aboveground Tank	Closed
50-37-115[b]	Aboveground Tank (2 Units)	Interim S[c]
50-37-115[b]	Container	Interim S[c]
50-37-117	Container	Permitted S[e]
50-37-117[b]	Container	Interim S[c]
50-37-118[b]	Container	Interim S[c]
50-37-CAI[b,g]	Incinerator	Interim T[c]
50-37-CAI	Incinerator	Permitted T[e]
50-69[b]	Container	Interim S[c]
50-69[b]	Container	Interim S[c]
50-114	Container	Permitted S[e]
50-114[b]	Container	Interim S[c]
50-137[h]	Container	Permitted S[e]
50-138[h]	Container	Permitted S[e]
50-139[h]	Container	Permitted S[e]
50-140[h]	Container	Permitted S[e]
53-166[b]	Surface Impoundment	Interim S[i]
53-166[b]	Surface Impoundment	Interim S[i]
53-166[b]	Surface Impoundment	Interim S[i]
54, Area G	Landfill	Interim D[i]
54, Area G Pad 1[b]	Container	Interim S[c]
54, Area G Pad 2[b]	Container	Interim S[c]
54, Area G Pad 4[b]	Container	Interim S[c]
54, Area G Over Pit 30[b]	Container	Interim S[c]
54, Area G Shaft 145[b]	Container	Interim S[c]
54, Area G Shaft 146[b]	Container	Interim S[c]
54, Area G Dome 153[b]	Container	Interim S[c]
54, Area G Dome 224[b]	Container	Interim S[c]

Table 2-3. Hazardous Waste Management Facilities at Los Alamos National Laboratory (Cont.)

Technical Area Building	Facility Type	Included in RCRA Permit or Interim Status[a]
54, Area G Dome 283[b]	Container	Interim S[c]
54, Area H	Landfill	Closure in Progress
54, Area L	Aboveground Tank (4 Tanks)	Permitted[e]
54, Area L	Container	Interim S[c]
54, Area L	Container	Permitted S[e]
54, Area L Shaft 36[b]	Container	Interim S[c]
54, Area L Shaft 37[b]	Container	Interim S[c]
54, Area L Gas Cyl[b]	Container	Interim S[c]
54, Area L Gas Cyl	Container	Permitted S[e]
54-8[b]	Container	Interim S[c]
54-31	Container	Permitted S[e]
54-32	Container	Permitted S[e]
54-33[b]	Container	Interim S[c]
54-48[b]	Container	Interim S[c]
54-49[b]	Container	Interim S[c]
54-68	Container	Permitted S[e]
54-69	Container	Permitted S[e]
55, Near Bldg. 4[b]	Container	Interim S[c]
55-4[b]	Container (4 Units)	Interim S[c]
55-4[b]	Aboveground Tank (13 Tanks)	Interim TS[c]
55-4[b]	Container	Interim S[c]
55-4[b]	Container	Interim S[c]
55-4[b]	Container	Interim TS[c]
55-4[b]	Container	Interim S[c]
55-4[b]	Container	Closure in Progress

[a] S = Storage; T = Treatment; D = Disposal.
[b] Designates mixed waste units.
[c] Part A, January 1991.
[d] OB/OD = open burning/open detonation.
[e] November 1989.
[f] These units have not yet been constructed; BWTP = Batch Waste Treatment Plant.
[g] Revised Part A, October 1993; CAI = Controlled Air Incinerator.

Table 2-4. Johnson Controls World Services, Inc., Fiscal Year 1995 Recycling Volumes

Type	Volume	
	kg	lb
Paper	345,327	759,720
Photographic film	1,000	2,200
Lead w/steel	24,333	53,533
Lead acid batteries	11,530	25,365
Electric cable	7,314	16,091
Aluminum shavings	1,005	2,210
Scrap steel/tin/iron	309,969	681,310
Aluminum solid	32,636	71,800
Copper	729	1,604
Stainless steel	1,632	3,590
Brass	50	110
Tires	7,455	16,400
Waste Oil	97,430	214,345
Flammable liquids	52,653	115,837
Chemicals	16,026	35,257
Mercury light bulbs	1,438	3,164
Gas cylinders	1,259	2,770
Phone books	5,545	12,200

Table 2-5. Environmental Inspections and Audits Conducted at the Laboratory in 1995

Date	Purpose	Performing Agency
January 18, 1995	Asbestos Inspection	NMED
January 18, 1995	General Open Burn	NMED
January 23–24, 1995	UST Inspection	NMED
March 3, 1995	Asbestos Inspection	NMED
March 10, 1995	NPDES Program Overview	Pantex
April 18, 1995	Sandia Canyon Sampling Survey	DOE & NMED/AIP
May 12, 1995	Tour of LANL and Overview of NPDES, Storm Water, SDWA, and Hydrology Team Programs	Cochiti and Santa Clara Environment Departments
May 15–19, 1995	Water Quality Programs Review	DOE/AL & EPA
June 5, 1995	Spill Cleanup Investigations	DOE & NMED/AIP
June 29, 1995	NPDES Permit Program Evaluation	EPA
August 11, 1995	TA-55 Programs Evaluation and Tour	DOE & NMED/AIP
September 12–18, 1995	Hazardous Waste Compliance Inspection	NMED
October 16, 1995	Spill Cleanup Investigations	DOE & NMED/AIP
October 30, 1995	Asbestos Inspection	NMED
November 6–17, 1995	Air Quality Audit–Pilot Oversight	DOE/AL/EPD
December 20, 1995	General Open Burn	NMED
July 9, 1996	General Open Burn	NMED

Table 2-6. Los Alamos National Laboratory National Pollutant Discharge Elimination System Storm Water General Permits Industrial and Construction Activity

Permit #	Location	Submittal	Approval	Type
NMR00A384	LANL Site University of California	09/29/92	08/25/93	Industrial
NMR10A064	TA-53 FM TA-53 Sanitary Pipeline Project University of California	10/01/92	03/04/93	Construction
NMR10A065	US West Communication Ductbank University of California	10/01/92	03/04/93	Construction
NMR10A236	DARHT Facility Construction University of California	05/20/94	12/29/94	Construction
NMR10A277	ER Project Small Arms Firing Range University of California	08/18/94	09/19/94	Construction
NMR10A378	Co-Permittee, TRU Dome Project TWISP Facility Construction University of California	02/28/95	04/07/95	Construction
NMR00A527	ER Project Tar Remnant Remediation University of California	05/26/95	07/07/95	Construction
NMR10A469	TA-9 and TA-16 Steam System Upgrade University of California	09/01/95	10/19/95	Construction

Table 2-7. Types of Discharges and Parameters Monitored at the Laboratory under National Pollutant Discharge Elimination System Permit NM0028355 (Effective August 1, 1994)

EPA Identification No.	Type of Discharge	Number of Outfalls	Monitoring Required	Sampling Frequency
001	Power plant	1	Total suspended solids, free available chlorine, pH, flow	Once per month
02A	Boiler blowdown	2	pH, total suspended solids, flow, total copper, total iron, total phosphorus, sulfite (as SO_3), and total chromium	Once per three months
03A	Treated cooling water	31	Total suspended solids, free available chlorine, flow, total phosphorus, total arsenic, pH	Once per three months
04A	Noncontact cooling water	32	pH, flow, total residual chlorine	Once per three months
051	Radioactive waste treatment plant (TA-21 and TA-50)	1	Ammonia (as N), chemical oxygendemand, total suspended solids, total cadmium, total chromium, total copper, total iron, total lead, total mercury, total nitrogen, total nickel, nitrate-nitrite (as N), total zinc, total toxic organics, radium-226, radium-228, pH, flow	Variable frequency from once per week to once per month
05A	High explosives wastewater	15	Chemical oxygen demand, pH, flow, total suspended solids, oil and grease	Once per three months
06A	Photo waste water	13	Total silver, pH, flow	Once per three months
S	Sanitary wastewater (05S & 13S)	2	Biochemical oxygen demand, flow, pH, total suspended solids, fecal coliform bacteria	Variable frequency, from three per month to once per three months
001, 02A 03A, 04A 051, 05A 06A, 05S 13S	All discharge categories	97	Total aluminum, total arsenic, total boron total cadmium, total chromium, total cobalt, total copper, total lead, total mercury, total, selenium, total vanadium, total zinc, radium-226 + radium-228, accelerator-produced tritium	Once per year

Table 2-8. Limits Established by National Pollutant Discharge Elimination System Permit NM0028355 for Sanitary Outfall Discharges

Discharge Category	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
13S TA-46 SWSC	BOD[a]	30.0	45.0	mg/L
		100.0	N/A[b]	lb/day
	TSS[c]	30.0	45.0	mg/L
		100.0	N/A	lb/day
	Fecal coliform bacteria	500.0	500.0	org/100 mL
	pH	6–9	6–9	standard unit
05S TA-21 Package Plant	BOD	30.0	45.0	mg/L
		0.5	N/A	lb/day
	TSS	30.0	45.0	mg/L
		0.5	N/A	lb/day
	COD[d]	125.0	125.0	mg/L
		2.1	N/A	lb/day
	pH	6–9	6–9	standard unit

[a]Biochemical oxygen demand.
[b]N/A means not required by permit.
[c]Total suspended solids.
[d]Chemical oxygen demand.

Table 2-9. National Pollutant Discharge Elimination System Permit Monitoring of Effluent Quality at Sanitary Sewage Treatment Outfalls

Discharge Location (Outfall)	Permit Parameters	Number of Deviations
TA-21 (05S)[a]	Fecal coliform bacteria	N/A[b]
	COD[c]	N/A
	BOD[d]	N/A
	TSS[e]	N/A
	pH	N/A
TA-46 (13S)	Fecal coliform bacteria	0
	BOD	0
	TSS	0
	pH	0

[a]No discharge from Outfall 05S during 1995.
[b]N/A means analysis not performed.
[c]Chemical oxygen demand.
[d]Biochemical oxygen demand.
[e]Total suspended solids.

Table 2-10. Limits Established by National Pollutant Discharge Elimination System Permit NM0028355 for Industrial Outfall Discharges, August 1, 1994

Discharge Category	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
001 Power Plant	TSS[a]	30.0	100.0	mg/L
	Free Cl	0.2	0.5	mg/L
	pH	6–9	6–9	standard unit
02A Boiler Blowdown	TSS	30.0	100.0	mg/L
	Total Fe	10.0	40.0	mg/L
	Total Cu	1.0	1.0	mg/L
	Total P	20.0	40.0	mg/L
	Sulfite	35.0	70.0	mg/L
	Total Cr	1.0	1.0	mg/L
	pH	6–9	6–9	standard unit
03A Treated Cooling Water	TSS	30.0	100.0	mg/L
	Free Cl	0.2	0.5	mg/L
	Total P	20.0	40.0	mg/L
	Total As	0.04	0.04	mg/L
	pH	6–9	6–9	standard unit
04A Noncontact Cooling	pH	6–9	6–9	standard unit
	Total Cl	Report[b]	Report[b]	mg/L
051 Radioactive Liquid Waste Treatment Plant (TA-50)	COD[c]	94.0	156.0	lb/day
	TSS	18.8	62.6	lb/day
	Total Cd	0.06	0.3	lb/day
	Total Cr	0.19	0.38	lb/day
	Total Cu	0.63	0.63	lb/day
	Total Fe	1.0	2.0	lb/day
	Total Pb	0.06	0.15	lb/day
	Total Hg	0.003	0.09	lb/day
	Total Zn	0.62	1.83	lb/day
	TTO[d]	1	1	mg/L
	Total Ni	Report	Report	mg/L
	Total N	Report	Report	mg/L
	NO_3-NO_2	Report	Report	mg/L
	Ammonia (as N)	Report	Report	mg/L
	pH	6–9	6–9	standard unit
	COD	125	125	mg/L
	$^{226,228}Ra$	30.0	30.0	pCi/L
05A High Explosive	Oil & Grease	15.0	15.0	mg/L
	COD	125.0	125.0	mg/L
	TSS	30.0	45.0	mg/L
	pH	6–9	6–9	standard unit
06A Photo Waste	Total Ag	0.5	1.0	mg/L
	pH	6–9	6–9	standard unit

Table 2-10. Limits Established by National Pollutant Discharge Elimination System Permit NM0028355 for Industrial Outfall Discharges, August 1, 1994 (Cont.)

Discharge Category	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
All Outfall Categories:	Total Aluminum	5.0	5.0	mg/L
Annual Water Quality	Total Arsenic	0.04	0.04	mg/L
Parameters	Total Boron	5.0	5.0	mg/L
	Total Cadmium	0.2	0.2	mg/L
	Total Chromium	5.1	5.1	mg/L
	Total Cobalt	1.0	1.0	mg/L
	Total Copper	1.6	1.6	mg/L
	Total Lead	0.4	0.4	mg/L
	Total Mercury	0.01	0.01	mg/L
	Total Selenium	0.05	0.05	mg/L
	Total Vanadium	0.1	0.1	mg/L
	Total Zinc	95.4	95.4	mg/L
	$^{226,228}Ra$	30.0	30.0	pCi/L
	Tritium	3,000,000	3,000,000	pCi/L

[a]Total suspended solids.
[b]Effluents are reported to EPA but are not subject to limits.
[c]Chemical oxygen demand.
[d]Total toxic organics.

Table 2-11. National Pollutant Discharge Elimination System Permit Monitoring of Effluent Quality at Industrial Outfalls: Deviation 1995

EPA ID	Technical Area	Date	Parameter		Results/Limits	Units
January—No exceedances during monitoring period.						
February						
128128	TA-22-91	02/22/95	pH	(daily max)	9.1/9.0	standard unit
March						
128128	TA-22-91	03/20/95	pH	(daily max)	9.1/9.0	standard unit
128128	TA-22-91	03/20/95	pH	(daily max)	9.1/9.0	standard unit
128128	TA-22-91	03/20/95	pH	(daily max)	9.1/9.0	standard unit
April						
03A114	TA-53-2	04/12/95	Cl_2	(daily avg)	0.38/0.2	mg/L
03A049	TA-53-64	04/19/95	As	(daily max)	0.084/0.04	mg/L
03A049	TA-53-64	04/19/95	As	(daily avg)	0.084/0.04	mg/L
May						
07A109	TA-03-73	05/10/95	pH	(daily max)	9.3/9.0	standard unit
June						
01A001	TA-03-22	06/09/95	Cl_2	(daily max)	0.58/0.5	mg/L
05A054	TA-16-340	06/14/95	COD[a]	(daily max)	196/125	mg/L
July						
03A045	TA-48-1	07/24/95	Cl_2	(daily max)	9.2/0.5	mg/L
03A045	TA-48-1	07/26/95	Cl_2	(daily avg)	4.6/0.2	mg/L
August—No exceedances during monitoring period.						
September						
05A056	TA-16-260	09/12/95	O & G[b]	(daily max)	17.8/15	mg/L
October						
01A001	TA-03-22	10/04/95	TSS[c]	(daily avg)	34/30	mg/L
November						
03A024	TA-03-187	11/02/95	As	(daily max)	0.055/0.04	mg/L
03A024	TA-03-187	11/06/95	As	(daily max)	0.063/0.04	mg/L
03A024	TA-03-187	11/06/95	As	(daily avg)	0.059/0.04	mg/L
03A027	TA-03-285	11/14/95	As	(daily max)	0.211/0.04	mg/L
03A027	TA-03-285	11/14/95	As	(daily avg)	0.132/0.04	mg/L
03A027	TA-03-285	11/14/95	pH	(daily max)	9.3/9.0	standard unit
03A027	TA-03-285	11/14/95	V[d]	(daily max)	0.13/0.10	mg/L
December						
03A027	TA-03-285	12/15/95	As	(daily max)	0.069/0.04	mg/L
03A027	TA-03-285	12/18/95	As	(daily avg)	0.105/0.04	mg/L

[a]Chemical oxygen demand.
[b]Oil and grease.
[c]Total suspended solids.
[d]Water quality parameter. Effluent limits were exceeded one time out of an estimated 1,060 samples collected for water quality parameters during 1995. These results were not used to calculate the Laboratory's overall compliance ratings for the NPDES Permit Program.

Table 2-12. Summary of Storm Water Flows for the Water Year 1995

	Days w/	Total Volume of Water		Instantaneous Max	
Canyon Sites	Flow	ac-ft	gal.	ft^3/S	GPM
E025 Upper Los Alamos	247	465	151,520,715	10	4,488
E030 Middle Los Alamos	169	492	160,318,692	12	5,386
E042 Lower Los Alamos[a]	110	328	106,879,128	54	24,235
E060 Pueblo[a]	365	874	28,481,038	6.3	2,621
E125 Sandia	6	5	1,629,255	13	5,834
E204 Lower Mortandad	0	0	—	0	—
E200 Middle Mortandad[b]	83	18	5,865,318	9.7	4,353
E225 Upper Cañada del Buey	1	0.4	130,340	17	7,630
E230 Lower Cañada del Buey	15	14	4,561,914	75	33,660
E240 Upper Pajarito	239	106	34,540,206	1.9	853
E245 Middle Pajarito	211	250	81,462,750	24	10,771
E250 Lower Pajarito	210	30	9,775,530	4.6	2,064
E255 Potrillo	3	3.5	1,140,479	63	28,274
E252 Upper Water	74	9.5	3,095,585	0.21	94
E253 Canyon de Valle	0		—		
E265 Lower Water[c]	2		—	21	9,425
E275 Ancho[c]	5		—		—

[a]USGS operated.
[b]Record began 5/10/95.
[c]Gage rating to be established.

Table 2-13. Status of National Environmental Policy Act Documentation as of December 31, 1995

Status	Project
Project for which EA-type document was completed for inclusion in Stockpile Stewardship and Management Programmatic EIS	Atlas
EAs that received FONSI during 1995	Actinide Source-Term Waste Test Program Weapons Component Test Facility Relocation High Explosives Wastewater Treatment Facility Low-Energy Accelerator Laboratory Radioactive Source Recovery Program
EA submitted to DOE before 1994; DOE determined in 1995 that an EIS would be required	Medical Radioisotope Production
Projects for which EA-type document (Specific Project Review) was completed for inclusion in Site-Wide EIS	Expansion of Area G, TA-54 Radioactive Liquid Waste Treatment Facility
EAs in preparation during 1995	Chemical and Metallurgy Research Building Upgrades-Phase II Hazardous Waste Treatment Facility and Mixed Waste Receiving and Storage Facility Low-Energy Demonstration Accelerator TRU Waste Drum Staging Building

E. Figures

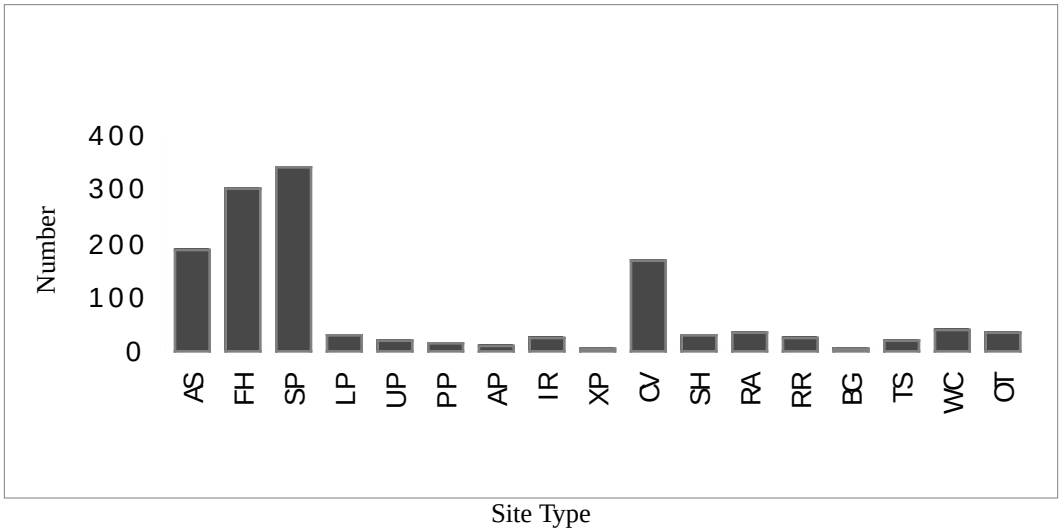

Figure 2-1. Los Alamos National Laboratory prehistoric sites.

SITE TYPE CODES:

AS	artifact scatter
FH	1-3 room structure
SP	single roomblock pueblo
LP	L-shaped pueblo
UP	U-shaped pueblo
PP	enclosed plaza pueblo
AP	highly eroded, indistinct shape pueblo
IR	indeterminate rubble mound
XP	complex shaped pueblo
WC	water control feature
BG	bedrock gametrap
TS	trail or steps
RR	rock ring
RA	rock art
CV	cavate pueblo
SH	rock shelter/overhang
OT	other prehistoric type

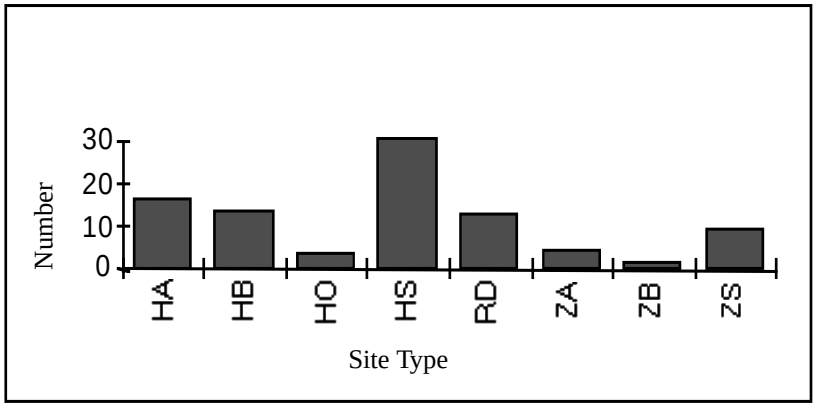

Figure 2-2. Los Alamos National Laboratory historic site types.

SITE TYPE CODES:

HB	homestead building
HS	homestead structure
HA	homestead artifact scatter
HO	homestead other
ZB	Laboratory building
ZS	Laboratory structure
ZA	Laboratory artifact scatter
ZO	Laboratory other

F. References

Broxton 1995: D. E. Broxton and P.G. Eller, "Earth Science Investigations for Environmental Restoration—Los Alamos National Laboratory, Technical Area 21," Los Alamos National Laboratory report LA-12934-MS (June 1995).

DOE 1995: Department of Energy, "1995 DOE Pollution Prevention Crosscut Plan - July 1995," US Department of Energy Office of the Secretary (1995).

EARE 1995: Environmental Assessments and Resource Evaluations Group, "Environmental Monitoring Plan for 1996-1998," Los Alamos National Laboratory document LA-UR-95-3770 (1995).

EG 1996: Ecology Group, "Environmental Surveillance at Los Alamos during 1994," Los Alamos National Laboratory report LA-13047-ENV (July 1996).

EPA 1989: US Environmental Protection Agency, US Army Corps of Engineers, US Fish and Wildlife Service, and USDA Soil Conservation Service, *Federal Manual for Identifying and Delineating Jurisdiction Wetlands*, (US Government Printing Office, Washington, DC, 1989).

Frenzel 1995: P. Frenzel, "Geohydrology and Simulation of Groundwater Flow near Los Alamos, North-Central New Mexico," USGS Water-Resources Investigations Report 95-4091 (1995).

Haarmann 1995: T. Haarmann and L. Dean, "Monitoring and Surveillance Planning Document," Los Alamos National Laboratory document LA-UR-96-128 (1995).

Hollis 1995: D. Hollis, E. Vold, K. Birdsell, J. Turin, P. Longmire, E. Springer, W. Hansen, D. Krier, R. Shuman, "Performance Assessment of LANL TA-54, Area G, LLRW Disposal Facility - Preliminary Draft," Los Alamos National Laboratory report (in press).

Kramer 1993: Kramer Associates, "Particulates Emissions Test Results: Barber-Greene Asphalt Batch Plant, Johnson Controls, Inc., Los Alamos National Laboratories," Kramer & Associates, Albuquerque, NM (August 25, 1993).

LANL 1996: "Annual PCB Document for Los Alamos National Laboratory, EPA, Region 6, January 1, 1995–December 31, 1995," Los Alamos National Laboratory document LA-UR-96-2363 (July 1996).

NMED 1996: New Mexico Environment Department, "Environmental Oversight and Monitoring at Department of Energy Facilities in New Mexico, 1995 Annual Performance Report," New Mexico Environment Department (March 29, 1996).

NMEIB 1995: New Mexico Environmental Improvement Board, State of New Mexico, "NM Water Supply Regulations" (as amended through January 1995).

Purtymun 1995: W.D. Purtymun, "Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area," Los Alamos National Laboratory report LA-12883-MS (January 1995).

Rogers 1995: D. B. Rogers and B. M. Gallaher, "The Unsaturated Hydraulic Characteristics of the Bandelier Tuff," Los Alamos National Laboratory draft report LA-12968-MS (May 1995).

3. Environmental Radiological Dose Assessment

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A. Overview of Programs

Radiological dose equivalents show the potential doses received by individuals exposed to radioactivity in the environment. Dose equivalent refers to the quantity of radiation energy absorbed per unit mass (the dose), multiplied by adjustment factors for the type of radiation absorbed. The effective dose equivalent (EDE), or dose, is the principal measurement used in radiation protection. The EDE is a hypothetical whole-body dose equivalent that would equal the same risk of cancer mortality and serious genetic disorder as the sum of the weighted dose equivalents of those organs considered to be most seriously affected by the radionuclide in question. The EDE includes the committed effective dose equivalent (CEDE) from internal deposition of radionuclides and the EDE due to penetrating radiation from sources external to the body.

Federal government standards limit the EDE to the public (DOE Order 5400.5, 40 Code of Federal Regulations [CFR] Part 61) (DOE 1990). The Department of Energy's (DOE's) public dose limit (PDL) is 100 mrem/yr EDE received from all pathways (i.e., ways in which people can be exposed to radiation, such as inhalation, ingestion, and immersion in water or air containing radioactive materials), and the dose received through the air pathway is restricted by the Environmental Protection Agency's (EPA's) effective dose standard of 10 mrem/yr (see Appendix A). These values are in addition to exposures from normal background, consumer products, and medical sources. The standards apply to locations of maximum probable exposure to an individual in an off-site, uncontrolled area.

B. Radiological Dose Equivalents

1. Methods for Dose Calculation

a. Introduction. Annual radiation doses are evaluated for three principal exposure pathways: external exposure (which includes exposure from immersion in air containing photon-emitting radionuclides and direct and scattered penetrating radiation), inhalation, and ingestion.

Two evaluations of potential releases are conducted: one to satisfy 40 CFR Part 61 requirements and one for all pathways. Results of environmental measurements are used as much as possible in assessing doses to individual members of the public. Calculations based on these measurements follow procedures recommended by federal agencies to determine radiation doses (DOE 1991, NRC 1977). If the impact of Laboratory operations is not detected by environmental measurements, individual and population doses attributable to Laboratory activities are estimated through computer modeling of releases.

The dose conversion factors used for inhalation and ingestion calculations are those recommended by the DOE (1988) and are based on factors in Publication 30 of the International Commission on Radiological Protection (ICRP 1979). Dose conversion factors for inhalation assume a particle size of 1-μm-activity median aerodynamic diameter as well as the lung solubility category that will maximize the EDE (for comparison with DOE's 100 mrem/yr PDL). Similarly, the ingestion dose conversion factors are chosen to maximize the EDE for comparison with DOE's 100 mrem/yr PDL for all pathways. These dose conversion factors give the 50-year dose commitment for internal exposure. The 50-year dose commitment is the total dose received by an organ during the 50-year period following the intake of a radionuclide.

External doses from ambient air concentrations are calculated using the dose-rate conversion factors published by DOE (1988). These factors give the photon dose rate in millirem (mrem) per year per unit radionuclide air concentration in microcuries per cubic meter ($\mu Ci/m^3$). If the conversion factor for a specific radionuclide of interest is not published in DOE 1988, it is calculated with the computer program DOSFACTOR II (Kocher 1981).

b. External Radiation. The Laboratory's largest contributor to the penetrating radiation environment is the Los Alamos Neutron Science Center (LANSCE), formerly called the Los Alamos Meson Physics Facility. During experimentation at LANSCE, short-lived positron emitters are released from the stacks and diffuse from the buildings. These emitters release photon radiation as they decay, producing a potential external radiation dose. Most of the emitters decay very quickly, and within a few hundred meters the dose is negligible. However, the dose at East Gate (the Laboratory boundary north-northeast of LANSCE) is elevated by these Laboratory emissions. The Laboratory's contribution to the penetrating radiation dose at East Gate is derived in two ways: in

one method, data from a high-pressure ion chamber are used to develop a direct evaluation of the penetrating radiation exposure rate; in the other method, calculated or measured emissions from the stacks and buildings at LANSCE are input to CAP-88 to model the potential dose at East Gate. The modeling is conservative and generally results in an overestimation of the Laboratory's contribution to the hypothetical maximally exposed individual (MEI) at East Gate. Other locations in the townsite are also modeled to determine potential doses from LANSCE operations.

The other potentially significant contributor to penetrating radiation exposures is the Criticality Facility at TA-18. Criticality experiments produce neutrons and photons, both of which contribute to the external penetrating radiation dose. During experiments that have the potential to produce a dose in excess of 1 mrem per operation, public access is restricted by closing Pajarito Road from White Rock to TA-51.

Environmental thermoluminescent dosimeters (TLD) are used to estimate external penetrating radiation doses. The Laboratory has a network of TLDs (TLDNET) around the Laboratory and townsite. The large variations in the natural background levels of penetrating radiation limit the ability of TLDs to discern the low-level Laboratory releases from natural background fluctuations. However, in the event of releases of penetrating radiation significantly above background, TLDs may be used as an indicator of the magnitude of the exposures. TLDs near the TA-18 facility have shown exposure levels above background as discussed further in Section 4.B.3. The Laboratory's TLDNET is not sensitive enough to reliably distinguish LANSCE emissions from background.

The TLDNET data are used to quantify the exposure from penetrating radiation in the Los Alamos area. The modeled dose contribution from LANSCE is subtracted from the measured TLD exposures to derive the net, nonradon, background dose at a number of locations in the Los Alamos area. The final, individual, nonradon dose is derived by reducing the measured exposure by 20% to account for building shielding and by 30% to account for the self-shielding of the body. The dose from self-irradiation, caused by natural radioactive emitters such as potassium-40 within the body, is about 40 mrem annually and is also factored into the calculation. (Note: these reductions are not used for demonstrating compliance with the EPA standard.) An assumed dose of 200 mrem to account for radon exposure is added to the calculated net dose to determine the total average background dose to a person residing in the Los Alamos area.

c. Inhalation Dose Equivalent. Annual average air concentrations of tritium; plutonium-238; plutonium-239,240; uranium-234; uranium-235; uranium-238; and americium-241, determined by the Laboratory's air monitoring network (AIRNET), are corrected for background by subtracting the average concentrations measured at representative background stations. The net concentration is reduced by 10% to account for indoor occupancy (Kocher 1980). These net concentrations are then multiplied by a standard breathing rate of 8,400 m^3/yr (ICRP 1975) to determine total adjusted intake by inhalation, in microcuries per year, for each radionuclide. Each intake is multiplied by appropriate dose conversion factors to convert radionuclide intake into 50-year committed dose equivalents (CDE). Following ICRP methods, doses are calculated for each organ that contributes more than 10% of the total EDE for each radionuclide. The dose calculated for inhalation of tritium is approximately one-half of the total dose received by being in an environment with tritium; the other half comes from direct absorption of tritium through the skin. The dose conversion factors (DCFs) for inhalation of tritium incorporate the dose received by absorption through the skin.

This procedure for dose calculation assumes conservatively that a hypothetical individual is exposed to the measured air concentration continuously throughout the entire year (8,760 h). This assumption is made for the boundary dose, dose to the MEI, and dose to the population living within 80 km (50 mi) of the site.

d. Ingestion Dose. Radioanalytical data from samples of foodstuffs are used to estimate the annual CDE to various tissues in the body and the total CEDE to the whole body for the average and maximum consumer of food products within the general population. The EPA's model CAP-88 also provides an estimate of the CEDE to the whole body for the air pathway only. The estimated CEDE is included in the total modeled EDE reported in Section 3.B.3.b. However, the CEDE from food products is calculated by multiplying the CDE, representing the total dose which an organ or tissue of the body is expected to receive over the 50-year period following an intake of radioactive material, by the weighting factors for that tissue as given in ICRP 26 (ICRP 1977). The CDE (and thus the CEDE) does not include contributions from exposures external to the body.

To calculate the CEDE, the radionuclide concentration in a particular foodstuff is multiplied by an estimated annual consumption rate to obtain the total adjusted intake for a particular radionuclide. The estimated annual consumption rates used for these calculations are presented in Table 3-1. Multiplication of this annual adjusted

intake by the appropriate radionuclide dose conversion factor for a particular organ gives the estimated CDE to the organ and, similarly the CEDE to the entire body [DOE 1988]. To determine the Laboratory impacts, if any, on a particular foodstuff, the maximum CEDE (i.e., average CEDE + two sigma) at regional stations or other background stations is subtracted from the maximum CEDE at each monitoring location. Since one cannot have a "negative exposure to radiation," all negative values are set to zero leaving only the net positive differences between the sampling location of interest and the background stations. This net positive difference is summed over all the monitored radionuclides to obtain the total net positive difference which is expressed in mrem. The total net positive difference is also reported as a percentage of the DOE's 100 mrem/yr PDL (DOE 1990) and is used to calculate the risk of cancer fatalities from consuming a particular foodstuff.

2. Estimation of Radiation Dose Equivalents

a. Dose Equivalents from Natural Background. Published EDE values from natural background and from medical and dental uses of radiation are used to provide a comparison with doses resulting from Laboratory operations. Global fallout doses due to atmospheric testing of nuclear weapons are only a small fraction of total background doses (<0.3% [NCRP 1987a]). Natural background radiation dose is due to exposure to the lungs from radon decay products and exposures from nonradon sources which affect the whole body.

External radiation comes from two sources of approximately equal magnitude: the cosmic radiation from space and terrestrial gamma radiation from radionuclides in the environment. Estimates of background radiation are based on a comprehensive report by the National Council on Radiation Protection and Measurements (NCRP 1987b). The 1987 NCRP report uses 20% shielding by structures for high-energy cosmic radiation and 30% self-shielding by the body for terrestrial radiation. The 30% protection factor is also applied to less energetic gamma radiation from LANL sources.

Whole-body external dose is incurred from exposure to cosmic rays, external terrestrial radiation from naturally occurring radioactivity in the earth's surface, and from global fallout. The EDE from internal radiation is due to radionuclides naturally present in the body and inhaled and ingested radionuclides of natural origin.

Annual external background radiation exposures for sources other than radon vary depending on factors such as snow cover and the solar cycle (NCRP 1975b). Estimates of background radiation in 1995 from nonradon sources are based on environmental dosimeter measurements of 109 mrem in Los Alamos and 96 mrem in White Rock using only complete datasets (i.e., measurements for all four quarters). The elevation difference between Los Alamos and White Rock accounts mainly for the difference between the two numbers. These measured doses were adjusted for structural shielding by reducing the cosmic ray component by 20%. The measured doses were also adjusted for self-shielding by the body by reducing the terrestrial component by 30%. The neutron dose from cosmic radiation and the dose from self-irradiation were then included to obtain the whole-body background dose of 149 mrem at Los Alamos and 136 mrem at White Rock from sources other than radon. Uranium decay products occur naturally in soil and building construction materials. Inhalation of radon-222 produced by decay of radium-226, a member of the uranium series, results in a dose to the lung, which also must be considered. The EDE from radon-222 decay products is assumed to be equal to the national average, 200 mrem/yr. This estimate may be revised if a nationwide study of background levels of radon-222 in homes is undertaken. Such a national survey has been recommended by the NCRP (NCRP 1984, 1987a).

In 1995 the EDE to residents was 349 mrem at Los Alamos and 336 mrem at White Rock from all natural sources. The individual components of the background dose for Los Alamos and White Rock, and the average EDE of 53 mrem/yr to members of the US population from medical and dental uses of radiation (NCRP 1987a) are listed in Table 3-2**.**

b. Summary of Doses to the Public from Laboratory Operations

Inhalation of Airborne Emissions. The net CEDE from the inhalation of airborne emissions as measured by the AIRNET in 1995 for the townsites of Los Alamos and White Rock are 0.05 mrem and 0.06 mrem, respectively. The maximum potential CEDE from TA-54, Area G operations, from explosive testing containing depleted uranium, and from decontamination and decommissioning activities at TA-21 are estimated at 0.002 mrem, 0.04 mrem, and 0.006 mrem, respectively. These potential doses to the public are well below the EPA standard of 10 mrem/yr for airborne emissions [EPA 1989]. Section 4.B.1.c provides further discussions on the CEDE by sampling locations as well as the radionuclides that contributed to this dose estimate**.**

External Penetrating Radiation from Airborne Emissions and Direct Sources. The annual EDE for airborne emissions was measured near the location of the MEI along the LANL boundary known as East Gate. The above background EDE at this location in 1995 was 2.0 mrem. No direct penetrating radiation dose to the public from Laboratory operations was detected by TLD measurements. Section 4.B.3.e provides further discussions on the EDE by sampling locations.

Ingestion of Drinking Water. The maximum annual CEDE (i.e., the total CEDE plus two sigma for the maximum consumption rate) for drinking water samples collected in 1995 from the LANL water distribution system is 0.579 mrem (14.5% of the 4-mrem drinking water standard). The maximum annual CEDE for the average consumption rate decreases to 0.411 mrem (10.3% of the 4-mrem drinking water standard). Section 5.C.4 provides further discussions on the CEDE for Los Alamos and White Rock and the Pueblos of San Ildefonso, Santa Clara, Cochiti, and Jemez**.**

Exposure to Sediments in Mortandad Canyon. The pathways of exposure evaluated for sediment sampling in Mortandad Canyon include the external gamma pathway from radioactive material deposited in the sediments, the inhalation pathway from materials resuspended by winds, animals, etc.; and the soil ingestion pathway. Using RESRAD v 5.61, the maximum total effective dose equivalent (TEDE) (i.e., the total of the EDEs from all pathways plus twice the error term) is estimated as 36.6 mrem (<37% of the DOE PDL). Cesium-137 from sampling locations GS-1 and MCO-5 contributed to more than 98% of the external gamma pathway which, in turn, contributed more than 84% to the maximum TEDE for the entire canyon system. The inhalation and soil ingestion pathway each contributed approximately 8% to this maximum TEDE. Modeling assumptions and more detail information is found in Section 5.E.6.

Exposure to TA-50 Effluent and Stream Below Outfall. The maximum annual CEDE (i.e., the total CEDE plus two sigma using the maximum consumption rate of 16.1 L/yr) for water samples collected in 1995 directly from the TA-50 effluent and from the stream below the outfall is 20.9 mrem (21% of the DOE PDL) and 7.8 mrem (7.8% of the DOE PDL), respectively. For the average consumption rate of 5.7 L/yr, the annual CEDE decreases to 7.4 mrem and 2.8 mrem, respectively. Section 5.E.7 provides further discussions on the assumptions used in this calculation.

Ingestion of Foodstuffs. Using the maximum consumption rate (see Table 3-1), the maximum difference between the total positive CEDE at all sampling locations and the regional background locations for each food group is as follows: produce, 0.228 mrem; honey, 0.010 mrem; eggs, 0.002 mrem; milk, 0.063 mrem; fish (bottom feeders), 0.027 mrem; fish (higher level feeders), 0.003 mrem; elk muscle, 0.027 mrem; and elk bone, 0.216 mrem. Assuming one individual consumed the total quantity for each food group (except elk bone), the total net positive difference for the CEDE is 0.360 mrem (<0.4 % of the DOE PDL) using the maximum consumption rate and 0.081 mrem (<0.09% of the DOE PDL) using the average consumption rate.

The single factor Analysis of Variance (ANOVA) test shows that, at the 95% level of confidence, there is no significant difference between the maximum CEDE (i.e., average CEDE + two sigma) for consuming food products collected at on-site, perimeter, or off-site locations in 1995. For foodstuffs that had more than one sample per year, the Student's t Test also shows that there is no significant difference, at the 95% level of confidence, between the CEDE for 1995 and the CEDE for 1994 (or a previous collection period). For foodstuffs that had only one sample per year, the confidence interval for each dataset overlapped, also indicating there is no difference between the CEDEs for 1994 and 1995. Section 6.B.2 provides further discussions on the CEDE by the food type and sampling locations as well as the radionuclides that contributed to this total net positive difference.

3. Total Maximum Individual Dose to a Member of the Public from 1995 Laboratory Operations

a. Measured Maximum Individual Dose. The maximum individual EDE to a member of the public from 1995 Laboratory operations is estimated to be 2.3 mrem. This is the total EDE from all potential pathways of radiation exposure and is based entirely on environmental measurements. This dose is 2.3% of the DOE's annual public dose limit of 100 mrem EDE from all pathways and 1% of the total annual dose contribution from all sources of radiation (Figure 3-1). The maximum individual dose occurred at East Gate and was primarily due to exposure to external penetrating radiation from air activation products released by the LANSCE accelerator. The contribution to the maximum individual off-site dose via each pathway is presented in Figure 3-2.

b. Modeled Maximum Individual Dose. As required by the EPA, compliance with regulation 40 CFR 61, Subpart H must be demonstrated with the CAP-88 version of the computer codes PREPAR2, AIRDOS2, DARTAB2, and RADRISK (EPA 1990). These codes use measured radionuclide release rates and meteorological

information to calculate airborne concentrations of radionuclides released to the atmosphere. The programs estimate radiation exposures from inhalation of radioactive materials; external exposure to the radionuclides present in the atmosphere and deposited on the ground; and ingestion of radionuclides in drinking water, produce, meat, and dairy products. The source term, the amount of a particular matter, for these calculations was based on measured emissions during 1995. Wind speed, wind direction, and stability class are continuously measured at meteorology towers located at TA-54, TA-49, TA-6, and TA-53. Emissions were modeled with the wind information most representative of the release point. The maximum individual EDE from 1995 airborne emissions, as determined by CAP-88, was 5.05 mrem. The maximum dose, which would occur in the area just north-northeast of LANSCE, is 50.5% of the EPA's air pathway standard of 10 mrem/yr EDE.

c. Comparison of Department of Energy and Environmental Protection Agency Dose Methodologies. The effects of increased dispersion of LANL's radioactive air effluents caused by the rugged topography of the Pajarito Plateau are not well incorporated by EPA's atmospheric dispersion model CAP-88. As such, the measured exposure rate at East Gate is typically less than the predicted exposure rate using CAP-88 (Figure 3-3). This is just one example of the many differences which contribute to the contrast between the dose measured for compliance to DOE standards and the dose modeled for compliance to EPA regulations presented above.

4. Population Distribution

The population distribution is used to calculate the collective dose resulting from 1995 Laboratory operations. In 1995, the estimated population of Los Alamos County was approximately 18,000 (BBER 1995). Two residential and a few commercial areas exist in the county (Figure 1-1). The Los Alamos townsite (the original area of development) now includes residential areas known as Eastern Area, Western Area, North Community, Barranca Mesa, and North Mesa. The townsite had an estimated population of 12,000 residents. The White Rock area includes the residential areas of White Rock, La Senda, and Pajarito Acres. The area had about 6,000 residents in mid-1995. It is estimated that over 241,000 persons lived within an 80-km (50-mi) radius of the Laboratory in mid-1995 (Table 3-3).

5. Collective Dose

The collective EDE from 1995 Laboratory operations is the sum of the estimated dose received by each member of the population within an 80-km (50-mi) radius of LANL. Over 99% of this dose is expected to have resulted from airborne radioactive emissions from Laboratory programs. As a result, the collective dose was estimated by modeling 1995 radioactive air emissions, their transport off site, and the resulting radiation exposures that could occur. The distribution given in Table 3-3 was used in the dose calculation. The collective dose was calculated with the CAP-88 collection of computer programs. These programs were also used to calculate the maximum EDE to a member of the public as required by the EPA regulations in 40 CFR Part 61. Airborne radioactive emissions from all types of releases were included in the analysis. The same exposure pathways that were evaluated for the maximum individual dose were also evaluated for the collective dose; these pathways include inhalation of radioactive materials, external radiation from materials present in the atmosphere and deposited on the ground, and ingestion of radionuclides in meat, produce, and dairy products. The 1995 population collective EDE attributable to Laboratory operations to persons living within 80 km (50 mi) of the Laboratory was calculated to be 3.2 person-rem. This dose is less than 0.004% of the 82,000 person-rem annual average exposure from natural background radiation and less than 0.03% of the 12,800 person-rem exposure an average person receives annually from medical radiation

C. Risk to an Individual from Laboratory Operations

1. Estimating Risk

Health effects from radiation exposure (primarily cancer) are observed in humans only at doses in excess of 10 rem delivered at high dose rates (HPS 1996). In past environmental surveillance reports, our practice has been to use the risk estimates, also called risk factors, presented in the BEIR documents (most recently, BEIR V 1990) to quantify the cancer risks from exposure to radiation. These risks were presented to provide a perspective on the potential risk of cancer from Laboratory contributions to the radiation environment of northern New Mexico.

Although it is important to address the potential risk from these radiation doses, it is also important not to mislead the reader into concluding that small radiation doses are more hazardous than they actually are.

The risk estimates in BEIR V were developed by the National Academy of Sciences and were based primarily on the dose-risk effects produced in survivors of the Hiroshima and Nagasaki atomic bomb blasts. These calculations, however, overestimate actual risk for low linear energy transfer (low-LET) radiation, which is the source of more than 95% of the dose to the MEI from Laboratory operations. The NCRP (1975a) has warned that "risk estimates for radiogenic cancers at low doses and low dose rates derived on the basis of linear (proportional) extrapolation from the rising portions of the dose incidence curve at high doses and high dose rates . . . cannot be expected to provide realistic estimates of the actual risks from low-level, low-LET radiation and have such a high probability of overestimating the actual risk as to be of only marginal value, if any, for purposes of realistic risk-benefit evaluation." The fundamental shortcoming of the BEIR V risk estimates for determining low-level radiation effects is that they are based, primarily, on the effects of doses of tens or hundreds of rem received over periods of seconds. Extrapolating these data linearly downward to the mrem or fractions of mrem annual doses from Laboratory operations almost certainly results in a great overestimation of risk.

As early as the 1920's, investigators concluded that low levels of radiation could not cause the mutations and other effects assigned to such doses (Muller 1935). More recently, Billen (1990) concluded that radiation-induced DNA damage is a small contributor to the ongoing, spontaneous DNA damage that occurs in mammalian cells. In Billen's discussion, he suggests that an annual dose in the range of less than or equal to 100 mrem can be considered a "negligible dose." In terms of DNA damage, this dose is so small as to provide no effect that could be discerned from other causes. Other researchers conclude that there is no scientific basis for the low-dose risk estimates recommended by the EPA and BEIR V, and instead, propose new risk assessment methodologies that involve defining minimum significant risk (Seiler 1994 and Seiler 1996).

Radiation hormesis (the concept that small radiation doses in the range of a few rem annually may be beneficial) should also be considered when evaluating radiation-induced risk. The following discussion is paraphrased from Gollnick (1994). The descriptor *beneficial* means that a population exposed to small amounts of radiation will experience fewer cancer deaths than a similar, unexposed population. Among the claimed effects of small radiation doses, in addition to the potential for reduced cancer risk, are increased life span, growth, and fertility. Gollnick describes possible biochemical bases for these effects including elevated antibody levels in irradiated animals and differential sensitivity of different types of lymphocytes to radiation which effectively increase the body's ability to attack tumors. Some population studies support the radiation hormesis concept, although there are generally too many potential conflicting or contributing factors to draw indisputable conclusions.

Recently, the Health Physics Society (HPS) published a position statement on the risks of radiation exposures (HPS 1996). They recommended "against quantitative estimation of health risk below an individual dose of 5 rem in one year. . . ." They concluded that below an individual dose of 5 rem in one year "risk estimates should not be used; expressions of risk should only be qualitative emphasizing the inability to detect any increased health detriment (i.e., zero health effects is the most likely outcome)."

Risk estimates range from 5×10^{-7} excess cancer deaths per mrem to members of the public (EPA 1994) to a negative (beneficial), although unquantified risk. We present the range of risk estimates in this section to allow readers to draw their own conclusions regarding the dangers of Laboratory radiation. If one chooses to use the BEIR or EPA risk estimates (factors) to calculate the potential excess cancer rates from a radiation dose, the result will overestimate the actual risk. The potential excess cancer deaths may be calculated according to the following equation:

$$R = D \times RF$$

where

R = incremental (or decremental) risk of cancer death expected from a radiation dose to an individual,

D = effective dose equivalent (mrem), and

RF = risk factor (excess cancer deaths/mrem).

As noted previously, RFs range from 5×10^{-7}/mrem to negative, as yet unquantified values. In the following sections, we do not report the potential risks associated with the reported doses, but the reader may calculate these according to the above equation, using whichever risk factors he/she believes to be appropriate.

2. Risk from Whole-Body Radiation

Radiation exposures considered in this report are of two types: (1) whole-body exposures, and (2) individual organ exposures. The primary doses from nonradon natural background radiation and from Laboratory operations are whole-body exposures. With the exception of natural background radon exposures, discussed below, radiation doses and associated risks from those radionuclides that affect only selected body organs are a small fraction of the dose and are negligible. Risks from whole-body radiation can be estimated using the factors of the BEIR V report.

Risk factors from the BEIR estimate (BEIR V 1990) are based on the risk from a single, instantaneous, high-dose-rate exposure of 10 rem. The BEIR V report states that this estimate should be reduced for an exposure distributed over time that would occur at a substantially lower dose rate. The National Academy of Sciences committee discussed dose rate effectiveness factors (DREFs) ranging from 2 to 10 that should be applied to the nonleukemia part of the risk estimate. Using the DREF value of 2 the total risk estimate from BEIR V is 440 cancer (nonleukemia and leukemia) fatalities per 10^{-7} person-mrem. The EPA recently recommended using a risk factor of 5×10^{-7} per person-mrem (EPA 1994) for estimating risks from whole-body radiation.

3. Risk from Exposure to Radon

Radon and radon-decay products are the largest contributors to natural background radiation exposures. These exposures differ from the whole-body radiation discussed above in that they principally involve only the localized exposure of the lung and not other organs in any significant way. Consequently, the risks from radon exposure are calculated separately. Exposure rates to radon (principally radon-222) and radon-decay products are usually measured with a special unit, the working level (WL); 1 WL corresponds to a liter of air containing short-lived radon decay products that have a total potential alpha energy of 1.3×10^5 MeV. An atmosphere having a 100 pCi/L concentration of radon-222 at equilibrium with its decay products corresponds to 1 WL. Cumulative exposure is measured in working level months (WLMs). A WLM is equal to exposure to 1 WL for 170 hours.

The estimated national-average radon EDE that was given by the NCRP is 200 mrem/yr. The NCRP derived this dose from an estimated national-average radon exposure of 0.2 WLM/yr. Because the risk factors are derived in terms of WLM, for the purposes of risk calculation it is more convenient to use the radon exposure of 0.2 WLM/yr than to use the radon dose of 200 mrem/yr. However, the 0.2 WLM/yr and the 200 mrem/yr EDE correspond to the same radiation exposure. Increased risks of fatal cancer from radon exposure can be estimated using a risk factor of 3.50×10^{-4}/WLM (BEIR IV 1988). Alternatively, on the basis of other data (Gollnick 1994), one may assume a zero or negative risk factor for exposure to radon.

4. Risk from Nonradon Natural Background Radiation

During 1995, persons living in Los Alamos and White Rock received an average EDE of 149 mrem and 136 mrem, respectively, of nonradon radiation (principally to the whole body) from natural sources (including cosmic, terrestrial, and self-irradiation sources, with allowances for shielding and cosmic neutron exposure) (Table 3-2).

The dose from natural background radiation also includes exposure to the lung from radon-222 and its decay products as discussed above.

5. Risk from Laboratory Operations

The risks calculated from natural background radiation and medical and dental radiation can be compared with the incremental risk caused by radiation from Laboratory operations. The average doses to individuals in Los Alamos and White Rock from 1995 Laboratory activities were 0.5 and 0.2 mrem, respectively. Assuming the EPA risk factors, these Laboratory doses would give approximately 0.1% of the risk attributed to exposure to natural background radiation or to medical and dental radiation. The exposure to Los Alamos County residents from Laboratory operations is well within variations in exposure of these people to natural cosmic and terrestrial sources and global fallout. For example, variation in the amount of snow cover and in the solar sunspot cycle can cause a 10-mrem difference from year to year (NCRP 1975b).

For Americans, the average lifetime risk is a 1-in-4 chance of contracting cancer and a 1-in-5 chance of dying of cancer (EPA 1979). Assuming one accepts the most conservative risk estimates (BEIR V 1990 and EPA 1994), the incremental risk from exposure to Laboratory operations is negligible.

D. Tables

Table 3-1. Annual Consumption Rates for Calculating the Committed Effective Dose Equivalent in Foodstuffs

Food Groups	Average Exposed Individuals	Maximum Exposed Individuals
Dairy Products	120 kg (0.3 L/d)[a]	300 kg (0.8 L/d)[a]
(Fresh Cow's Milk)	96 kg (0.25 L/d)[a]	190 kg (0.5 L/d)[a]
Elk		
Meat	9.5 kg (21 lb)[a]	23 kg (50 lb)[c]
Bone	2.4 kg (5 lb)[d]	5.7 kg (13 lb)[d]
Fish (Fresh)	5.7 kg (13 lb)[a]	21 kg (46 lb)[b]
Fruits	17 kg (37 lb)[e]	46 kg (102 lb)[e]
Vegetables	42 kg (91 lb)[e]	114 kg (250 lb)[e]
Beverages[g]	540 kg (1.5 L/d)[a]	760 kg (2.1 L/d)[a]
(Tap Water &		
Water Based Drinks)	421 kg (1.1 L/d)[a]	557 kg (1.5 L/d)[a]
Eggs	12 kg (34 g/d)[a]	20 kg (55 g/d)[f]
Honey	1.4 kg (3 lb)[h]	5 kg (11 lb)[h]

[a] EPA 1984.
[b] NRC 1977.
[c] Based on the consumption of one 233 kg elk (Meadows 1982) per year per 4.5 persons family.
[d] Based on the meat consumption rate and the weight distribution of elk tissue groups (Meadows 1982).
[e] Based on values from the NRC Regulatory Guide 1.109 (NRC 1977) with 22% fruit and 54% vegetables. The homegrown fraction is estimated at 40% (EPA 1989).
[f] EPA 1991.
[g] Modified to reflect the percent of water that a particular well contributed to the total amount of drinking water pumped in a year.
[h] Value used in previous years and/or based on professional judgment.

Table 3-2. Calculation of Total Effective Dose Equivalent (mrem/yr) from Natural or Man-Made Sources

	Los Alamos	White Rock
Radon	200	200
Self-irradiation	40	40
Total External[a]	109	96
Total Effective Background Dose	349	336
Medical	53	53

[a] Includes correction for shielding.

Table 3-3. Estimated 1995/1996 Population within 80 km of Los Alamos National Laboratory[a]

	Distance from TA-53 (km)									
Direction	**0-1**	**1-2**	**2-4**	**4-8**	**8-15**	**15-20**	**20-30**	**30-40**	**40-60**	**60-80**
N	7	69	241	134	0	13	89	932	797	577
NNE	7	65	95	23	2	10	2,301	386	660	307
NE	4	11	0	0	1	1,163	14,508	2,495	2,415	3,527
ENE	1	0	0	0	550	1,468	4,480	3,525	1,392	1,564
E	0	0	0	1	311	1,310	4,034	381	21	402
ESE	0	0	0	0	9	10	658	7,890	721	2,222
SE	0	2	0	4,576	577	0	967	71,531	7,371	661
SSE	3	3	0	523	350	0	288	5,565	2,541	106
S	2	2	0	0	22	0	16	143	390	3,028
SSW	3	3	0	0	30	1	764	1,263	6,708	51,824
SW	3	10	0	1	4	1	0	0	2,158	181
WSW	1	16	27	0	7	0	29	373	2,379	4
W	0	4	121	178	0	6	64	277	59	68
WNW	2	14	1,029	5,976	0	0	25	30	61	2,519
NW	5	30	907	1,466	0	2	23	48	0	568
NNW	6	60	696	288	0	6	19	255	157	27
Total	44	289	3,116	13,166	1,863	3,990	28,265	95,094	27,830	67,837

[a]Total population within an 80-km radius of Los Alamos National Laboratory is more than 241,000.

E. Figures

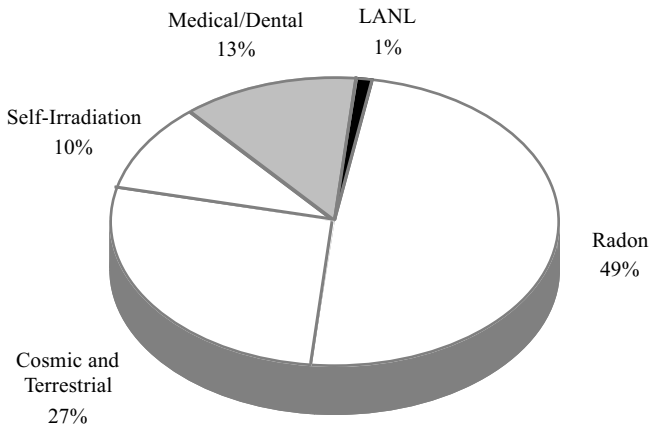

Figure 3-1. Total contributions to 1995 dose at the Laboratory's maximum exposed individual location.

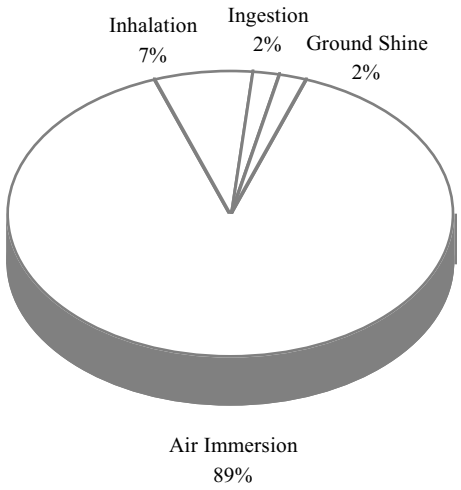

Figure 3-2. The Laboratory's contribution to dose by pathway at the maximum exposed individual location.

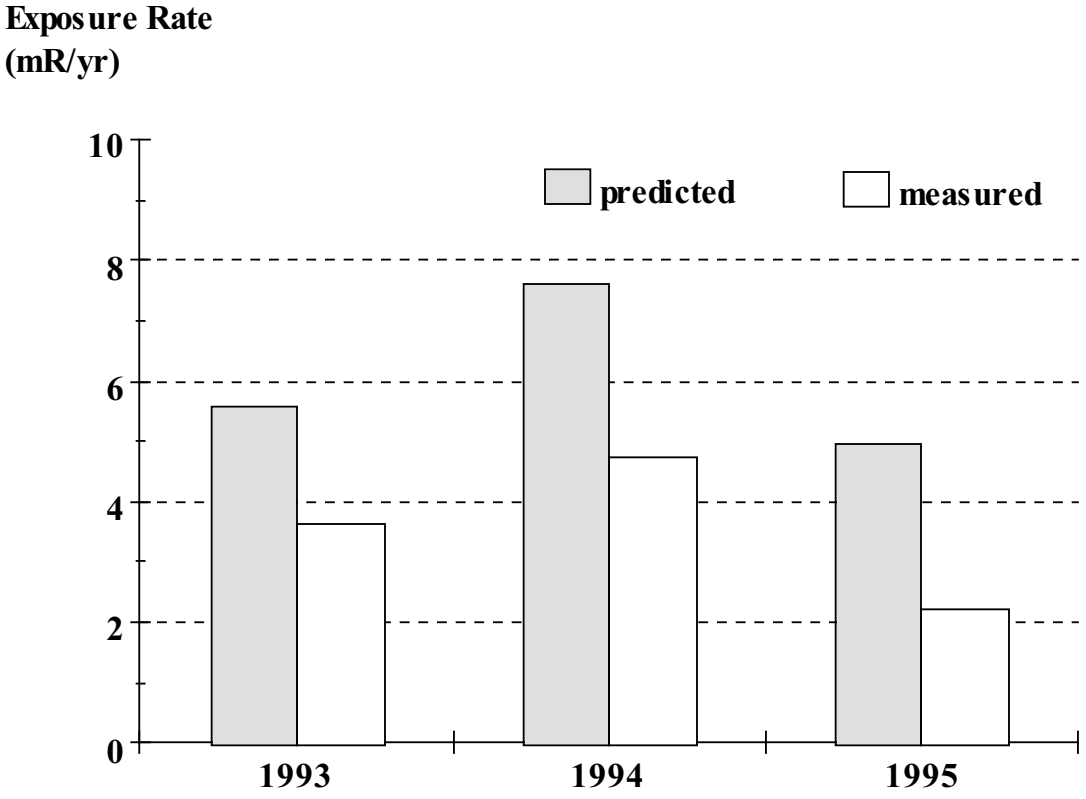

Figure 3-3. A comparison of predicted and measured radiation exposure at East Gate.

F. References

BBER 1995: Bureau of Business and Economic Research, New Mexico, projected population data for New Mexico counties (1995).

BEIR IV 1988: National Research Council, Committee on the Biological Effects of Ionizing Radiations, *Health Risks of Radon and Other Internally Deposited Alpha Emitters* (National Academy Press, Washington, DC, 1988).

BEIR V 1990: National Research Council, Committee on the Biological Effects of Ionizing Radiations, *Health Effects of Exposures to Low Levels of Ionizing Radiation* (National Academy Press, Washington, DC, 1990).

Billen 1990: D. Billen, "Spontaneous DNA Damage and Its Significance for the 'Negligible Dose' Controversy in Radiation Protection," Radiation Research, Vol. 124, pp. 242–245 (1990).

DOE 1988: US Department of Energy, "External Dose Conversion Factors for Calculating Dose to the Public," US Department of Energy report DOE/EP-0070 (July 1988).

DOE 1990: US Department of Energy, "Radiation Protection of the Public and the Environment," US Department of Energy Order 5400.5 (February 1990).

DOE 1991: US Department of Energy, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," US Department of Energy report DOE/EH-0173T (January 1991).

EPA 1979: US Environmental Protection Agency, "National Emission Standards for Identifying, Assessing, and Regulating Airborne Substances Posing a Risk of Cancer," *Federal Register* **44,** 197 58643 (October 1979).

EPA 1984: Environmental Protection Agency, "An Estimation of Daily Average Food Intake by Age and Sex for Use in Assessing the Radionuclide Intake of Individuals in the General Population" EPA 520/1-84-021 (October 1984).

EPA 1989: Environmental Protection Agency, "Exposure Factors Handbook," EPA 600/8-89-043, (July 1989).

EPA 1990: US Environmental Protection Agency, "CAP-88 Clean Air Act Assessment Package," distributed by the Radiation Shielding Information Center, RS1C Code Package CCC-542 (1990).

EPA 1991: Environmental Protection Agency, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," EPA 400-R-92-001 (October 1991).

EPA 1994: US Environmental Protection Agency, Federal Radiation Protection Guidance for Exposure of the General Public; Notice Federal Register, December 23, 1994.

Gollnick 1994: D. A. Gollnick, *Basic Radiation Protection Technology, 3rd Edition,* Pacific Radiation Corporation, 2945 Stonehill Drive, Altadena, CA 91001 (1994).

HPS 1996: Health Physics Society, "Radiation Risk in Perspective," Health Physics Society Position Statement, HPS Newsletter (March 1996).

ICRP 1975: International Commission on Radiation Protection, "Report on the Task Group on Reference Man," International Commission on Radiological Protection report No. 23, Pergamon Press, New York, NY (1975).

ICRP 1977: International Commission on Radiological Protection, "Recommendation of the International Commission on Radiological Protection," Pergamon Press, Oxford (1977).

ICRP 1979: International Commission on Radiation Protection, Limits on Intake of Radionuclides by Workers, International Commission on Radiological Protection report No. 30, Pergamon Press, New York, NY (1979).

Kocher 1980: D. C. Kocher, "Effects of Indoor Residence on Radiation Doses from Routine Releases of Radionuclides to the Atmosphere," *Nuclear Technology* **48** (April 1980).

Kocher 1981: D. C. Kocher, "Dose Rate Conversion Factors for External Exposure to Photons and Electrons," US Nuclear Regulatory Commission report NUREG/CR-1918 (August 1981).

Meadows 1982: S. D. Meadows and T. E. Hakonson, "Contribution of Tissues of Body Mass in Elk," *Journal of Wildlife Management* **46** (3), pp. 838–841, (1982).

Muller 1935: H. J. Muller and L. M. Mott-Smith, " Evidence that Natural Radioactivity Is Inadequate to Explain the Frequency of Natural Mutations," Proceedings of the Natural Academy of Sciences, USA, Vol. 16, pp. 277–285 (1935).

NCRP 1975a: National Council on Radiation Protection and Measurements, "Review of the Current State of Radiation Protection Philosophy," National Council on Radiation Protection and Measurements report 43, pp. 2–3 (1975).

NCRP 1975b: National Council on Radiation Protection and Measurements, "Natural Background Radiation in the United States," National Council on Radiation Protection and Measurements report 45 (November 1975).

NCRP 1984: National Council on Radiation Protection and Measurements, "Exposures from the Uranium Series with Emphasis on Radon and Its Daughters," National Council on Radiation Protection and Measurements report 77 (March 15, 1984).

NCRP 1987a: National Council on Radiation Protection and Measurements, "Ionizing Radiation Exposure of the Population of the United States," National Council on Radiation Protection and Measurements report 93 (September 1987).

NCRP 1987b: National Council on Radiation Protection and Measurements, "Exposure of the Population in the United States and Canada from Natural Background Radiation," National Council on Radiation Protection and Measurements report 94 (December 1987).

NRC 1977: Nuclear Regulatory Commission, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," Nuclear Regulatory Commission Report, Regulatory Guide 1.109 (October 1977).

Seiler 1994: F. A. Seiler and J. L. Alvarez, "Definition of Minimum Significant Risk," *Technology—Journal of the Franklin Institute*, Vol. 331A, pp. 83–95 (1994).

Seiler 1996: F. A. Seiler and J. L. Alvarez, "Toward a New Risk Assessment Paradigm: New Nonlinearities in Linear and Nonlinear Risk Models," *Technology—Journal of the Franklin Institute* (May 1996).

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A. Overview of Programs

1. Ambient Air Sampling Program

Natural atmospheric and fallout radioactivity levels fluctuate and affect measurements made using Los Alamos National Laboratory's (LANL or the Laboratory) air sampling program. Worldwide background airborne radioactivity is largely composed of fallout from past atmospheric nuclear weapons tests by several countries, natural radioactive constituents from the decay of thorium and uranium attached to dust particles, and materials resulting from interactions with cosmic radiation (for example, natural tritiated water vapor produced by interactions of cosmic radiation and stable water). Levels of background radioactivity in the atmosphere, which are useful in interpreting air sampling data, are summarized in Table 4-1. Note that the measurements taken in Santa Fe by the US Environmental Protection Agency (EPA) are similar to those taken by the Laboratory as regional background values and are significantly lower than EPA concentration limits for the general public.

The radiological air sampling network at the Laboratory is designed to measure environmental levels of airborne radionuclides that may be released from Laboratory operations. Laboratory emissions include microcurie (μCi) quantities of plutonium and americium, millicurie (mCi) quantities of uranium, and curie (Ci) quantities of tritium and activation products.

Particulate matter in the atmosphere is primarily caused by the resuspension of soil, which is dependent on current meteorological conditions. Windy, dry days can increase the soil resuspension, whereas precipitation (rain or snow) can wash particulate matter out of the air. Consequently, there are often large daily and seasonal fluctuations in airborne radioactivity concentrations caused by changing meteorological conditions. The measured airborne concentrations (Table 4-1) are less than the EPA concentration limit for the general public. The EPA limit represents a concentration that would result in an annual dose of 10 mrem.

2. Stack Sampling Program

Radioactive materials are an integral part of many activities at the Laboratory. Some operations involving these materials may be vented to the environment through a stack. These operations are evaluated to determine impacts on the public and the environment. If this evaluation shows that emissions from a stack may potentially result in a member of the public receiving 0.1 mrem in a year, this stack must be sampled in accordance with 40 Code of Federal Regulations (CFR) 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" (EPA 1989). As of the end of 1995, 27 stacks were identified as meeting this criterion. An additional five sampling systems are in place to meet Department of Energy (DOE) requirements for nuclear facilities prescribed in DOE Order 6430.1a, "General Design Criteria." (DOE 1989) Where sampling is not required, emissions are estimated using engineering calculations and radionuclide inventory information.

3. Cosmic and Gamma Radiation Monitoring Program

Naturally occurring external penetrating radiation originates from terrestrial and cosmic sources. The terrestrial component results primarily from naturally occurring potassium-40, thorium, and uranium decay chains. Terrestrial radiation varies diurnally, seasonally, and geographically. External penetrating radiation levels can vary from 15% to 25% at a given location because of changes in soil moisture and snow cover (NCRP 1975). There is also spatial variation due to topographical and geological variations (ESG 1978).

Naturally occurring ionizing radiation from cosmic sources increases with elevation because of reduced atmospheric shielding. At sea level, cosmic sources yield between 25 and 30 mrem/yr. Los Alamos, with a mean elevation of about 2.2 km (1.4 mi), receives about 75 mrem/yr (unshielded) from cosmic sources. However, different locations in the region range in elevation from about 1.7 km (1.1 mi) at Española to 2.7 km (1.7 mi) at Fenton Hill, resulting in a corresponding range of 45 to 90 mrem/yr from cosmic sources. This component can

also vary ±10% because of solar modulations (NCRP 1987). These fluctuations along with those from terrestrial sources make it difficult to detect an increase in radiation levels from man-made sources, especially when the increase is small relative to the magnitude of natural fluctuations (see Appendix C for the locations of man-made sources of radiation at the Laboratory).

To evaluate natural and man-made radiation, including x-rays and gamma rays and charged-particle contributions from cosmic, terrestrial, and man-made sources, LANL's environmental monitoring program uses thermoluminescent dosimeters (TLDs) and a high-pressure ion chamber (HPIC). LANL's environmental monitoring of external penetrating radiation is made up of three TLD networks described in Section 4.B.3.a.

4. Meteorology Program

Meteorological data obtained from the meteorological monitoring network support many Laboratory activities, including emergency management and response, regulatory monitoring, safety analysis, and engineering studies. To accommodate the broad demands for weather data at the Laboratory, a wide variety of meteorological variables are measured across the network, including wind, temperature, pressure, relative humidity and dew point, and solar and terrestrial radiation. Details of the meteorological monitoring program are available through the Internet at http://weather.lanl.gov/monplan/mmp96.html and are discussed in Stone (1995).

5. Quality Assurance Program in the Air Quality Group

a. Quality Assurance Program Development. Quality assurance (QA) includes all the planned and systematic activities necessary to provide adequate confidence that a process will perform satisfactorily. The Air Quality Group (ESH-17) made significant programmatic improvements during 1995 by continuing the development of quality plans and procedures which document and formalize its operations. Six plans were developed or revised during 1995:

Quality Management Plan for the Air Quality Group (ESH-17-QMP, R0) (Dewart 1995)

QA Project Plan for Unmonitored Point Source Radioactive Air Emissions (ESH-17-UMS, R0) (Lochamy 1995)

QA Project Plan for Radioactive Particulate and Vapor Stack Emissions Monitoring (ESH-17-PARTIC, R0) (Merkey 1995a)

QA Project Plan for Tritium Stack Emissions Monitoring (ESH-17-TRIT, R0) (Merkey 1995b)

QA Project Plan for Radiological Air Sampling Network (ESH-17-AIRNET, R3) (Morgan 1995)

QA Project Plan for Thermoluminescent Dosimeter Project (ESH-17-TLDNET, R4) (Durrer 1995)

ESH-17's Quality Management Plan was written and approved during 1995. This document was written in the format described in DOE Order 5700.6C (DOE 1991a) and describes the overall group management structure, defines and describes general quality processes applicable to all projects and all group members, and defines the lower-tier project-level plans. Project plans were developed to document and describe the essential elements of each project. Because most ESH-17 projects are required by EPA for compliance with Clean Air Act regulations, the writing of these project plans followed EPA requirements and guidance. The format for the Unmonitored Point Source plan was based on the order of the required elements of a quality plan specified in 40 CFR 61, Appendix B, Method 114, Section 4.0 (EPA 1989). For the other four projects, EPA's guidance QA/R-5 (EPA Requirements For Quality Assurance Project Plans for Environmental Data Operations) (EPA 1994a) was followed. As part of the plan development process described in QA/R-5, the data quality objectives process described in EPA QA/G-4 (Guidance for the Data Quality Objectives Process) (EPA 1994b) was used to develop the necessary data accuracy, precision, and completeness objectives. The QA Project Plan for Meteorology was not modified in 1995 (Olsen 1993). ESH-17 staff also took the lead role in development of the QA Project Plan for the Los Alamos Neutron Science Center (LANSCE, formerly Los Alamos Meson Physics Facility) Radioactive Air Emissions Monitoring (Lochamy 1996).

More than 40 procedures were written, reviewed, and approved during 1995. Procedures were written as necessary to document and describe the specific steps used to accomplish essential work. Procedures describe processes such as records management, procedure writing and revision, training, deficiency documentation and

correction, sample collection, sample shipment, data handling, data entry, calculation of dose, calibration of equipment, maintenance of equipment, internal assessments, and numerous other activities.

b. Analytical Laboratory Assessments. During 1995, prompt-turnaround analytical chemistry services were supplied by the Laboratory's Health Physics Analytical Laboratory (HPAL), which is part of the Health Physics Measurements Group (ESH-4). Quarterly analytical chemistry services were provided by Analytical Technologies, Inc. (ATI) of Fort Collins, Colorado, and the Grand Junction Rust-GeoTech Project Office (GJPO) of Grand Junction, Colorado. Application of the data quality objective (DQO) process led to definition of analytical chemistry DQOs. These DQOs were summarized as purchase requirements in statements of work (SOWs) used for procurement of chemical analyses from the commercial laboratories. Before awarding the purchases, ESH-17 evaluated the lab procedures, quality plans, and interlaboratory comparison program results of these suppliers and found that they met purchase requirements. ESH-17 also performed formal on-site assessments at the ATI and HPAL laboratories during 1995. Quality control aspects of the analytical chemistry will be presented in later sections of this document.

The three analytical laboratories participated in intercomparison studies during 1995. Two federal agencies, EPA and DOE, sponsor intercomparison studies: the EPA Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, and the DOE Environmental Measurements Laboratory in New York, New York. The DOE laboratory sends spiked air filters twice a year to the participating laboratories. The EPA laboratory sends one type of spiked media from one to three times a year. The three laboratories' intercomparison program results on relevant test samples for 1995 are summarized in Table 4-2.

Both the EPA and DOE programs rate the results either "accept," "accept with warning," or "not acceptable," based on the value and the associated uncertainty. As indicated in Table 4-2, only two analytical results were rated "not acceptable" and one was rated "accept with warning;" all involved test samples analyzed by ATI in June. ATI performed acceptably on the test samples submitted in December and obtained consistent results on blanks and spikes throughout the year (see later sections on laboratory quality control); therefore, ESH-17 believed no corrective action was warranted.

B. Description of Programs and Monitoring Results

1. Ambient Air Sampling

a. Air Monitoring Network. During 1995, ambient air sampling for airborne radioactivity was conducted at more than 50 locations, with 6 stations added and 4 stations discontinued in 1995. Stations are categorized as regional, perimeter, or on site. Three regional monitoring stations, 28 to 44 km (18 to 28 mi) from the Laboratory, are located in Española, Pojoaque, and Santa Fe. The data from these stations are used as reference points for determining regional background and fallout levels of atmospheric radioactivity. There are now more than 20 perimeter stations located within 4 km (2.5 mi) of the Laboratory boundary.

Over 30 stations are within the Laboratory boundary. For quality assurance purposes, two samplers are co-located as duplicate samplers, one at Station #27 at Technical Area (TA) 54 and one at Station #26 at TA-49. In addition to the three categories mentioned previously, stations can also be classified as being inside or outside a controlled area. A controlled area is where radioactive materials or elevated radiation fields may be present and are clearly posted as such (DOE 1988). The active waste site TA-54 Area G is an example of a controlled area.

History of Changes in Sampling Stations. In addition to Station #27, four site-specific stations were located at the active radioactive waste disposal site at TA-54, Area G in October 1984. In August 1992, five stations for sampling iodine-131 in air were added to the air monitoring network, with an additional station being added in January 1993. These iodine-131 stations were co-located with other stations, but were discontinued in 1995. In October 1992, five new stations were established at TA-21 to monitor potential emissions resulting from the demolition and removal of a decommissioned nuclear facility, which is part of the DOE's Environmental Restoration (ER) Project. In May 1993, five additional stations were established at TA-54, Area G to monitor potential emissions from the waste remediation project known as the Transuranic Waste Inspectable Storage Project (TWISP). Also during 1993, the Laboratory installed stations at the northern New Mexico Pueblos of Jemez, San Ildefonso, and Taos at the request of the respective tribal governments. In 1994, three stations were installed to monitor potential emissions from the pulsed high-energy radiographic machine emitting x-rays (PHERMEX) and R-306 firing sites. The station located on the roof of the TA-59, Occupational Health Laboratory

was discontinued in 1994, and at the request of residents the Pajarito Acres subdivision, Station #14 (Pajarito Acres) was discontinued in 1994. Station #1 (Española) was moved to an alternate location in Española during 1994 because of a change in property ownership.

In 1995, Stations #29 (TA-2 Omega), #33 (Area AB), #44 (Area G, South Perimeter), and #46 (Area G, East Perimeter) were discontinued. Station #14 was relocated to another location in Pajarito Acres and restarted in 1995. The four new perimeter stations added in 1995 were #60 (LA Canyon), #61 (Los Alamos Hospital), #62 (Trinity Bible Church), and #63 (WR Monte Rey South). Two new stations were also added at TA-54, Area G.

b. Sampling Procedures, Data Management, and Quality Assurance

Sampling Procedures. The Laboratory operates a network of more than 50 environmental air stations (called AIRNET) to sample radionuclides in ambient air (Figure 4-1). Each sampler is equipped with a filter to collect a particulate matter sample (for gross alpha/beta and radiochemical determinations) and a silica gel cartridge to collect a water sample (for tritium determination). A pump pulls ambient air into the housing that protects the sampling apparatus and through the filter and cartridge. Instrumentation within the housing records the total time the pump ran during the two-week sample period and the flow in the particle and the tritium sampling trains. During a two-week period, the filter will collect particulate material from approximately 2,280 m^3 of air, and the silica gel cartridge will collect the moisture from approximately 4 m^3 of air. The particulate filter and the gel cartridge are collected and are generally analyzed biweekly. The particulate filters are accumulated for three months, composited, split, and then sent to commercial analytical laboratories for radiochemical analyses. Details about the sample collection, sample management, chemical analysis, and data management activities are provided in the project plan (Morgan 1995) and in the numerous procedures through which the plan is implemented. Descriptions of activities in 1995 are summarized in the following sections.

Data Management. The 1995 field data including timer readings, readings for the flow in the sampling trains at the start and stop of the sampling period, and comments pertaining to these data were recorded by hand on field sheets. These data were later transferred to spreadsheets in electronic format. Similarly, data from weighing silica gel cartridges and distilling the tritium were hand recorded and then transferred to spreadsheets. All the data were then compiled in a Microsoft Access database. At the end of 1995, an automated field data recording method was developed to eliminate the need for transcribing field data, to reduce errors in field data, and to streamline the quality assurance process. This system replaced the hand recording for field data collected in 1996 but was not ready for deployment in 1995. In 1995, all field and analytical data from previous years were transferred to tables in the Microsoft Access database. As 1995 data were received from the analytical laboratories, the data were transferred to the database. These field and chemistry data tables are relationally linked to allow reporting.

Analytical Chemistry. For 1995, ESH-17 embarked on a program to improve the quality of data packaging and the timeliness of the reporting of chemical analyses. The decision was made to subcontract the analyses to new internal and external laboratory vendors. The vendors were chosen based on prior assessments of their capabilities.

The 1995 particulate filters were analyzed biweekly by the ESH-4 HPAL, using analytical procedures that meet the requirements of 40 CFR 61, Appendix B, Method 114. Gross alpha, beta, and tritium measurements were generally performed biweekly. A composite was prepared quarterly for each station by combining the filters from the six or seven sampling periods during the quarter. The composites (one for each station) were split, and the first half submitted to commercial laboratories for analysis. During 1995, analyses were performed at ATI of Fort Collins, CO or at GJPO of Grand Junction, CO. The second half of each composite was temporarily retained for reanalysis, if needed. Because of apparent sample contamination, reanalyses were required for 2 first-quarter and 12 second-quarter samples. At these laboratories, chemical analyses consisted of complex radiochemical separations followed by instrument determinations which conformed to EPA requirements.

Every two weeks, ESH-17 staff distilled the moisture from the silica gel cartridges and submitted the distillate to the ESH-4 HPAL for tritium determination by liquid scintillation spectrometry. Summary data for the biweekly and quarterly analyses are provided in Table 4-3.

Minimum detectable amounts (MDAs) for upcoming 1996 analyses were established early in 1995 by application of the DQO process. These MDAs were defined, in a manner consistent with EPA guidelines, as functions of the standard deviations (sigma) of background count rates for radioisotopes. These 1996 MDA targets were considered advisory for 1995 samples. As experience was gained during 1995, laboratories increased count times where necessary to meet these MDAs. The tritium results in Table 4-4 provide an example. In the first half

of the year, the MDA was 1.0 pCi/L; in the second half of the year, the MDA improved to 0.6 pCi/L as a result of increasing count time. Target MDAs (as three sigma values) may be found in Table 4-3.

Laboratory Quality Control Samples. For 1995, ESH-17 maintained a program of blank, spike, duplicate, and replicate analyses, which was designed to provide information on the quality of the data received from analytical chemistry suppliers. Overall, the chemistry program was sufficiently in control and capable of providing results suitable for use in the air quality programs.

Analyses of blank samples (i.e., with no added radioisotopes) were used to assess the ability of the laboratories to detect very low levels of radionuclides. Blank samples were of three types: reagent, filter, and field blanks. Each commercial laboratory maintained a program of reagent blanks (chemicals used in the analytical process) alongside the ESH-17 radiochemical analyses. At the request of ESH-17, each laboratory also maintained a program of filter blank analyses (filters never in the field, plus the chemicals used in the analytical process), using filter material supplied by ESH-17. In addition, ESH-17 maintained a program of field blank samples (unused filters which were submitted for analysis as blind samples) during 1995. Two field blank samples were submitted with each biweekly batch. These field blanks were also composited and analyzed as blind samples with the quarterly radioisotopic analyses. Concentrations for blank samples were expected to be near the detection limits. Conversely, MDAs reported for these blanks were expected to conform to the target detection limits referenced above. For tritium, average blank values for the second half of 1995 met 1996 DQOs. For most other categories of blanks (representing more than 90% of all spikes), blank results for all of 1995 were consistently near 1996 DQOs. More detailed average values and actual MDA performance are listed in Table 4-4.

Analyses of spiked samples (i.e., samples with deliberately added radioisotopes) were used to assess the ability of the laboratories to accurately quantify radionuclides. For 1995, each commercial laboratory maintained a program of reagent spikes. At the request of ESH-17, each commercial lab also maintained a program of filter spikes, using filter material supplied by ESH-17. In all, a total of more than 175 analyses of spikes were performed in 1995. For most categories (representing more than 90% of the spikes analyzed), spike recoveries were consistently very near 100% of the actual, which meets or exceeds DQOs. An exception proved to be low (50%) spike recovery of relatively small amounts (approximately 0.75 pCi) of uranium-235 in the presence of relatively large amounts (approximately 20 pCi total) of both uranium-234 and uranium-238. This difficult situation is not applicable to, and is not believed to represent a quality control problem for, real samples. More detailed values can be found in Table 4-5.

During 1995, ESH-17 maintained a program of analyses of duplicate field samples (i.e., samples collected from a second sampling station co-located at a site). There were two such dual sites. These were used to assess the overall ability of the ESH-17 pumps and filters and laboratory analysis systems to provide precise results for real samples. A control chart was set up in mid-1995 to track replication of the biweekly analyses (alpha, beta, and tritium) for the paired stations. Only a single tritium data pair exceeded three sigma and required review. The cause could not be determined. It is important to note that the level of tritium was well below any real level of concern. See Section 4.B.1.c for more detail. For gross alpha and gross beta duplicates, all 1995 data were well within control limits. Duplicate analyses which were within control limits represented more than 90% of the biweekly duplicate data sets.

In most programs which it regulates, EPA recommends duplicate analyses of 5% of the sample load as a DQO. For radiochemical analyses of air filters, only later (i.e., replicate) analyses of the retained portions of filters can be done because the air filters are small, and, with the very low detection limit requirements, the laboratory uses the entire sample and cannot take duplicate portions at the time of analysis. During 1995, ESH-17 required replicate radiochemical analyses of the retained portion of 14 samples for plutonium and americium. For these analytes, this portion was slightly greater than 5% of the annual sample load. To further test the overall system, these replicates were scheduled for analysis at a laboratory different from the laboratory providing the first analyses. Four fresh blanks were also scheduled for analyses. The 14 samples chosen for the replicate analyses were first and second quarter 1995 samples for which contamination was suspected, based on comparisons of the first analyses with historical values. Replicate analyses were completed in January 1996. All laboratory quality controls (blanks and spikes) were in the control range during both the original and the replicate analyses. The blanks which accompanied both the original and the replicate samples all gave appropriate results. The replicate results for analyses of the 14 samples were mixed. For only 4 of the 14 replicate samples results were the same (i.e., 85% to 145% of the first results). However, for 10 of the 14 samples, results were lower (i.e., 15% to 35% of the first results). When results for blanks, spikes, samples, and replicates were considered in total, these results indicated

the probability that contamination occurred in the processes up to and including the first shipment for analysis. Other results for first and second quarter must therefore also be considered suspect.

c. Radiochemical Analytical Results

Gross Alpha and Beta Radioactivity. Gross alpha and beta analyses are used primarily to evaluate general radiological air quality and to identify potential trends in the data. The total gross alpha or beta concentration found on a filter defines the upper limit of alpha or beta activity for any single radionuclide. If gross activity in a sample is consistent with past observations and background, immediate special analyses for specific radionuclides are not necessary. If the gross analytical results appear to be elevated, then immediate analyses for specific radionuclides may be performed to confirm or deny a problem, such as an unplanned release. Gross alpha and beta activity in air exhibit considerable environmental, especially seasonal, variability, as shown in Figures 4-2 and 4-3. The National Council on Radiation Protection and Measurements (NCRP) estimated the average concentration of long-lived gross alpha activity in air to be 2.0 fCi/m^3. The primary alpha activity is due to polonium-210 (a decay product of radon gas) and other naturally occurring radionuclides (NCRP 1987). The NCRP also estimated average concentration levels of long-lived gross beta activity in air to be 20.0 fCi/m^3. This activity is primarily due to the presence of lead-210 and bismuth-210 (decay products of radon) and other naturally occurring radionuclides.

There were more than 1,000 air samples collected in 1995 and analyzed for gross alpha and gross beta activity. As shown in Table 4-6, all of the stations were within two standard deviations of the NCRP's estimated average (2 fCi/m^3) for gross alpha concentrations with one exception. The annual means of Station #52 at TA-54, Area G shows an annual mean below 2.0 fCi/m^3 for gross beta concentrations. The lowest group mean annual concentrations occurred at the regional stations and the pueblo stations. These groups show averages slightly below the NCRP estimated average. Gross alpha activity is almost entirely from the decay of natural radionuclides, primarily radon, and is dependent on variations in natural conditions such as atmospheric pressure, temperature, and soil moisture. The differences among the groups are most likely attributable to these factors.

Table 4-7 shows gross beta concentrations within and around the Laboratory. These data show variability similar to the gross alpha. All group averages are below 20 fCi/m^3, the NCRP estimated national average for gross beta concentrations.

Comment on Data Significance for All AIRNET Data. Individual data values (concentrations) are generally above zero but are equal to or less than the uncertainty in the analytical process. However, calculating the annual concentration for a monitoring site or group of sites usually results in an estimated number that is still close to, but greater than, zero.

Tritium. Tritium is released by the Laboratory in curie amounts. In addition, tritium is present in the environment as the result of nuclear weapons tests and is also produced naturally by the cosmogenic process (Kathern 1984). Sampling results are presented in Table 4-8. Eleven of the off-site mean annual concentrations were above the upper limit background (ULB), which is calculated as the mean of the regional samplers plus two standard deviations) value of 1.8 pCi/m^3. The maximum off-site mean annual concentration of 8.0 pCi/m^3 was recorded at Station #9, Los Alamos Airport. The calculated gross tritium dose (no background subtraction) based on local mean air concentration at Station #9 was 0.53% of the EPA's public dose limit (PDL) of 10 mrem per year. Elevated concentrations were observed at a number of on-site stations, with the highest maximum concentrations at Stations #25, #35, and #36 and the highest annual mean concentration at Station #35. Stations #35 and #36 are located at Area G in the TA-54 waste site near shafts where tritium-contaminated waste is disposed, and Station #25 is located among tritium facilities. However, the maximum annual mean gross (no background subtraction) concentration, which was observed at Station #35, is approximately 0.0019% of the DOE Derived Air Concentration (DAC) for controlled areas (20×10^6 pCi/m^3). All annual mean concentrations were well below the applicable EPA and DOE guidelines.

Plutonium. Plutonium is released by the Laboratory in microcurie amounts. In addition, plutonium is present in the environment because of fallout from past nuclear weapons testing and, in some isolated cases, from natural sources (Kathern 1984).

Sampling results for plutonium-238 are presented in Table 4-9. The table shows that the highest group summary mean was for the category Off-Site Regional Stations (28-44 km). These stations provide regional, baseline concentration levels, and are presumably unaffected by Laboratory emissions because of their location. Assuming there were some contribution from Laboratory emissions to the local/regional radiation environment, we would

expect the regional group mean to be among the lowest of the group concentrations. The high regional group mean is caused largely by a high value for the second quarter for the Española station, although the Santa Fe mean also appears to be somewhat elevated. As discussed further below, we believe that the second-quarter Española sample was contaminated after it was taken from the air station and that the high values are the result of that contamination. The remaining discussion of plutonium-238; plutonium-239,240; and americium-241 disregards the second-quarter Española values, because including those values would bias the results in a nonconservative manner. Using an erroneously high regional number to compare with other monitoring stations would give the impression that ambient air concentrations near the Laboratory and, presumably, Laboratory emissions were less than they actually were.

The annual mean concentration is 12.3 ± 29.1 aCi/m^3 of plutonium-238. This annual mean concentration of 12.3 aCi/m^3 corresponds to approximately 0.59% of the EPA's public dose limit, or about 0.059 mrem. After eliminating the questionable second-quarter plutonium-238 results for Española, the corrected plutonium-238 regional group mean and two standard deviations is 4.3 ± 7.2 aCi/m^3. None of the on- or off-site annual means were above the ULB value of 11.5 aCi/m^3 in 1995.

Sampling results for plutonium-239,240 are presented in Table 4-10. The annual mean concentration is 107.3 ± 343.6 aCi/m^3 of plutonium-239,240. This annual mean concentration of 107.3 aCi/m^3 corresponds to approximately 5.6% of the EPA's public dose limit, or about 0.6 mrem. After eliminating the questionable second-quarter results for Española (second-quarter results are included in the table but not in the calculated values below), the corrected plutonium-239,240 group mean and two standard deviations is 7.5 ± 18.8 aCi/m^3. None of the mean annual concentrations for the off-site stations was above the ULB of 26.3 aCi/m^3. The calculated plutonium-239,240 dose (gross dose, no background subtraction) based on local mean air concentration at Station #13, the highest off-site station, was 1.2 % of the EPA's public dose limit (PDL) of 10 mrem per year. The maximum on-site station mean (108 aCi/m^3) was recorded at Station #27, TA-54, Area G. The gross mean concentration observed at Station #27 was approximately 0.0005% of the DOE DAC guide for controlled areas (2×10^6 aCi/m^3). All annual mean concentrations were below the applicable EPA and DOE guidelines.

Americium. Because americium often occurs along with plutonium, a subset of plutonium samples is submitted for americium analysis. Results are presented in Table 4-11. The mean annual concentration is 46.4 ± 139.8 aCi/m^3 for americium-241. This annual mean concentration of 46.4 aCi/m^3 corresponds to approximately 2.4% of the EPA's public dose limit, or about 0.2 mrem. Three on-site stations had annual mean concentration levels above the ULB value of 11.6 aCi/m^3 (5.7 ± 5.9 aCi/m^3 after removal of second-quarter Española values from the regional group summary). The highest on-site concentration (82.6 aCi/m^3) occurred at Station #27 at TA-54, Area G. The highest off-site concentration (11.4 aCi/m^3) occurred at Station #13, Piñon School. The gross (not corrected for background) americium-241 dose at Station #13 was 0.6% of the EPA's PDL of 10 mrem/year. All annual mean concentrations were well below the applicable EPA and DOE guidelines.

Discussion of Validity of Second-Quarter Plutonium and Americium Results for Española. As mentioned above, the second-quarter values for the Española station appear to be anomolously high, by two to three orders of magnitude. One possibility is that the reported values are correct and indicate an elevated concentration of plutonium-238; plutonium-239,240; and americium-241 in the Española area. The other possibility is that the values are incorrect and should not be used. Comparing plutonium-239 activity at the Española station for 1991-1995 (Figure 4-4) indicates that a concentration of this magnitude is unprecedented. In fact, the plutonium-239 filter activity for all other years cannot be distinguished from zero in the figure, whereas the second-quarter value is nearly 16 pCi.

The Laboratory has a number of operations with potential sources for airborne plutonium and americium. Most of the sources are within facilities that have monitored stacks. Emissions records for 1995 do not show an increase in emissions that could account for the magnitude of the elevated Española results. The Laboratory also has several diffuse emissions sources that are evaluated by on-site and perimeter AIRNET stations. The AIRNET results from on-site and perimeter stations also do not show any significantly increased plutonium or americium air concentrations during the second-quarter. Figure 4-5 compares the Española results with those of Santa Fe and Station #27 at Area G. Station #27 was chosen for comparison because it has the highest annual mean concentration (by almost two orders of magnitude) of any Area G station. Station #27 normally has higher radioactive particulate concentrations than other Area G stations or other on-site stations. If there had been a very large release from Area G, the Area G monitoring stations, along with other stations in AIRNET, would have shown significantly increased concentrations.

Partially to provide short-term indication of a problem or unexpected emissions, AIRNET samples are analyzed for gross alpha activity on a biweekly basis. A very large plutonium release should show up as increased gross alpha activity. Figure 4-2 shows the gross alpha activity at Española, Santa Fe, and East Gate during 1995. The Española values are consistent with the other two stations and show no increase during the second quarter. This is further indication that there were not elevated radioactive particulate concentrations in Española during 1995.

In addition to the discussion above, which argues against elevated plutonium-238 air concentrations near Española, we have reason to suspect the analytical data during the second quarter (see Section 4.B.1.b). We believe that contamination of the Española sample after it left the air monitoring station caused the anomalous values.

Uranium. Uranium is released from the Laboratory in microcurie amounts and occurs naturally in rocks and soil (please refer to a general discussion regarding uranium in the environment in a previous annual report [EARE 1995a]). Tables 4-12 through 4-14, present radioisotopic results for uranium-234, uranium-235, and uranium-238 respectively. None of the annual mean concentrations for the off-site or on-site samples for uranium-234 were greater than the ULB value of 56.1 aCi/m^3. The maximum off-site concentration was recorded at Station #61; Los Alamos Hospital. The gross (not corrected for background) uranium-234 dose at Station #61 was 0.22% of the EPA's PDL.

Of the off-site stations, Barranca School (Station #4) exceeded the ULB value of 2.5 aCi/m^3 for uranium-235. This maximum off-site value was 3.4 ± 3.2 aCi/m^3. The gross, uncorrected for background, dose was 0.048% of the EPA's PDL.

None of the annual mean concentrations for the off-site stations for uranium-238 were above the ULB value of 55.7 aCi/m^3. The only station exceeding the ULB was Station #77, IJ Site, with a reported concentration of 120.7 ± 279.2 aCi/m^3. This and all other annual mean concentrations were well below the applicable EPA and DOE guidelines.

Total uranium concentrations, in terms of mass, can be calculated using the conversion factors provided in Table 4-15 for comparison with uranium data from previous environmental surveillance reports.

In addition to releases of uranium from some Laboratory facilities, depleted uranium (consisting primarily of uranium-238) is dispersed by experiments that use conventional high explosives. About 144 kg of depleted uranium containing about 0.0535 Ci of radioactivity was used in such experiments in 1995 (Table 4-16). Most of the debris from these experiments was deposited on the ground in the vicinity of the firing sites. Limited experimental data show that no more than about 10% of the uranium becomes airborne in a high-explosive test (Dahl 1977). Dispersion calculations indicate that the resultant maximum airborne concentrations would be greater than concentrations attributable to the natural abundance of uranium that is resuspended in dust particles; however, the predicted values were not detected at on-site stations or off-site stations. The actual amount released is likely to be smaller than the values given in Table 4-16. Air sampling conducted near the active firing sites supports this conclusion.

Iodine. With the shutdown of the Omega West research reactor in December 1992, the potential for radioiodine emissions from LANL was essentially eliminated. As previously noted, the Laboratory discontinued sampling for radioiodine. Therefore, no results are reported here for 1995.

d. Investigation of Elevated Air Concentration. In 1995, a number of air sampling values exceeded investigation levels established by ESH-17. A discussion of how investigation levels are determined can be found in the Environmental Monitoring Plan (EARE 1995b). When an measured air concentration exceeds an investigation level, the following steps are taken:

determine if the result exceeds its three sigma value,

resubmit the sample for analysis,

review field data for errors and interview field personnel, and

investigate the possible causes such as operational activities, unplanned releases, etc.

Elevated tritium results observed at the TA-16-450 sampler are believed to be related to increased tritium activities (stack and nonstack emissions) by the Weapons Engineering Tritium Facility at TA-16, which became fully operational during 1995. Stack effluents from TA-16 totaled 89 Ci, with 85% as tritium oxide. Diffuse

emissions were estimated using the air sampler data at 35 Ci of tritium oxide. The maximum off-site dose that could have occurred to a member of the public from the release of these effluents was calculated to be 0.01 mrem.

Tritium concentration values exceeding an investigation level were also observed at the following stations: Los Alamos Airport (#9), TA-21-DP Site (#19), and TA-21-03 (#73). These concentrations could be attributed to increased tritium operations in the TA-21 area. In 1995, about 410 Ci of tritium oxide was released from TA-21 (compared to about 170 Ci in 1994). In addition, tritium values exceeding the investigation level were observed at the Pueblo of San Ildefonso (#41) and TA-15-NNE, or IJ-Site (#77). These values could not be reconciled with any specific facility or activity at LANL.

Concentrations of transuranic radionuclides exceeding the investigation level(s) have been observed at TA-21 (Stations #19 and #71 through #75) in the past and have been attributed to operations occurring at that site (see also Section 4.D.7). Elevated concentrations of isotopes of uranium observed at Station #77 are attributed to open air explosive testing at TA-15-PHERMEX. The amount of uranium released to the air by such tests is provided in Table 4-16.

More than 85% of the americium-241 results obtained in 1995 exceeded the investigation level previously established in the Environmental Monitoring Plan. This is most likely an indication of an improvement in analysis sensitivity over previous years. A new radiochemical-analytical lab (located off site) was employed beginning with AIRNET samples collected in 1995. When the appropriate background value for americium-241 was subtracted from the air-concentration values, results were more consistent with what has been observed for americium-241 results in the past, and not due to any Laboratory release.

Although it could not be proved conclusively, the remaining elevated particulate sample readings were thought to be from contamination of the samples after they were collected but before they were shipped off site. Although these concentrations may not represent actual air concentrations that had occurred, LANL is publishing these results. Some of the elevated results included samples from stations normally used to calculate air concentrations for background subtraction; for the purposes of estimating doses resulting from airborne radionuclides, those stations with the lowest concentration of airborne radioactivity (naturally occurring and fallout sources) were used to represent the background concentration (see Table 4-1). For further discussion of anomalous results at regional stations, see Sections 4.B.1.b and 4.B.1.c above.

e. Long-Term Trends. Air samples collected from perimeter stations (0 to 4 km from LANL) and analyzed for tritium during 1971 through 1995 were subjected to a Mann-Kendal nonparametric test for trends. Air concentrations of tritium showed a significantly decreasing ($p < 0.01$) trend over time for perimeter air samples (Figure 4-6). Also shown Figure 4-6 is a linear regression analysis of the data; however, since the correlation coefficient is low (that is, $r^2 = 34\%$), it is not appropriate to presume a linear decrease as presented. A number of factors must be considered. There have been some 36 atmospheric tests (France and China) conducted between 1970 and 1980 (Shapiro 1990). In contrast, the global inventory of tritium has been decreasing since the end of large-scale atmospheric nuclear weapons testing, which reached a peak in 1962 (Kathern 1984). Since tritium has a physical half-life of 12.3 years, it decays at the rate of 5.5% a year. Another regression analysis was performed, applying the decay curve for tritium, and demonstrated at least partially that the decreasing trend could be attributed to physical decay.

Also presented for comparison are the annual stack releases of tritium from the Laboratory for the same time period (Figure 4-7). There is a weak correlation (27%) between perimeter concentrations of tritium in air with past stack releases. Many factors need to be considered in correlating the data, such as tritium releases at individual facilities, tritium concentration at individual samplers, and the chemical form of tritium released.

Although there is no clear indication as to the cause of this decreasing trend, it is obvious that current tritium in air concentrations are 10 times lower than those observed in the 70's and early 80's. Factors contributing to the reduction in tritium concentration in air over time are likely to include physical decay, the cessation of atmospheric testing, weathering, and a reduction in LANL emissions to the environment. A more in-depth trend analysis of tritium and other radionuclides sampled by the AIRNET system will be provided in future reports.

f. Dose Equivalents to Individuals from Inhalation of Airborne Emissions. The maximum individual effective dose equivalents (EDEs) attributable from exposure to airborne emissions were below the EPA air pathway standard of 10 mrem/yr. Emissions of air activation products from LANSCE resulted in negligible inhalation exposures, with the majority of the dose resulting from external penetrating radiation, as measured by an HPIC located at East Gate (Figure 3-2).

Inhalation dose resulting from exposure to airborne tritium (as tritiated water vapor); plutonium-238; plutonium-239,240; americium-241; uranium-234; uranium-235; and uranium-238 was determined from samples collected by the AIRNET program. The background concentration values of these radionuclides, which includes natural radioactivity and worldwide fallout, were measured at selected locations and subtracted from the annual average concentrations values given in Tables 4-8 and 4-14 to determine net dose from LANL airborne effluents. The net dose measured by AIRNET in the townsites of Los Alamos and White Rock were 0.05 mrem and 0.06 mrem, respectively.

Airborne emissions were calculated for the active low-level waste disposal area (TA-54, Area G). The total EDE to a member of the public from Area G airborne emissions during 1995 was estimated to be 0.002 mrem, or about 5,000 times less than the applicable standard. For explosive tests containing depleted uranium conducted in 1995, the maximum potential dose to a member of the public from these operations was 0.04 mrem. For tritium released as liquid effluent to holding lagoons at LANSCE and to an outfall in Mortandad Canyon, the maximum potential dose from these emissions was estimated to be 0.006 mrem. Airborne emissions and subsequent dose for decontamination and decommissioning (D&D) activities at TA-21 are given in Section 4.D.7.

2. Stack Air Sampling for Radionuclides

a. Sampling Methodology. During 1995, LANL continuously sampled approximately 75 stacks for the emission of radioactive material to the ambient air. LANL has identified four types of radioactive stack emissions: (1) particulate matter, (2) vaporous activation products (VAP), (3) tritium, and (4) gaseous/mixed air activation products (G/MAP). For each of these emission types, the Laboratory employs an appropriate sampling method, as described below.

Emissions of radioactive particulate matter, generated by operations at the Chemistry and Metallurgy Research Building (CMR), TA-55, and other facilities around the Laboratory, are sampled using a glass-fiber filter. A continuous sample of stack air is pulled through the filter, where small particles of radioactive material are captured. These samples are analyzed using gross alpha/beta counting and/or gamma spectroscopy. Radiochemical methods are employed for the determination of radionuclides that cannot be identified using gamma spectroscopy.

VAP emissions, generated by LANSCE operations and by hot cell activities at CMR and TA-48, are sampled using a charcoal filter or canister. A continuous sample of stack air is pulled through a charcoal filter where vaporous emissions of radionuclides are adsorbed. The amount and identity of the radionuclide(s) present on the filter are determined through the use of gamma spectroscopy.

Tritium emissions from the Laboratory's tritium facilities are measured using a collection device known as a bubbler. This device enables the Laboratory to determine not only the total amount of tritium released but also whether it is in the elemental (HT) or oxide (HTO) form. The bubbler operates by pulling a continuous sample of air from the stack, which is then "bubbled" through three sequential vials containing ethylene glycol. The ethylene glycol, with its high affinity for water, collects the water vapor from the sample of air, including any tritium that may be part of a water molecule (HTO). After "bubbling" through these three vials, essentially all HTO is removed from the air, leaving only elemental tritium. The sample, containing the elemental tritium, is then passed through a palladium catalyst which converts the elemental tritium to HTO. The sample is then pulled through three additional vials containing ethylene glycol, which collects the newly formed HTO. The amount of HTO and HT is determined by analyzing the ethylene glycol for the presence of tritium using liquid scintillation counting (LSC).

Tritium emissions from LANSCE are determined using a silica gel sampler. A sample of stack air is pulled through a cartridge containing silica gel. The silica gel collects the water vapor from the air, including any HTO. The water is distilled from the sample, and the amount of HTO is determined by analyzing the water using LSC. Since the primary source for tritium is activated water, sampling for only HTO is appropriate.

G/MAP emissions, resulting from activities at LANSCE, are measured using real-time monitoring data. A sample of stack air is pulled through an ionization chamber which measures the total amount of radioactivity in the sample. Specific radioisotopes are identified through the use of gamma spectroscopy and decay curves.

b. Sampling Procedures, Analysis, and Quality Assurance

Sampling and Analysis. Analytical methods, which were chosen for compliance with EPA requirements (40 CFR 61, Appendix B, [EPA 19] Method 114), are summarized in Table 4-17. These requirements were derived during 1995, as part of the development of quality assurance project plans for tritium, particulate, and vapor sampling. Analytical methods for G/MAP are described below.

Particulate Matter Emissions. Glass-fiber filters, used to sample facilities with significant radioactive particulate emissions, were removed and replaced once a week and transported to the HPAL. Before screening the samples for the presence of alpha and beta activity, the HPAL allowed approximately 72 hours for the short-lived progeny of radon to decay. These initial screening analyses were used to ensure that potential emissions were within normal values. Final analyses were performed after the sample had been allowed to decay for approximately one week. After completion of alpha and beta analyses, the HPAL, using gamma spectroscopy, identified gamma-emitting isotopes in the samples by determining the energy of the gamma photon(s) emitted during radioactive decay. Since the energy of decay is specific to a given radioactive isotope, the HPAL could determine the identity of any isotopes detected by the gamma spectroscopy. The amount, or activity, of an isotope could then be found by noting the number of photons detected during analysis. Glass-fiber filters from LANSCE were analyzed using only gamma spectroscopy.

Since gross alpha/beta counting cannot identify specific radionuclides, the glass-fiber filters were periodically composited for radiochemical analysis at a commercial laboratory. This program was added in 1995. During 1995, samples were analyzed by ATI of Fort Collins, CO. The composites were analyzed for the presence of radioisotopes, such as plutonium-238, plutonium-239, uranium-234, uranium-235, uranium-238, americium-241, strontium-90, and lead-210. ESH-17 used these results to identify the source of the activity found during the initial gross alpha/beta counting. The composite solutions were also analyzed for gross alpha and beta to account for any changes in concentrations of the natural radon decay products since the initial count, which was performed as much as several months earlier.

VAP Emissions. Charcoal canisters, used to sample facilities with the potential for significant VAP emissions, were generally removed and replaced weekly. These samples were transported to the HPAL where gamma spectroscopy, as described above, was used to identify and quantify the presence of vaporous radioactive isotopes.

Tritium Emissions. Tritium bubbler samples, used to sample facilities with the potential for significant gaseous and oxide form tritium emissions, were generally collected and transported to the HPAL on a weekly basis. The HPAL added an aliquot of each sample to the appropriate amount of liquid scintillation cocktail and determined the amount of tritium in each vial by LSC.

Silica gel samples were used to sample facilities with the potential for significant tritium emissions in the vapor form only. These samples were transported to the Inorganic Trace Analysis Group (CST-9), where the water was distilled from the silica gel, and the amount of tritium in the sample was determined using LSC.

G/MAP Emissions. Continuous monitoring was used to record and report G/MAP emissions for two reasons. First, the nature of the emissions is such that standard filter paper and charcoal filters will not collect the radionuclides of interest. Second, the half-lives of these radionuclides are so short that the activity would decay away before any sample could be analyzed off line. The G/MAP monitoring system includes a flow-through ionization chamber in series with a gamma spectroscopy system. Total G/MAP emissions were measured with the ionization chamber. The real-time current measured by this ionization chamber was recorded on a strip chart, and the total amount of charge collected in the chamber over the entire beam operating cycle was integrated on a daily basis. The composition of these G/MAP emissions was analyzed with the gamma spectroscopy system. Using decay curves and energy spectra to identify the various radionuclides, LANSCE personnel determined the relative composition of the emissions. Decay curves were typically taken one to three times per week based on accelerator operational parameters. When major ventilation configuration changes were made at LANSCE, new decay curves and energy spectra were recorded.

Data Management. Analysis results were reported to ESH-17 and to the appropriate operating groups when necessary. Upon receipt of these data, ESH-17 calculated non-LANSCE emissions. LANSCE personnel calculated the emissions values for the sampled TA-53 stacks. These emissions values were forwarded to the ESH-17 for review and reporting.

Radioactive air emissions data for sampled LANL stacks were maintained by ESH-17 in the Radioactive Air Emissions (RAEM) database. During 1995, a new relational database (using Microsoft Access) was initiated for these data. ESH-17 used these data to perform dose assessments, emissions evaluations, and compliance assessments. These data also served as the official source for emissions values for Laboratory stacks.

Laboratory Quality Control Performance. Groups of discrete samples were submitted to a commercial laboratory for radiochemical analyses. For these analyses, the laboratory maintained a program of blanks and spikes consistent with EPA guidelines (EPA 1991). These EPA guidelines call for a frequency of 1 blank and 1

duplicate for every 20 samples. For the instrumental gross alpha/beta and tritium analyses for the stack program, the HPAL maintained a program of blanks and duplicates analyses that was more frequent than EPA guidelines. The distinctions are discussed below.

For tritium bubblers, a blank vial of the ethylene glycol was submitted with each bubbler sample set, at a frequency of 1 blank vial per 6 sample vials. This high (1 to 6) rate of blank samples exceeded general EPA guidelines (1 to 20). All tritium samples and blanks were analyzed in duplicate, and results were averaged for final reporting. This high (100%) rate of duplicates greatly exceeded general EPA guidelines (5%).

For gross alpha and beta analyses, the ESH-4 HPAL maintained a supply of new filters to count as blanks. Sample results were reported as a function of the count rate above the count rate for a blank. Since 10 blanks were counted for a batch of approximately 40 samples, the high blank frequency of 1 to 4 greatly exceeded general EPA guidelines.

For on-line LANSCE gamma analyses, the dual instrument system described above (gamma spectrometer and ion chamber), calibrated with National Institute of Standards and Technology (NIST) traceable standards, provided two different sources of independent, accurate data for emissions during operations. This dual instrument system is analogous to 100% duplicate analysis rate.

Radiochemical analyses of composited samples were initiated in 1995 for the stack program. These samples were submitted in batches, and quality control samples typical of commercial environmental labs were run alongside the ESH-17 samples. For the 1995 samples, three types of blanks were analyzed: reagent blanks, filter blanks, and field blanks. Two types of spikes were analyzed: reagent spikes and filter spikes. The types and frequencies of analyses are summarized in Table 4-18 and Table 4-19.

Analyses of composited fiberglass filters proved to be technically challenging. The results for analyses of blank samples are indicative of the problems that were encountered. The need for multiple analytes limited the portion of the sample mass that could be analyzed for each. This requirement placed limits on the detection limits for all analytes. The large amount of dissolved fiberglass-derived solids placed additional limits on the MDA. Presence in the fiberglass of either traces of the analytes themselves, or of inseparable traces of interfering analytes, placed similarly severe limits on MDAs for the individual radioisotopes. Despite these limitations, data quality objectives for low blank levels and for low MDAs were met for most of the analytes tabulated.

Analyses of spiked samples (i.e., samples with deliberately added radioisotopes) were used to assess the ability of the laboratories to accurately quantify radionuclides. For 1995, each commercial laboratory maintained a program of reagent spikes. At the request of ESH-17, each commercial laboratory also maintained a program of filter spikes and used filter material supplied by ESH-17. In all, more than 290 analyses of spikes were performed for the stack program in 1995, and the results were satisfactory. Two filters spiked with high activity levels of strontium-90 shared the lowest recovery (83%).

Overall, the 1995 program of blanks and spikes demonstrated the Stacks Chemistry Program was sufficiently in control and was capable of providing results suitable for use in the air quality programs.

c. Analytical Results. Measurements of Laboratory stack emissions during 1995 totaled 45,380 Ci. Of this total, tritium emissions comprised 1,010 Ci, and air activation products from LANSCE contributed 44,370 Ci. Combined airborne emissions of materials such as plutonium, uranium, americium, and particulate/vapor activation products were less than 0.5 Ci. Detailed emissions data for Laboratory buildings with sampled stacks are provided in Table 4-20. Table 4-21 provides a detailed listing of the constituent radionuclides in the groupings G/MAP and particulate/vapor activation and fission products (P/VAFP).

Radioactive particulate source terms were developed differently for 1995 than in past years. Specifically, radionuclide identification was historically based on process knowledge. In an effort to provide better data, the identities of radionuclides emitted from Laboratory stacks were determined through the use of radioanalytical chemistry in 1995. For this reason, emissions of americium-241 are now presented separately from emissions of plutonium. Where sampling was discontinued or analyses were added during the year, calculated emissions are not representative of annual emissions. To account for this, incomplete emissions were scaled to reflect an entire year.

d. Long-Term Trends. Radioactive emissions from sampled Laboratory stacks are presented in Figures 4-8 through 4-11. These figures illustrate trends in emissions for plutonium, uranium, tritium, and G/MAP emissions, respectively. As Figure 4-8 shows, plutonium emissions for 1995 were higher than in recent years. This was due primarily to a release from the FE-24 stack of the CMR facility during the first part of 1994. The total release was

approximately 120 μCi, consisting primarily of enriched uranium; however, approximately 30 μCi of plutonium was also released. Figures 4-9 through 4-11 show that total stack emissions of uranium, tritium, and G/MAP were either consistent with past years or were slightly decreased.

Figure 4-12 shows the total contribution of each of these emission types to the total Laboratory emissions. It clearly shows that G/MAP emissions and tritium emissions comprise the vast majority of radioactive stack emissions.

Since G/MAP emissions account for most of the airborne radioactivity, and since the FE-3 stack at LANSCE is the primary source of G/MAP isotopes, LANSCE operating personnel have developed and implemented a delay line to reduce these emissions. The delay line operates by removing a large part of the concentrated activated air from the production point at the LANSCE beam stop. This air is passed through a 1,200-m tube, allowing approximately 100 minutes of additional decay time (Fuehne 1996). Due to the short half-lives of the G/MAP isotopes, carbon-10 (19.5 s), carbon-11 (20 min), nitrogen-13 (10 min), nitrogen-16 (7 s), oxygen-14 (71 s), oxygen-15 (123 s), and argon-41(1.8 h), this delay is sufficient to significantly reduce the total activity prior to returning the air to the stack. A recent study shows that, with the delay line operating, G/MAP emissions were reduced by 28.8%, as compared to similar operations without the benefit of the delay line (Fuehne 1996). Through such efforts, emissions of airborne radioactivity can be reduced while limiting the impact on the operating schedule.

3. Cosmic and Gamma Radiation Monitoring

a. Monitoring Network

Laboratory and Regional Areas (TLDNET). This environmental network consists of 55 stations divided into three groups. The off-site regional group has seven locations ranging 28 to 117 km (17 to 73 mi) from the Laboratory boundary. The regional stations are located at Fenton Hill and in the neighboring communities of Española, Pojoaque, and Santa Fe. The Pueblos of San Ildefonso, Jemez, and Taos are also part of this network. The off-site perimeter group consists of 25 stations within 4 km (2.5 mi) of the Laboratory boundary; a new perimeter station was added at State Road 4 and Monte Rey South in the third quarter of 1995. The on-site group includes 23 locations within Laboratory boundaries (Figure 4-13).

Technical Area (TA) 53 Network (LANSCENET) (Formerly referred to as LAMPFNET). This network monitors external penetrating radiation from airborne gases, particles, and vapors resulting from LANSCE operations at TA-53. Air emissions from the LANSCE linear accelerator operation constitute the largest Laboratory source of off-site external penetrating radiation exposure. The network consists of 24 TLD stations. Twelve monitoring TLD stations are located approximately 800 m (0.5 mi) north of and downwind from LANSCE to measure emissions. The other 12 TLDs are background sites and are located about 9 km (5.5 mi) from LANSCE, near the southern boundary of the Laboratory (Figure 4-14). Both monitoring and background TLD stations are placed at approximately the same elevations.

The network of three high-purity germanium detector systems installed on the north side of Los Alamos Canyon was discontinued in 1995. However, an HPIC is still active at the center north-northeast station. Figure 4-14 presents an example of the hourly dose rate measured by the HPIC during a typical month of the 1995 LANSCE facility operating cycle.

Low-Level Radioactive Waste Management Areas Network (WASTENET). Environmental TLDs are placed at 86 locations to monitor external penetrating radiation at 11 active or inactive low-level radioactive waste management areas. TA-54, Area G was the only active low-level radioactive waste management area in 1995. The waste management areas are controlled-access areas and are not accessible to the general public. The average annual dose at each location is calculated from a set of TLDs located at each site.

b. Sampling Procedures, Data Management, and Quality Assurance. TLDs used at the Laboratory are composed of natural lithium fluoride (LiF) crystals containing 7.4% lithium-6 in the form of 6.4-mm-square by 0.9-mm-thick chips, referred to as TLD-100s. After exposure to external penetrating radiation, TLDs emit light when heated under laboratory conditions. The amount of light released is proportional to the amount of radiation absorbed by the TLD. The TLD-100s used in the Laboratory's environmental monitoring program are insensitive to fast, energetic neutrons. As a result, the contribution of energetic cosmic neutrons to natural background radiation is not included in the exposure determined with LANL TLDs.

To ensure similar responses to radiation exposure, TLD chips are selected from the same production batch so that the measured standard deviation in thermoluminescent sensitivity is between 2.0% and 4.0% of the mean at a 10 R exposure. These chips are annealed at 400°C (752°F) for 1 hour and then cooled rapidly to room temperature. This process is followed by another annealing at 100°C (212°F) for 1 hour and another rapid cooling to room temperature. For the annealing conditions to be repeatable, chips are put into rectangular borosilicate glass vials that each hold 48 LiF chips. These vials are placed in a borosilicate glass rack so that all vials in a batch can be simultaneously placed in the annealing ovens.

Each dosimeter is made up of four LiF chips and a two-part threaded assembly made of an opaque yellow acetate plastic. A calibration set of TLDs is prepared each time chips are annealed and is read at the start of the dosimetry cycle. Each calibration set contains up to 150 chips, which are irradiated at levels between 0 and 80 mR, the expected range of environmental dose in a quarter, using a cesium-137 source traceable to the NIST at the ESH-4 calibration facility.

Exposure in air (mR) is converted to dose in tissue (mrem) by multiplying by the conversion factor 1.05. This factor is derived as the reciprocal of the product of the roentgen-to-rad conversion factor (0.958) for muscle tissue of the 661-KeV decay photon of cesium-137, and 0.994, which is the attenuation factor at the electronic equilibrium thickness. A rad-to-rem conversion factor of l.0 for gamma rays is used, as recommended by the International Commission on Radiation Protection (ICRP 1970). A weighted least-squares linear regression is used to determine the relationship between TLD reader response and calculated dose, the weighting factor being the variance of the sample set (Bevington 1969).

Field data including the date of collection, the condition of TLDs and any observed anomalies are recorded by hand on field sheets which are compiled in a field file. During the read cycle, control blanks (unirradiated dosimeters) and control irradiated dosimeters (i.e. dosimeters irradiated at 20 mR) are interspersed among field dosimeters as a quality check of the system performance. All chips are read and stored as raw data files. These are converted and read by a dose-conversion program to calculate doses at each monitoring location. These results are validated and statistically evaluated before being reported. At the end of each field cycle, the dose at each location in the network is estimated from the regression line, along with the upper and lower confidence limits at the estimated value (Natrella 1963). These individual field cycle doses are summed for each location at the end of the calendar year. The uncertainty is calculated as the summation in quadrature of the individual uncertainties (Bevington 1969).

c. Analytical Results

Laboratory and Regional Areas (TLDNET). Results from the environmental monitoring networks are presented in Table 4-22. TLDs from station #52 at Taos Pueblo were not collected in the fourth quarter of 1993 through the second quarter of 1995 because of the repeated loss of TLDs from the station. TLDs were collected from this location beginning the third quarter of 1995. Some of the other TLD stations are lacking one or more quarters of data as a result of vandalism, animal damage, processing error, or removal requests by the public. A new station, #55, was placed at Monte Rey South and State Road 4 in the third quarter of 1995.

In general, the TLD measurements indicate no detectable radiological impact to the public due to external penetrating radiation from LANL operations. The ranges of values observed within each network are consistent with the expected variability in natural background radiation and are also consistent with the range of results observed in 1994. The Student's t-Test and a single factor analysis of variance (ANOVA), both at a 95% level of confidence, revealed no statistical difference between 1994 and 1995 TLD measurements. Among stations having a complete set of data, the 1995 annual dose at off-site regional stations ranged from 100 to 114 mrem, whereas the annual measurements at off-site perimeter stations ranged from 93 to 156 mrem. Annual measurements at on-site stations ranged from 102 to 168 mrem. The Student's t-Test at a 95% level of confidence, shows no significant difference when comparing on-site TLD measurements to off-site perimeter TLD measurements; however, there is a significant difference at the 95% level of confidence when comparing the on-site and perimeter measurements to the regional measurements. This statistical difference is attributed to differences in elevation and/or geology at each location. Efforts to improve the characterization of background radiation levels at each location are currently being evaluated.

The second-quarter measurement of 255 mrem at Station #28 is included in the total annual dose of 378 mrem for that station; however, this measurement is not considered a public dose. TA-18 administrative controls requires operations to be conducted after hours with minimum site occupation and the closure of Pajarito Road from TA-51 to White Rock whenever the potential dose to a member of the public exceeds 1 mrem. For example, in the second

quarter of 1995, 13 of 17 TA-18 operations had road closures. The 255-mrem measurement at Station #28 includes measurements during times when these administrative controls were being utilized and does not reflect a potential dose to a member of the public. TLD measurements at Station #22 also reflect TA-18 operations and do not represent a public dose for the above reasons.

Technical Area (TA) 53 Network (LANSCENET). The TLD measurements collected at the 12 stations located directly to the north of LANSCE were statistically compared to the 12 background stations located at TA-49. The Student's t-Test at a 95% level of confidence shows no statistical difference between the TLD results observed at LANSCE and those observed at the background locations**.**

Low-Level Radioactive Waste Management Areas Network (WASTENET). Annual doses at the waste management areas are presented in Table 4-23. Among the sites with a complete data set, the annual average doses at all waste management areas during 1995 ranged from 125 to 161 mrem. Exposure data for TA-6, Area F are not available for first and second quarters of 1995. Extensive and detailed geophysical sampling and characterization of the site disrupted the monitoring program. Monitoring of Area F resumed in the third quarter of 1995 upon completion of the site characterization study. The annual dose for TA-50, Area C does not include second quarter measurements because the data were lost due to an equipment malfunction.

The highest WASTENET annual average dose for 1995 was measured at TA-54, Area G, LANL's only active low-level radioactive waste area. The 25 environmental surveillance TLDs of TA-54, Area G are located within the waste site and along the perimeter fence. The highest dose was measured close to the transuranic (TRU) waste storage areas. In 1995, these areas were uncovered in preparation for retrieval of the contents in conjunction with a plan to build new domes for the temporary storage of TRU waste materials. Since the other TLDs placed around Area G received exposures similar to those observed at the regional stations, any exposure due to waste management activities is localized within Area G.

d. Future Efforts. In an effort to improve the precision and accuracy of the TLD system and its measurements, the ESH-17 will be deploying, in the second quarter of 1996, new environmental TLDs to measure external penetrating radiation. These dosimeters consist of five 3.2-mm-square LiF chips enclosed in the same two-part threaded assembly currently in use. Each dosimeter will have its own correction factor allowing for greater accuracy, rather than a batch correction factor. In addition, the new automatic Harshaw 5500 TLD chip reader will replace the manual Harshaw 4000 reader.

e. Dose Equivalents to Individuals from External Penetrating Radiation from Airborne Emissions and Direct Sources. The major source of external penetrating radiation from LANL operations has been airborne emissions from LANSCE. Nuclear reactions with air in the beam target areas at LANSCE (TA-53) cause the formation of air activation products, principally carbon-10, carbon-11, nitrogen-13, oxygen-14, and oxygen-15. These radioisotopes are positron emitters and have 19-s, 20-min, 10-min, 71-s, and 122-s half-lives, respectively. These radioisotopes are sources of penetrating radiation due to the formation of two 0.511-MeV photons through positron-electron annihilation (oxygen-14 also emits a 2.4-MeV gamma ray). These air activation products are primarily released from a 30-m-tall stack, while an additional small percentage of the releases occur as diffuse emissions from LANSCE. An HPIC is used to record the total external penetrating dose. The HPIC is near the location of the maximum exposed individual (MEI) along the Laboratory boundary known as East Gate. Typical readings recorded during LANSCE operation by the East Gate Station are shown in Figure 4-14. The above background dose measured at this location in 1995 was 2.0 mrem. Doses from LANSCE emissions are currently not detectable by the TLDNET located in the Los Alamos townsite or White Rock.

No direct penetrating radiation dose equivalents to the public from Laboratory operations were detected by TLD monitoring at off-site locations. There was no statistical significant difference between on-site TLD measurements and perimeter TLD measurements. The significantly lower measurements collected at the regional stations are attributed to differences in elevation and geology. On-site TLD measurements of external penetrating radiation reflect Laboratory operations; however, they do not represent any significant public exposure since these were in controlled areas or along roads with restricted public access during operations. Specifically, measurements from stations #22 and #28 reflect operations at TA-18 but do not represent a potential dose to the public, because all personnel, including the public, are excluded from an enlarged operational area from Pajarito Road between TA-51 and the White Rock interchange on State Road 4.

4. Meteorological Monitoring

a. Monitoring Network. A meteorological network of five towers was used to gather data at the Laboratory during 1995 (see Fig. 13.1 in the Environmental Monitoring Plan [Stone 1995] or access through the Internet at http://weather.lanl.gov/monplan/mmp96.html). A sodar (SOnic Detection And Ranging) device and three precipitation measurement sites also supplemented the data collected. The towers are located at TA-6 (the official meteorological measurement site of the Laboratory), TA-49, TA-53, TA-54, and TA-41 (located in Los Alamos Canyon). The sodar is located at TA-6, and the precipitation measurement sites are located at TA-74, North Community in the Los Alamos townsite, and TA-16.

b. Sampling Procedures, Data Management, and Quality Assurance. Instruments in the meteorological network are located in areas where there is adequate exposure to the elements being measured and in open fields to avoid the wake effects of trees and buildings on measurements of wind and precipitation. The open fields also provide an unobstructed view of the sky for the upward-directed radiometers, a device that measures solar radiation.

Temperature and wind are measured at multiple levels on open-lattice towers, with instruments positioned on west-pointing booms having a length of two times the tower width. The length of the boom helps to decrease wake effects from the tower, as do the west-pointing direction of the booms, since winds from the east are uncommon. The multiple levels give duplicate measurements for quality assurance. Temperature sensors are white in color and aspirated with small fans to minimize radiative heating of the sensor housing.

Most of the meteorological variables are sampled every 3 s, and the results are averaged every 15 min to give a sample size of 300 (for each of the 15-min periods). The data are stored by dataloggers located at the tower sites and then fed to a Hewlett Packard workstation through telephone lines. At the workstation, automatic range checking is performed on the data, and data edits are automatically performed on variables falling outside of preset ranges. Next, time series plots are constructed. These plots are used by a meteorologist to perform quality checking on the data. Daily statistical quantities are included on the time series plots (such as daily maximum and minimum temperature, total solar radiation, maximum wind gust, etc.) and are also checked for quality.

All meteorological instruments are audited twice a year. An internal audit is performed in the winter, and an external audit is conducted during the summer. All instrument calibrations are traceable to NIST standards. No significant problems were found during either audit in 1995 (Oviatt 1995).

c. Analytical Results. A graphical summary of the 1995 Los Alamos weather recorded at TA-6, the official meteorological measurement site of the Laboratory, can be seen in Figure 4-15. This figure shows the average temperature ranges and precipitation by month compared with the normals, which are averages based on a 30-yr record (1961–1990). February was significantly warmer than usual in 1995. Also, October experienced a large diurnal temperature range, on average, due to the lack of clouds during the month. The other months saw near normal variations in temperature. For the entire year temperatures were only slightly above normal.

The year 1995 was slightly drier than normal with 95% of normal precipitation being recorded. After a wet first half of the year, when all months were above normal except for March, a dry second half of the year was observed. From July through December all of the months were drier than normal except for September, and in October no precipitation was recorded. The rainy season, which usually runs from July through September, started late in 1995. Near normal precipitation was recorded in August and September, while July was unusually dry. Snowfall was abundant, compared to normal, due to a snowy January and April. January received 21.3 in. of snow, which is 75% greater than normal. Over 20 in. of snow fell during April, a month which normally receives 4.6 in. of snow. For the remainder of the year, all months received less than normal snowfall. Precipitation data for 1995 for all recording sites are listed in Table 4-24.

Wind statistics based on observations at the four towers on the Pajarito Plateau, shown in the form of wind roses, can be seen in Figures 4-16 through 4-18. Wind roses show the percentage of the time the wind blows from each of 16 different wind directions. Also shown in the wind roses are the distributions of wind speed for each of the 16 directions; these are displayed by the shading of the wind rose barbs, as shown in the legend. For example, at TA-6 (Figure 4-16), the most common daytime wind direction is southerly, which occurs almost 14% of the time. The wind speed for that direction is most often in the 2.5 to 5.0 m/s category, and least often in the 7.5 + m/s category. Winds were calm 1.7% of the time at TA-6 during the daytime in 1995.

During the daytime (Figure 4-16), winds were predominately southerly at all four towers. The nighttime wind roses (Figure 4-17), indicate that the winds were more westerly and northwesterly and generally weaker. Wind roses for all times are given in Figure 4-18.

5. Nonradioactive Emissions and Effluent Monitoring

a. Introduction. Criteria pollutants were monitored for several years without any detected increases above typical regional background levels; therefore, ambient monitoring for these pollutants was discontinued. However, the emissions from nonresearch sources are calculated annually because these sources are responsible for nearly half of all the nonradiological air pollutant emissions at the Laboratory. Research sources vary continuously and have very low emissions. As such, they are not calculated annually; instead, each new or modified research source is addressed in the new source review process.

b. Detonation and Burning of Explosives. The Laboratory conducts explosive testing by detonating explosives at firing sites operated by the Dynamic Testing Division. The Laboratory maintains monthly shot records, including the type of explosive and weight fired at each mound to track emissions from this activity. Table 4-25 summarizes the explosives detonations conducted at the Laboratory during 1994 and 1995. The Laboratory also burns scrap and waste explosives when burning proves to be the safest disposal option. In 1994 and 1995 the Laboratory burned 3,450 and 5,090 kg (7,590 and 11,198 lb) of high explosives, respectively.

c. Asbestos. Under the National Emission Standards for Hazardous Waste Pollutants (NESHAP) for asbestos, the Laboratory must ensure that no visible asbestos emissions to the atmosphere are produced by asbestos removal operations at the Laboratory. During 1994 and 1995, no visible emissions were observed during periodic inspections.

The Laboratory is also required to notify the New Mexico Environment Department (NMED) of asbestos removal activities and disposal quantities. Such activities involving less than 80 m (263 linear ft) on pipes, or 15 m^2 (160 ft^2) of friable asbestos, are covered by an annual small job notification to the NMED. For projects involving greater amounts of friable asbestos, separate notification to the NMED is required in advance of each project. Nonfriable materials are also included in a large job special notice. The NMED is notified of asbestos wastes containing nonfriable as well as friable materials from both small and large jobs on a quarterly basis, which includes any material contaminated or potentially contaminated with radionuclides. Radioactively contaminated material is disposed of on site in a designated radioactive asbestos burial area. Nonradioactive asbestos is transported off site to designated asbestos disposal areas.

During 1994, the Laboratory's off-site shipments of small job waste material totaled approximately 36.62 m^3 (1,293 ft^3). Johnson Controls Inc. (JCI) disposed of approximately 16.85 m^3 (1,293 ft^3) of potentially radioactively contaminated material from small job activity. One large D&D job that was begun in 1993 accounted for an additional 83.6 m^3 (2,951 ft^3) of potentially radioactive, friable or non friable, asbestos waste during the year.

During 1995, LANL shipped 52.27 m^3 (1,846 ft^3) of material from small job activities off site. One Environmental Restoration project generated an additional 66.9 m^3 (2,362 ft^{-3}) of nonfriable asbestos waste. A total of 107.6 m^3 (3,799 ft^3) of potentially radioactively contaminated asbestos and asbestos wastes known to have low-level contamination were disposed of on site.

d. Emissions Calculations. The 1995 estimated emissions are shown in Table 4-26. These are typical industrial-type sources. LANL nonradiological emissions from research operations are small when compared with these listed sources.

The NO_x emissions from the TA-3 power plant were calculated using an emissions factor of 163 lb/million cubic feet (MMCF), which was obtained from the 1995 TA-3 stack test and is adjusted for 20% uncertainty. The particulate matter emission factor of 5 lb/MMCF for the asphalt plant represents the maximum emission factor listed in AP-42 (EPA 1995). For volatile organic compounds, an emission factor of 1.4 was used, which is corrected for 17% methane as specified in AP-42. The emission factor for SO_x is 0.6 lb/MMCF, as specified in AP-42.

The three power plants, the largest sources of nonradioactive emissions, are used to supply steam for heating. The steam plant at TA-3 also produces electricity when sufficient power from outside sources is not available; approximately one-third of the emissions from this steam plant results from electricity production. The plants are primarily operated on natural gas but can use fuel oil as a backup.

C. Unplanned Radiochemical Airborne Release

There was one unplanned release during 1995. During the period from December 28, 1994, to January 6, 1995, an estimated 116 μCi of uranium-235 was released from the FE-24 stack at the CMR facility (Miller 1995). The dose from this release calculated at the nearest off-site location was estimated to be 5.1×10^{-3} mrem, which is less than 0.1% of the applicable standard.

In addition, there were four instances of higher-than-normal stack readings observed in 1995 at TA-3-29, TA-3-35, TA-21-209, and TA-53-3M. However, the annual total emissions were within the normal release rates for LANL (AQG 1996).

D. Special Studies

1. Air Monitoring at Technical Area 54, Area G

In addition to the routine air monitoring performed for the environmental surveillance program, 12 air samplers are operated within TA-54, Area G, or along its perimeter. Area G is the Laboratory's active low-level waste management area. During 1993, 5 new stations (included in the 12 described above) were established to monitor potential emissions resulting from the uncovering and repackaging of 16,500 barrels of TRU waste at the far eastern edge of Area G. This recovery effort is expected to last through FY 2002.

Samplers are located near active and past-waste handling and disposal operations to ensure that the air sampled is representative of worst-case potential emissions. Filters within the samplers collect ambient air and are then analyzed to determine air concentrations of tritium; uranium-234; uranium-235; uranium-238; plutonium-238; plutonium-239,240; and americium-241. The measured air concentrations reflecting operations for 1995 are given in Tables 4-8 through 4-14.

Some of the mean annual air concentrations are above background but are well below the DOE's DAC guides for controlled and uncontrolled areas and are also well below the EPA's 40 CFR 61 concentration guide.

Tritium air concentrations at Stations #35 and #36 were observed to be higher than readings from the other samplers in Area G (Table 4-8*)*. The mean annual air concentrations at Stations #35 and #36 for 1995 were 370 and 49 pCi/m^3, respectively. All other air samplers at TA-54, Area G measured tritium concentrations within the range of those observed elsewhere. Air samplers #35 and #36 are located in the proximity of shafts used to dispose of higher-activity waste containing tritium, and these results indicate the elevated tritium air concentrations close to these shafts.

2. Los Alamos Neutron Scattering Center Diffuse Emissions

Buildings along the high-intensity beam line at LANSCE are sources of diffuse emissions. Air around the various targets at LANSCE becomes activated through various beam interactions and migrates into the surrounding buildings. From the buildings, this slightly radioactive air can escape to the environment.

Potential diffuse emission sources are evaluated by the LANSCE staff to determine if a source meets certain monitoring criteria. Each diffuse source meeting these criteria is continuously monitored throughout the LANSCE operational cycle to determine the radioactive air concentration within each building. Air flow from the building is measured and combined with this activity concentration to determine released radioactivity. Off-site dose from diffuse releases is determined by using the released activity from each source as an input into the CAP-88 computer modeling program, in a manner similar to the stack emissions program.

Throughout the beam operation period, activity concentrations of each monitored source are recorded continuously on strip charts. Each instrument is checked daily to ensure proper operation is maintained. Strip charts are changed each month and analyzed at the end of the run cycle. The instruments are calibrated before each run cycle and again after each cycle. The radiological composition of each source is determined by gamma ray spectroscopy.

Over the past several years, diffuse emissions have decreased as shown in Table 4-27. The decreases in diffuse emissions are the result of sealing, controlling operating environments, and the installation of engineering controls, all of which reduce air migration from target cells into surrounding facilities.

3. Evaluation of Site-Specific Acceptability of AIRNET Stations

The AIRNET program evaluated site-specific characteristics of all ambient air sampling stations to assess whether airflow around the stations' locations was being affected by nearby obstacles or topography. The stations were compared with the criteria from applicable sections in DOE/EH-0173T (DOE 1991b) and 40 CFR 58 App. E (EPA 1992).

The primary site-specific criteria were favorable surface characteristics, airflow obstructions, and topography. A favorable surface is one that is stabilized by vegetation or other cover such that the local generation of wind-borne dusts and dust-loading of the air filters is minimized. The criteria applied to trees, buildings, and other potential obstructions are intended to ensure that airflow from a source or sources toward the sampler is not obstructed. Likewise, topographic depressions and edges of canyons are to be avoided as AIRNET station locations.

As a result of the study, several stations were relocated to better sites and some sites were modified, primarily by trimming or removing nearby vegetation. LANL periodically reviews the AIRNET stations to ensure optimal airflow and representative sampling.

4. Comparison of Thermoluminescent Dosimeters

In addition to the Laboratory's external penetrating radiation monitoring program described in Section 4.B.3, special studies were conducted during 1995. One such study is a continuation of work initiated in 1990 to compare results of LANL TLDs with those of TLDs obtained from a commercial vendor.

The study involves placing vendor TLDs next to Laboratory TLDs. There are a total of 40 vendor TLDs co-located with LANL TLDs at TLDNET locations. The vendor's TLDs are set out and collected following the vendor's specifications and in conjunction with the LANL TLD quarterly change-out schedule. No information is provided to the vendor regarding the TLD locations and possible environmental radiation fields. The vendor TLDs are analyzed and processed by the commercial vendor, and the analytical results are later provided to LANL.

Statistical analyses are applied to the LANL and vendor data sets for normality of distribution. First, the data distribution is determined. If the data are normally distributed, the comparison is made by using a paired t-test, which is very sensitive to systematic differences in sample sets. The data from 1995 were not normally distributed, so the Wilcox Signed Rank test for differences was applied. To ensure that the full power of the statistical test is achieved, only the TLD results from each program that are spatially and temporally comparable are used. Individual quarterly data were evaluated instead of the summed annual results used in previous years. For the second year in a row, there was a statistical and systematic difference in the two data sets. Considering 150 paired data values, the median quarterly value of the LANL TLDs was 6.7 mrem higher than that of the co-located vendor TLDs (34.7 mrem for the LANL TLDs, 28.0 mrem for the vendor TLDs). This result is the opposite of the findings from 1994, when the vendor's TLDs were found to be an average of 5 mrem higher per quarter than the LANL TLD values (EG 1996).

5. Highly Sensitive Dosimeters

A new dosimeter was tested in 1995 containing aluminum oxide, which is nearly 30 times more sensitive than the presently used lithium fluoride crystals. The test dosimeters were located next to those normally used at the northern boundary of LANSCE to monitor the emissions from the facility during the annual run cycle. Preliminary data from this study indicated that the dosimeters were not as sensitive as desired and produced results with higher variability than desired. The cause of this poor dosimeter performance appeared to be the substandard quality of the aluminum oxide material.

6. Neighborhood Environmental Watch Network Community Monitoring Stations

The Neighborhood Environmental Watch Network (NEWNET) is a LANL Dynamic Experiment Division program focused on establishing a partnership with communities, state and tribal governments, and the DOE to address concerns about radiological monitoring in local communities. It establishes meteorological and external penetrating radiation monitoring stations in local communities and around radiological sources. These stations are the responsibility of a station manager from the local community. The stations have a local readout, and the data can be downloaded into a personal computer at the station if this process is coordinated with the station manager.

The data from these stations are transmitted via satellite communications to a downlink station at Los Alamos National Laboratory. The data are converted to engineering units, checked and annotated for transmission errors or station problems, and stored in a public access database. The data from all the stations are available to the public with, at most, a 24-hr delay. Methods to decrease this period to near real time are being developed.

Station measurements include wind speed and wind direction, ambient temperature, relative humidity, barometric temperature, and gross gamma radiation using a pressurized ion chamber. The station can be adapted to monitor other sensors of interest with electrical outputs. The radiation sensors are sampled at 5-s intervals and averaged every 15 min. These values are transmitted every 4 hr.

More information about NEWNET and the data is available on the Internet at http://newnet.jdola.lanl.gov/newnet.html.

7. Technical Area 21 Decommissioning and Decontamination Project

Five environmental air monitoring stations were established in October 1992 to monitor potential diffuse emissions during decommissioning of TA-21; stack emissions were also monitored. The environmental sampling results were analyzed using an atmospheric dispersion equation along with local meteorological data to estimate the potential airborne releases during 1995. Conservative assumptions were used in the calculation to place an upper limit on the possible emissions; actual emissions may have been many times less than the results shown in Table 4-28. The maximum off-site dose from these estimated emissions is less than 0.1 mrem.

E. Tables

Table 4-1. Average Background Concentrations of Radioactivity in the Regional Atmosphere

	Units	Santa Fe (EPA)[a] 1990–1993	Northern New Mexico (LANL)[b] 1995	EPA Concentration Limit[c]
Gross Beta	fCi/m^3	10	12.5	NA
^{234}U	aCi/m^3	17	29.1	7,700
^{235}U	aCi/m^3	0.7	1.9	7,100
^{238}U	aCi/m^3	15	27.9	8,300
^{238}Pu	aCi/m^3	0.2	1.8	2,100
$^{239,240}Pu$	aCi/m^3	0.3	2.3	2,000
Tritium	pCi/m^3	NA	0.8	1,500
^{241}Am	aCi/m^3	NA	3.8	1,900

[a] EPA (1991–1994), Reports 63 through 75. Data are from the EPA Santa Fe, New Mexico, sampling location and were taken from July 1990 through July 1993. Data for 1994 and 1995 were not available at time of publication.
[b] LANL data explained in the footnote.
[c] Each EPA limit equals 10 mrem/yr.
NA = not available.

Table 4-2. Analytical Laboratory Intercomparison Program Results

Test and Testing Agency	Units[a]	True Value Acceptable Range	Analytical Laboratory Results		
			HPAL[b]	ATI[c]	GJPO Rust GeoTech[d]
In Water					
Tritium (Mar. EPA)	pCi/L	6,144.2–8,725.8	7,708.0 ± 346.41	N/A[e]	N/A
Tritium (Aug. EPA)	pCi/L	4,027.1–5,716.9	4,856.67 ± 225.9	N/A	N/A
On Filter					
^{234}U (Jun. DOE)	Bq/F	0.059	N/A	0.104 ± 0.010[f]	0.067 ± 0.003
^{234}U (Dec. DOE)	Bq/F	0.052	N/A	0.063 ± 0.009	0.056 ± 0.010
^{238}U (Jun. DOE)	Bq/F	0.002	N/A	0.045 ± 0.005[f]	DNP[g]
^{238}U (Dec. DOE)	Bq/F	0.053	N/A	0.054 ± 0.007	0.056 ± 0.010
^{238}Pu (Jun. DOE)	Bq/F	0.122	N/A	0.104 ± 0.010	0.119 ± 0.005
^{238}Pu (Dec. DOE)	Bq/F	0.096	N/A	0.078 ± 0.010	0.094 ± 0.009
^{239}Pu (Jun. DOE)	Bq/F	0.062	N/A	0.060 ± 0.009	0.068 ± 0.004
^{239}Pu (Dec. DOE)	Bq/F	0.093	N/A	0.081 ± 0.011	0.094 ± 0.009
^{241}Am (Jun. DOE)	Bq/F	0.177	N/A	0.156 ± 0.016	0.177 ± 0.005
^{241}Am (Dec. DOE)	Bq/F	0.189	N/A	0.174 ± 0.023	0.186 ± 0.013
Alpha (Aug. EPA)	pCi/F	14.1–35.9	27.20 ± 0.87	32.87 ± 1.33	N/A
Alpha (Jun. DOE)	Bq/F	3.220	DNP	3.680 ± 0.400	N/A
Alpha (Dec. DOE)	Bq/F	3.30	DNP	3.720 ± 0.490	N/A
Beta (Aug. EPA)	pCi/F	69.3–103.9	84.70 ± 3.48	84.57 ± 1.72	N/A
Beta (Jun. DOE)	Bq/F	1.850	DNP	2.360 ± 0.240[h]	N/A
Beta (Dec. DOE)	Bq/F	1.060	DNP	1.060 ± 0.130	N/A
^{90}Sr (Aug. EPA)	pCi/F	21.3–38.7	DNP	31.0 ± 0.00	N/A
^{90}Sr (Jun. DOE)	Bq/F	0.739	DNP	0.737 ± 0.074	N/A
^{90}Sr (Dec. DOE)	Bq/F	1.060	DNP	1.130 ± 0.210	N/A
^{137}Cs (Aug. EPA)	pCi/F	16.3–33.7	31.67 ± 3.06	27.33 ± 1.53	N/A

[a] Data units reported here are the same as given in the source reports. Note: pCi = Bq × 27.
[b] HPAL = Health Physics Analytical Laboratory.
[c] ATI is now known as Paragon Laboratory, Inc.
[d] GJPO = Grand Junction Project Office.
[e] N/A indicates laboratory did not perform relevant analyses for any ESH-17 Air Quality projects during 1995.
[f] Indicates not acceptable. Because the laboratory obtained consistent results on blanks and spikes throughout the year and performed acceptably on the test samples submitted in December, ESH-17 felt no correction action was warranted.
[g] DNP indicates laboratory did not participate in this test during 1995.
[h] Indicates acceptable with warning.

Table 4-3. Analytical Chemistry Requirements for 1995 Ambient Air Samples

Analysis Required	No. of Samples Analyzed	Technique or Instrument	Typical Count Time	Target MDA (3 sigma)
Biweekly:				
Alpha	1,299	Proportional Counter	30 min	1 pCi
Beta	1,299	Proportional Counter	30 min	2 pCi
Tritium	1,321	Distillation and Liquid Scintillation	60 min	0.75 pCi/L[b]
Quarterly:				
^{241}Am	196	Radiochemistry and Alpha Spec.	1,000 s	0.04 pCi
^{238}Pu	229	Radiochemistry and Alpha Spec.	1,000 min	0.04 pCi
^{239,240}Pu	229	Radiochemistry and Alpha Spec.	1,000 min	0.04 pCi
^{234}U	230	Radiochemistry and Alpha Spec.	1,000 min	0.04 pCi
^{235}U	230	Radiochemistry and Alpha Spec.	1,000 min	0.04 pCi
^{238}U	230	Radiochemistry and Alpha Spec.	1,000 min	0.04 pCi

[a]MDA = minimum detectable amount.
[b]L refers to the volume (liters) of distillate.

Table 4-4. Blank Sample Performance for 1995 Ambient Air Samples

Analyte	Type of Blank	No. of Samples	Expected Result	Average Result[a]	Average MDA[a,b] Reported
Alpha	Field Blank	46	0	0.06 pCi	0.62 pCi
^{241}Am	Reagent Blank	12	0	0.03 pCi	0.02 pCi
	Filter Blank	18	0	0.02 pCi	0.03 pCi
	Field Blank	8	0	0.02 pCi	0.04 pCi
Beta	Field Blank	46	0	0.6 pCi	1.5 pCi
Tritium	Field Blank	26 (Jan.–June)	0	1.2 pCi/L [c,d]	1.0 pCi/L [c,d]
Tritium	Field Blank	23 (Jul.–Dec.)	0	0.6 pCi/L [c,d]	0.6 pCi/L [c,d]
^{238}Pu	Reagent Blank	11	0	0.02 pCi	0.02 pCi
	Filter Blank	18	0	0.01 pCi	0.02 pCi
	Field Blank	8	0	0.02 pCi	0.03 pCi
^{239}Pu	Reagent Blank	11	0	0.003 pCi	0.015 pCi
	Filter Blank	18	0	0.006 pCi	0.016 pCi
	Field Blank	8	0	0.01 pCi	0.03 pCi
^{234}U	Reagent Blank	10	0	0.01 pCi	0.03 pCi
	Filter Blank	17	0	0.05 pCi	0.03 pCi
	Field Blank	8	0	0.04 pCi	0.03 pCi
^{235}U	Reagent Blank	10	0	0.00 pCi	0.031 pCi
	Filter Blank	17	0	0.010 pCi	0.024 pCi
	Field Blank	8	0	0.001 pCi	0.028 pCi
^{238}U	Reagent Blank	10	0	0.01 pCi	0.03 pCi
	Filter Blank	17	0	0.03 pCi	0.03 pCi
	Field Blank	8	0	0.06 pCi	0.03 pCi

[a] Significant figures vary by isotope, but each is reported to the level justified by the repeatability (standard deviation) of the replicate analyses.
[b] MDA = minimum detectable amount.
[c] See text for discussion of temporal difference.
[d] L refers to the volume (liters) of distillate.

Table 4-5. Spiked Sample Performance for 1995 Ambient Air Samples

Analyte	Type of Spike	No. of Samples	Spike Added (pCi)	Average Spike[a] Recovery (pCi)	Percent Spike[a] Recovery Average% ± 1 Sigma%
^{241}Am	Reagent Spike	8	4.7	4.5	96 ± 5%
	Filter Spike	8	2.37	2.24	95 ± 3%
	Filter Spike	10	7.5	7.5	99 ± 3%
	Filter Spike	6	8.3	8.2	98 ± 2%
^{238}Pu	Reagent Spike	1	10.5	10.3	98 single[b]
	Reagent Spike	7	10.7	10.3	96 ± 2%
	Reagent Spike	1	5.4	4.9	91 single
	Filter Spike	7	5.3	5.3	98 ± 3%
^{239}Pu	Reagent Spike	8	10.5	10.5	100 ± 3%
	Filter Spike	8	5.3	5.3	100 ± 3%
	Filter Spike	13	6.5	7.1	109 ± 4%
	Filter Spike	9	7.2	7.8	108 ± 3%
^{234}U	Reagent Spike	7	17	17	99 ± 7%
	Filter Spike	7	8.3	8.7	104 ± 7%
	Filter Spike	16	10.3	10.4	101 ± 7%
	Filter Spike	6	12	13	111 ± 9%
^{235}U	Reagent Spike	7	1.51	0.72	47 ± 11%[c]
	Filter Spike	6	0.40	0.37	92 ± 18%
	Filter Spike	1	0.76	0.35	46 single[c]
	Filter Spike	1	10.3	9.5	92 single
^{238}U	Reagent Spike	7	16.6	15.7	95 ± 2%
	Filter Spike	7	8.3	7.8	94 ± 5%
	Filter Spike	15	10.3	10.8	105 ± 6%
	Filter Spike	6	11.5	12.3	107 ± 6%

[a] Significant figures vary by isotope, but each is reported to the level justified by the repeatability (standard deviation) of the replicate analyses.
[b] Single sample does not allow for calculation of standard deviation.
[c] See text for discussion of spike recovery.

Table 4-6. Airborne Long-Lived Gross Alpha Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	2s
Regional Stations						
01 Española	22	0	3.3	0.6	1.3	1.4
02 Pojoaque	24	1	3.8	0.5	1.4	1.8
03 Santa Fe	21	0	5.7	0.4	1.5	2.6
Group Summary	67	1	5.7	0.4	1.4	0.2
Pueblo Stations						
41 Pueblo of San Ildefonso	24	1	3.1	0.4	1.3	1.6
42 Taos Pueblo	14	1	5.5	0.3	1.6	3.2
48 Jemez Pueblo	20	2	14.4	0.2	1.9	6.2
Group Summary	58	4	14.4	0.2	1.6	0.6
Perimeter Stations						
04 Barranca School	22	1	5.7	0.6	1.9	2.7
05 Urban Park	23	0	5.4	0.4	1.8	2.5
06 48th Street	25	0	5.3	0.6	1.7	2.2
07 Los Alamos Shell Station	24	0	5.1	0.4	1.8	2.3
08 McDonald's Restaurant	25	0	4.9	0.5	1.7	2.0
09 Los Alamos Airport	25	0	5.9	0.3	1.9	2.6
10 East Gate	25	2	5.8	0.1	1.6	2.7
11 Well PM-1	25	0	4.3	0.2	1.7	2.0
12 Royal Crest Trailer Court	20	0	8.1	0.6	2.1	3.6
13 Piñon School	24	0	7.1	0.5	1.9	3.3
14 Pajarito Acres	8	0	5.1	0.7	2.3	3.1
15 White Rock Fire Station	25	0	5.4	0.3	1.6	2.3
16 Nazarene Church	24	1	4.2	0.5	1.8	2.1
17 Bandelier National Monument	25	0	6.5	0.4	1.9	2.8
60 LA Canyon	9	0	4.9	1.1	2.5	2.7
61 LA Hospital	15	0	8.3	0.5	2.1	4.1
62 Trinity Bible Church	14	0	5.5	1.0	2.2	2.9
63 Monte Rey South	13	0	7.2	0.6	2.1	3.8
Group Summary	371	4	8.3	0.1	1.9	0.5
On-Site Stations						
19 TA-21 DP Site	25	0	7.9	0.7	2.0	3.3
20 TA-21 Area B	25	0	5.1	0.6	2.0	2.2
21 TA-6	25	1	4.5	0.1	1.6	2.0
22 TA-53, LANSCE (formerly LAMPF)	24	0	5.9	0.5	2.0	2.5
23 TA-52, Beta Site	25	1	18.5	0.5	2.4	7.2
25 TA-16-450	22	0	5.8	0.6	1.9	2.2
26 TA-49	25	0	5.5	0.5	1.7	2.3
28 TA-33, HP Site	24	0	5.6	0.7	1.9	2.3
29 TA-2, Omega Site	14	0	2.5	0.5	1.3	1.3
30 Booster P-2	25	0	9.2	0.3	2.2	3.6
31 TA-3	19	1	4.2	0.1	1.9	2.0
32 TA-48	25	0	4.9	0.4	1.3	2.2
33 Area AB	6	0	2.8	0.8	1.9	1.4
49 TA-36 Sludge Pond	18	2	6.2	0.2	1.9	3.3
Group Summary	302	5	18.5	0.1	1.9	0.6

Table 4-6. Airborne Long-Lived Gross Alpha Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	2s
Area G Stations						
27 TA-54, Area G	24	1	7.0	0.6	1.5	2.6
34 Area G-1, NE Corner	25	0	6.4	0.7	2.0	2.9
35 Area G-2, South Fence	25	0	7.6	0.7	2.1	3.2
36 Area G-3, Gate	25	0	5.4	0.8	2.0	2.5
37 Area G-4, Water Tank	23	1	8.0	0.2	2.1	3.9
44 Area G (S Perimeter)	18	0	2.4	0.2	1.2	1.2
45 Area G (SE Perimeter)	25	0	7.9	0.7	1.9	3.2
46 Area G (E Perimeter)	20	0	12.7	0.6	1.9	5.2
47 Area G (N Perimeter)	25	0	6.8	0.8	1.9	3.0
50 Area G	21	0	12.1	0.5	2.1	5.6
51 Area G	21	0	6.0	0.5	1.6	2.8
52 Area G	16	0	1.6	0.5	1.0	0.8
Group Summary	268	2	12.7	0.2	1.8	0.8
Decontamination and Decommissioning						
71 TA-21.01	25	0	5.5	0.4	1.7	2.3
72 TA-21.02	25	0	4.8	0.5	1.9	2.2
73 TA-21.03	24	0	4.9	0.5	1.9	2.3
74 TA-21.04	23	0	6.2	0.7	2.2	2.9
75 TA-21.05	25	1	7.1	0.6	2.1	3.0
Group Summary	122	1	7.1	0.4	2.0	0.4
TA-15 Firing Sites						
76 TA-15-41	23	1	3.4	0.0	1.7	1.9
77 IJ Site	23	0	5.3	0.4	2.0	2.6
78 TA-15-vacant	24	1	5.1	0.5	1.7	2.3
Group Summary	70	2	5.3	0.0	1.8	0.3

Concentration Guidelines are not available for gross alpha concentrations.

Table 4-7. Airborne Long-Lived Gross Beta Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	2s
Regional Stations						
01 Española	22	0	30.5	6.5	13.4	11.2
02 Pojoaque	24	0	29.0	8.1	12.6	10.8
03 Santa Fe	21	0	31.4	5.7	11.5	13.3
Group Summary	67	0	31.4	5.7	12.5	1.9
Pueblo Stations						
41 Pueblo of San Ildefonso	24	0	26.3	7.1	12.4	9.2
42 Taos Pueblo	14	0	29.5	8.8	14.1	11.6
48 Jemez Pueblo	20	0	29.2	3.2	12.6	13.3
Group Summary	58	0	29.5	3.2	13.0	2.0
Perimeter Stations						
04 Barranca School	22	0	37.7	7.6	13.7	14.2
05 Urban Park	23	0	32.8	8.1	13.4	11.9
06 48th Street	25	0	37.6	4.8	12.5	13.9
07 Los Alamos Shell Station	24	0	27.6	4.1	12.8	11.4
08 McDonald's Restaurant	25	0	23.1	6.2	12.3	8.5
09 Los Alamos Airport	25	0	30.9	6.7	14.6	11.7
10 East Gate	25	0	34.8	5.0	13.0	15.1
11 Well PM-1	25	0	36.5	5.3	13.3	14.2
12 Royal Crest Trailer Court	20	0	45.0	7.4	16.7	17.6
13 Piñon School	24	0	36.1	6.9	15.1	16.8
14 Pajarito Acres	8	0	30.6	12.1	17.2	14.5
15 White Rock Fire Station	25	0	27.3	5.1	11.5	11.0
16 Nazarene Church	24	0	26.7	7.1	13.6	9.0
17 Bandelier National Monument	25	0	31.5	7.3	14.6	11.2
60 LA Canyon	9	0	23.4	11.4	16.5	9.2
61 LA Hospital	15	0	37.2	8.9	16.5	14.4
62 Trinity Bible Church	14	0	25.3	9.2	17.6	9.9
63 Monte Rey South	13	0	27.8	9.7	16.6	9.4
Group Summary	371	0	45.0	4.1	14.5	3.8
On-Site Stations						
19 TA-21 DP Site	25	0	35.2	7.6	14.6	13.2
20 TA-21 Area B	25	0	32.7	9.4	15.3	10.4
21 TA-6	25	0	23.7	2.7	13.3	9.5
22 TA-53, LANSCE (formerly LAMPF)	24	0	32.7	5.8	14.7	11.4
23 TA-52, Beta Site	25	0	133.6	7.1	17.4	49.1
25 TA-16-450	22	0	22.2	7.6	13.3	9.5
26 TA-49	25	0	26.9	6.5	13.7	10.7
28 TA-33, HP Site	24	0	27.3	6.5	13.7	9.0
29 TA-2, Omega Site	14	0	24.2	6.8	10.8	8.8
30 Booster P-2	25	0	45.4	4.7	16.9	18.8
31 TA-3	19	0	27.4	1.6	16.5	13.5
32 TA-48	25	0	31.4	3.9	11.6	12.3
33 Area AB	6	0	14.5	7.1	11.8	6.0
49 TA-36 Sludge Pond	18	0	37.7	3.8	15.2	16.5
Group Summary	302	0	133.6	1.6	14.2	4.0

Table 4-7. Airborne Long-Lived Gross Beta Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	2s
Area G Stations						
27 TA-54, Area G	24	0	27.4	3.7	13.0	10.9
34 Area G-1, NE Corner	25	0	40.9	3.4	15.5	16.8
35 Area G-2, South Fence	25	0	33.0	7.5	14.1	11.3
36 Area G-3, Gate	25	0	44.8	8.2	15.7	14.8
37 Area G-4, Water Tank	23	0	53.6	6.3	15.0	18.8
44 Area G (S Perimeter)	18	0	20.0	3.4	10.7	9.5
45 Area G (SE Perimeter)	25	0	40.4	4.5	14.8	14.8
46 Area G (E Perimeter)	20	0	29.7	4.0	13.1	12.4
47 Area G (N Perimeter)	25	0	43.8	4.9	14.8	16.5
50 Area G	21	0	35.5	3.8	14.3	15.5
51 Area G	21	0	43.8	6.7	13.7	16.4
52 Area G	16	0	17.7	8.4	11.2	5.4
Group Summary	268	0	53.6	3.4	13.8	3.2
Decontamination and Decommissioning						
71 TA-21.01	25	0	31.2	5.7	13.6	12.9
72 TA-21.02	25	0	30.3	5.4	13.7	11.5
73 TA-21.03	24	0	29.6	6.1	13.2	10.9
74 TA-21.04	23	0	36.1	7.3	14.9	13.0
75 TA-21.05	25	0	35.3	6.9	14.3	12.7
Group Summary	122	0	36.1	5.4	14.0	1.3
TA-15 Firing Sites						
76 TA-15-41	23	0	29.1	8.4	14.3	9.8
77 IJ Site	23	0	31.2	8.9	14.2	11.3
78 TA-15-vacant	24	0	25.0	8.3	13.2	8.6
Group Summary	70	0	31.2	8.3	13.9	1.2

Concentration Guidelines are not available for gross beta concentrations.

Table 4-8. Airborne Tritium as Tritiated Water Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	2s
Regional Stations						
01 Española	18	9	8.6	–1.4[a]	1.4	4.9
02 Pojoaque	24	17	4.5	–1.5	0.7	3.1
03 Santa Fe	21	15	3.5	–0.9	0.4	2.0
Group Summary	63	41	8.6	–1.5	0.8	1.0
Pueblo Stations						
41 Pueblo of San Ildefonso	23	13	70.4	–2.6	5.1	30.5
42 Taos Pueblo	14	9	7.0	–0.7	0.9	3.8
48 Jemez Pueblo	22	15	9.8	–1.6	1.4	5.8
Group Summary	59	37	70.4	–2.6	2.4	4.6
Perimeter Stations						
04 Barranca School	22	9	9.6	–1.2	1.5	5.1
05 Urban Park	22	10	22.5	–1.3	2.2	9.8
06 48th Street	25	13	22.9	–3.2	1.5	9.4
07 Los Alamos Shell Station	24	11	2.7	–1.1	0.8	1.9
08 McDonald's Restaurant	23	8	43.8	–1.4	6.0	20.7
09 Los Alamos Airport	21	5	59.0	–2.2	8.0	28.9
10 East Gate	21	5	33.1	–1.0	5.3	14.9
11 Well PM-1	25	10	23.1	–0.6	2.4	9.4
12 Royal Crest Trailer Court	23	10	11.6	–1.1	2.0	5.6
13 Piñon School	20	7	9.4	–2.1	2.8	6.5
14 Pajarito Acres	9	1	12.6	0.9	3.7	7.4
15 White Rock Fire Station	24	13	7.4	–1.0	1.4	3.9
16 Nazarene Church	19	7	12.2	–0.5	2.3	6.7
17 Bandelier National Monument	22	11	6.1	–1.3	1.4	3.7
60 LA Canyon	8	3	3.0	–0.1	1.3	2.0
61 LA Hospital	15	9	38.3	–2.2	3.1	19.8
62 Trinity Bible Church	13	7	5.4	0.0	1.8	2.9
63 Monte Rey South	12	6	3.2	0.0	1.1	2.1
Group Summary	348	145	59.0	–3.2	2.7	3.9
On-Site Stations						
19 TA-21 DP Site	24	0	58.1	2.5	17.9	31.3
20 TA-21 Area B	23	4	12.8	–0.7	3.8	7.8
21 TA-6	23	15	58.4	–1.9	3.6	24.8
22 TA-53, LANSCE (formerly LAMPF)	24	7	13.4	0.0	2.7	5.8
23 TA-52, Beta Site	23	10	8.9	–1.0	2.4	5.3
25 TA-16-450	21	1	820.5	0.0	178.8	525.1
26 TA-49	23	6	17.9	0.0	3.4	8.8
28 TA-33, HP Site	22	9	19.8	0.0	3.5	9.2
29 TA-2, Omega Site	12	3	13.9	–1.1	3.4	8.2
30 Booster P-2	25	10	7.8	0.0	1.9	3.9
31 TA-3	19	8	45.8	–1.4	6.0	21.1
32 TA-48	23	10	14.7	–0.5	1.8	6.2
33 Area AB	6	3	4.0	–3.2	0.9	4.9
49 TA-36 Sludge Pond	18	12	7.3	–1.0	1.3	4.7
Group Summary	286	98	820.5	–3.2	16.5	93.8

Table 4-8. Airborne Tritium as Tritiated Water Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	2s
TA-54, Area G	21	1	57.6	1.7	18.4	31.2
34 Area G-1, NE Corner	24	0	94.1	1.2	12.7	38.7
35 Area G-2, South Fence	25	0	1,889.8	4.7	370.5	974.8
36 Area G-3, Gate	25	5	1,136.1	–0.4	49.3	453.0
37 Area G-4, Water Tank	20	2	32.1	0.0	8.8	16.5
44 Area G (S Perimeter)	17	0	44.5	1.5	12.8	26.8
45 Area G (SE Perimeter)	24	1	134.7	0.7	15.5	53.1
46 Area G (E Perimeter)	20	3	24.8	0.0	7.0	13.4
47 Area G (N Perimeter)	23	1	54.5	1.4	17.2	27.3
50 Area G	20	1	52.7	1.3	6.9	22.8
51 Area G	20	6	9.9	–0.7	3.2	5.5
52 Area G	15	10	3.6	–0.6	1.3	2.8
Group Summary	254	30	1,889.8	–0.7	43.6	207.3
Decontamination and Decommissioning						
71 TA-21.01	23	3	10.6	–0.7	2.6	5.3
72 TA-21.02	24	4	12.2	–0.5	2.7	5.6
73 TA-21.03	25	1	68.2	0.5	11.7	27.4
74 TA-21.04	22	3	51.8	0.0	11.0	26.4
75 TA-21.05	23	3	16.7	0.0	6.2	9.7
Group Summary	117	14	68.2	–0.7	6.8	8.8
TA-15 Firing Sites						
76 TA-15-41	23	14	32.0	–0.8	2.2	13.2
77 IJ Site	23	12	118.9	–0.6	6.0	49.2
78 TA-15-vacant	21	10	9.9	–0.8	1.3	4.4
Group Summary	67	36	118.9	–0.8	3.2	5.0

Concentration Guidelines.
Controlled Area DOE Derived Air Concentration Guide 20,000,000 pCi/m^3.
Uncontrolled Area DOE Derived Air Concentration Guide 100,000 pCi/m^3.
EPA 40 CFR 61 Concentration Guide 1,500 pCi/m^3.

[a] See Appendix B for a discussion of negative values.

Table 4-9. Airborne Plutonium-238 Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Regional Stations						
01 Española	4	2	109.1	1.7	28.9	106.8
02 Pojoaque	4	3	5.4	–1.4[a]	1.8	5.8
03 Santa Fe	4	1	28.4	0.0	6.3	13.3
Group Summary	12	6	109.1	–1.4	12.3	29.1
Pueblo Stations						
41 Pueblo of San Ildefonso	4	3	2.7	0.0	1.4	2.2
42 Taos Pueblo	3	2	2.2	–2.3	0.7	5.2
48 Jemez Pueblo	3	3	2.2	0.0	1.3	2.3
Group Summary	10	8	2.7	–2.3	1.1	0.8
Perimeter Stations						
04 Barranca School	4	2	7.9	1.2	3.4	6.2
05 Urban Park	4	2	13.2	0.6	4.7	11.6
06 48th Street	4	3	2.6	1.2	1.6	1.4
07 Los Alamos Shell Station	4	2	3.9	0.0	2.7	3.7
08 McDonald's Restaurant	4	4	2.1	–1.3	0.6	3.2
09 Los Alamos Airport	4	3	3.5	1.2	2.5	1.9
10 East Gate	4	2	4.0	0.0	1.9	3.3
11 Well PM-1	4	3	6.1	0.0	1.8	5.8
12 Royal Crest Trailer Court	3	3	3.0	1.8	2.3	1.2
13 Piñon School	4	3	10.2	1.0	4.2	8.2
14 Pajarito Acres	1	1	1.4	1.4	1.4	
15 White Rock Fire Station	4	0	5.1	1.8	3.1	2.9
16 Nazarene Church	4	2	3.5	1.5	2.2	1.9
17 Bandelier National Monument	4	3	2.8	0.7	1.7	1.8
60 LA Canyon	1	0	2.1	2.1	2.1	
61 LA Hospital	2	1	2.2	1.2	1.7	1.5
62 Trinity Bible Church	2	0	4.9	2.3	3.6	3.7
63 Monte Rey South	2	2	3.4	1.7	2.5	2.3
Group Summary	59	36	13.2	–1.3	2.4	2.1
On-Site Stations						
19 TA-21 DP Site	4	2	5.2	0.0	2.6	4.2
20 TA-21 Area B	4	2	4.5	1.7	2.8	2.7
21 TA-6	4	4	7.2	0.9	3.3	5.4
22 TA-53, LANSCE (formerly LAMPF)	4	2	6.9	1.3	3.2	5.1
23 TA-52, Beta Site	4	3	2.6	1.4	2.0	1.3
25 TA-16-450	4	3	3.6	0.0	2.1	3.5
26 TA-49	4	2	5.1	0.0	2.8	4.5
28 TA-33, HP Site	4	3	6.4	0.0	2.0	5.9
29 TA-2, Omega Site	3	3	3.1	1.6	2.2	1.6
30 Booster P-2	4	3	4.0	–2.6	0.9	5.8
31 TA-3	2	1	2.4	1.5	2.0	1.3
32 TA-48	4	1	5.3	0.0	2.6	4.3
33 Area AB	1	1	0.0	0.0	0.0	
49 TA-36 Sludge Pond	3	2	4.3	0.0	2.1	4.3
Group Summary	49	32	7.2	–2.6	2.2	1.7

Table 4-9. Airborne Plutonium-238 Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Area G Stations						
27 TA-54, Area G	4	1	9.1	5.0	6.8	3.5
34 Area G-1, NE Corner	4	0	7.1	2.9	5.4	3.8
35 Area G-2, South Fence	4	2	5.5	1.9	3.3	3.2
36 Area G-3, Gate	4	3	4.3	1.0	2.9	2.8
37 Area G-4, Water Tank	4	3	4.3	0.7	2.7	3.2
44 Area G (S Perimeter)	3	3	4.5	1.6	2.7	3.3
45 Area G (SE Perimeter)	4	2	6.0	–1.3	1.8	6.5
46 Area G (E Perimeter)	3	1	14.8	0.0	7.5	14.8
47 Area G (N Perimeter)	4	2	4.7	0.0	2.7	4.7
50 Area G	3	2	2.1	–2.5	0.4	5.5
51 Area G	3	1	3.8	2.3	3.0	1.5
52 Area G	2	2	2.6	1.4	2.0	1.7
Group Summary	42	22	14.8	–2.5	3.4	4.2
Decontamination and Decommissioning						
71 TA-21.01	4	3	2.4	1.2	1.7	1.1
72 TA-21.02	4	2	5.2	1.3	2.6	3.6
73 TA-21.03	4	2	6.2	1.3	3.3	4.2
74 TA-21.04	4	2	6.4	1.4	4.0	4.4
75 TA-21.05	4	1	7.4	2.5	4.2	4.6
Group Summary	20	10	7.4	1.2	3.2	2.1
TA-15 Firing Sites						
76 TA-15-41	4	3	4.5	0.0	2.1	3.9
77 IJ Site	4	2	4.7	0.0	2.6	4.0
78 TA-15-vacant	4	3	5.8	–5.0	0.9	9.2
Group Summary	12	8	5.8	–5.0	1.9	1.7

Concentration Guidelines.
Controlled Area DOE Derived Air Concentration Guide 3,000,000 aCi/m^3.
Uncontrolled Area DOE Derived Air Concentration Guide 30,000 aCi/m^3.
EPA 40 CFR 61 Concentration Guide 2,100 aCi/m^3.

[a] See Appendix B for a discussion of negative values.

Table 4-10. Airborne Plutonium-239,-240 Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Regional Stations						
01 Española	4	2	1,219.3	–0.3[a]	305.6	1218.3
02 Pojoaque	4	2	7.3	–1.4	2.3	7.4
03 Santa Fe	4	2	41.7	0.2	14.0	38.7
Group Summary	12	6	1,219.3	–1.4	107.3	343.6
Pueblo Stations						
41 Pueblo of San Ildefonso	4	2	15.0	–0.3	5.9	14.5
42 Taos Pueblo	3	2	7.0	–0.1	2.3	8.1
48 Jemez Pueblo	3	2	3.7	0.9	1.9	3.1
Group Summary	10	6	15.0	–0.3	3.4	4.4
Perimeter Stations						
04 Barranca School	4	2	39.5	0.4	11.4	37.6
05 Urban Park	4	3	4.2	0.1	2.0	3.4
06 48th Street	4	2	8.1	0.0	2.4	7.7
07 Los Alamos Shell Station	4	2	4.7	–1.4	1.6	5.3
08 McDonald's Restaurant	4	3	10.5	0.0	3.4	9.7
09 Los Alamos Airport	4	2	5.0	1.4	2.8	3.2
10 East Gate	4	4	0.7	0.0	0.2	0.7
11 Well PM-1	4	3	10.4	1.2	3.5	9.2
12 Royal Crest Trailer Court	3	2	3.7	0.0	1.8	3.7
13 Piñon School	4	2	88.0	–0.8	22.3	87.7
14 Pajarito Acres	1	1	0.0	0.0	0.0	
15 White Rock Fire Station	4	3	27.7	–1.0	7.2	27.5
16 Nazarene Church	4	4	2.2	0.3	1.3	1.6
17 Bandelier National Monument	4	3	4.8	0.0	1.8	4.3
60 LA Canyon	1	1	0.3	0.3	0.3	
61 LA Hospital	2	2	2.4	0.3	1.3	3.0
62 Trinity Bible Church	2	0	4.7	2.8	3.7	2.8
63 Monte Rey South	2	2	1.8	1.2	1.5	0.9
Group Summary	59	41	88.0	–1.4	3.8	10.7
On-Site Stations						
19 TA-21 DP Site	4	2	8.2	0.0	2.7	7.7
20 TA-21 Area B	4	1	4.7	0.0	3.1	4.3
21 TA-6	4	3	33.1	0.2	8.9	32.3
22 TA-53, LANSCE (formerly LAMPF)	4	2	24.2	0.9	7.6	22.3
23 TA-52, Beta Site	4	3	10.5	–1.5	2.4	11.0
25 TA-16-450	4	3	3.5	0.0	1.2	3.2
26 TA-49	4	4	1.5	0.4	1.1	1.0
28 TA-33, HP Site	4	2	43.6	0.8	13.3	40.9
29 TA-2, Omega Site	3	2	9.4	0.6	4.0	9.4
30 Booster P-2	4	4	1.7	–1.3	0.2	2.5
31 TA-3	2	2	1.1	0.6	0.9	0.7
32 TA-48	4	1	36.1	1.1	10.6	34.1
33 Area AB	1	1	2.3	2.3	2.3	
49 TA-36 Sludge Pond	3	3	1.3	0.3	0.9	1.1
Group Summary	49	33	43.6	–1.5	4.2	8.3

Table 4-10. Airborne Plutonium-239 Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Area G Stations						
27 TA-54, Area G	4	0	151.9	51.3	108.0	84.3
34 Area G-1, NE Corner	4	3	9.7	0.4	4.0	8.1
35 Area G-2, South Fence	4	3	3.0	0.0	1.2	2.6
36 Area G-3, Gate	4	3	11.0	0.8	4.1	9.5
37 Area G-4, Water Tank	4	3	6.2	–0.2	2.1	5.6
44 Area G (S Perimeter)	3	1	7.1	1.5	5.1	6.3
45 Area G (SE Perimeter)	4	0	32.6	10.7	17.8	20.1
46 Area G (E Perimeter)	3	1	7.4	0.0	4.8	8.3
47 Area G (N Perimeter)	4	0	11.0	2.7	6.5	8.9
50 Area G	3	0	6.4	3.7	5.2	2.7
51 Area G	3	2	15.4	0.6	6.3	16.0
52 Area G	2	1	7.7	0.4	4.0	10.3
Group Summary	42	16	151.9	–0.2	14.1	59.8
Decontamination and Decommissioning						
71 TA-21.01	4	2	3.6	0.0	2.1	3.1
72 TA-21.02	4	0	14.1	2.6	6.0	10.9
73 TA-21.03	4	0	21.5	8.2	13.4	12.4
74 TA-21.04	4	0	37.7	7.0	20.1	25.7
75 TA-21.05	4	1	43.0	1.5	16.3	36.6
Group Summary	20	3	43.0	0.0	11.6	14.8
TA-15 Firing Sites						
76 TA-15-41	4	2	11.9	–1.9	3.3	12.2
77 IJ Site	4	3	69.5	0.3	17.0	64.8
78 TA-15-vacant	4	3	1.6	0.4	1.1	1.0
Group Summary	12	8	69.5	–1.9	7.1	17.2

Concentration Guidelines.
Controlled Area DOE Derived Air Concentration Guide 2,000,000 aCi/m^3.
Uncontrolled Area DOE Derived Air Concentration Guide 20,000 aCi/m^3.
EPA 40 CFR 61 Concentration Guide 1,900 aCi/m^3.

[a] See Appendix B for a discussion of negative values.

Table 4-11. Airborne Americium-241 Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Regional Stations						
01 Española	3	0	373.1	3.3	127.1	426.1
02 Pojoaque	2	0	3.9	3.7	3.8	0.3
03 Santa Fe	4	0	13.6	5.5	8.3	7.5
Group Summary	9	0	373.1	3.3	46.4	139.8
Pueblo Stations						
41 Pueblo of San Ildefonso	4	1	6.7	2.7	4.7	3.8
42 Taos Pueblo	3	1	7.0	3.5	4.9	3.7
48 Jemez Pueblo	3	1	6.5	0.0	3.6	6.6
Group Summary	10	3	7.0	0.0	4.4	1.4
Perimeter Stations						
04 Barranca School	2	0	3.8	3.2	3.5	0.9
05 Urban Park	2	0	4.9	3.0	4.0	2.7
06 48th Street	2	0	2.8	2.7	2.8	0.3
07 Los Alamos Shell Station	2	0	5.6	4.4	5.0	1.7
08 McDonald's Restaurant	2	0	5.4	5.2	5.3	0.2
09 Los Alamos Airport	4	1	5.2	1.4	3.4	3.1
10 East Gate	4	0	5.2	3.5	4.0	1.6
11 Well PM-1	2	1	6.7	4.2	5.5	3.5
12 Royal Crest Trailer Court	3	0	4.0	2.7	3.5	1.4
13 Piñon School	4	1	32.1	3.3	11.4	27.7
14 Pajarito Acres	1	0	2.0	2.0	2.0	
15 White Rock Fire Station	4	0	11.3	3.0	5.7	7.6
16 Nazarene Church	4	2	4.9	0.0	3.4	4.5
17 Bandelier National Monument	3	1	4.3	2.8	3.7	1.5
60 LA Canyon	1	0	4.3	4.3	4.3	
61 LA Hospital	2	0	6.3	3.0	4.7	4.6
62 Trinity Bible Church	2	0	4.7	4.6	4.7	0.2
63 Monte Rey South	2	0	5.1	4.8	4.9	0.5
Group Summary	46	5	32.1	0.0	4.5	3.9
On-Site Stations						
19 TA-21 DP Site	4	1	11.0	2.6	6.0	7.2
20 TA-21 Area B	4	1	6.7	0.0	3.9	5.6
21 TA-6	4	1	14.4	1.4	5.7	11.8
22 TA-53, LANSCE (formerly LAMPF)	4	0	12.5	3.7	6.1	8.6
23 TA-52, Beta Site	2	0	4.8	2.0	3.4	3.9
25 TA-16-450	3	1	5.5	2.9	4.6	2.9
26 TA-49	4	1	5.1	0.0	3.4	4.7
28 TA-33, HP Site	2	0	4.0	3.8	3.9	0.2
29 TA-2, Omega Site	1	0	5.2	5.2	5.2	
30 Booster P-2	4	1	8.4	1.3	5.4	6.9
31 TA-3	3	0	33.3	4.8	14.4	32.8
32 TA-48	2	0	6.2	4.4	5.3	2.5
49 TA-36 Sludge Pond	3	0	7.8	3.7	5.3	4.5
Group Summary	40	6	33.3	0.0	5.6	5.6

Table 4-11. Airborne Americium-241 Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Area G Stations						
27 TA-54, Area G	4	0	127.5	31.4	82.6	78.8
34 Area G-1, NE Corner	4	0	7.3	3.4	5.6	3.3
35 Area G-2, South Fence	4	2	5.5	0.0	3.7	5.0
36 Area G-3, Gate	4	0	11.0	4.8	7.5	5.5
37 Area G-4, Water Tank	4	2	13.0	3.4	6.8	8.5
44 Area G (S Perimeter)	3	3	7.1	6.0	6.5	1.1
45 Area G (SE Perimeter)	4	1	9.3	2.7	5.7	6.3
46 Area G (E Perimeter)	3	2	7.4	3.4	5.0	4.3
47 Area G (N Perimeter)	4	2	10.1	4.1	6.6	5.5
50 Area G	3	0	6.4	4.5	5.9	2.8
51 Area G	3	0	9.0	4.8	7.1	5.8
52 Area G	2	0	3.7	3.7	3.8	0.2
Group Summary	42	12	127.5	0.0	12.2	44.4
Decontamination and Decommissioning						
71 TA-21.01	4	0	6.9	4.2	5.4	2.4
72 TA-21.02	4	1	8.5	0.0	4.5	7.0
73 TA-21.03	4	0	33.6	5.0	12.9	27.6
74 TA-21.04	4	1	13.9	4.2	7.9	8.3
75 TA-21.05	4	1	14.8	0.0	6.0	12.6
Group Summary	20	3	33.6	0.0	7.3	6.7
TA-15 Firing Sites						
76 TA-15-41	2	0	5.8	5.1	5.4	1.0
77 IJ Site	2	0	4.2	3.6	3.9	0.8
78 TA-15-vacant	2	0	5.5	3.8	4.7	2.5
Group Summary	6	0	5.8	3.6	4.7	1.6

Concentration Guidelines.
Controlled Area DOE Derived Air Concentration Guide 2,000,000 aCi/m^3.
Uncontrolled Area DOE Derived Air Concentration Guide 20,000 aCi/m^3.
EPA 40 CFR 61 Concentration Guide 1,900 aCi/m^3.

Table 4-12. Airborne Uranium-234 Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Regional Stations						
01 Española	4	0	23.6	8.1	15.7	12.7
02 Pojoaque	4	0	72.1	18.3	42.7	46.8
03 Santa Fe	4	0	41.6	13.0	28.8	23.6
Group Summary	12	0	72.1	8.1	29.1	27.0
Pueblo Stations						
41 Pueblo of San Ildefonso	4	0	25.1	16.4	21.2	27.0
42 Taos Pueblo	3	0	35.1	19.6	25.8	16.4
48 Jemez Pueblo	3	0	37.0	31.2	34.1	5.8
Group Summary	10	0	37.0	16.4	27.0	13.0
Perimeter Stations						
04 Barranca School	4	0	12.5	8.4	10.5	4.0
05 Urban Park	4	0	21.2	7.3	13.6	13.0
06 48th Street	4	1	8.1	3.0	5.2	4.8
07 Los Alamos Shell Station	4	1	14.3	4.3	9.6	9.2
08 McDonald's Restaurant	4	2	13.2	2.6	8.2	10.6
09 Los Alamos Airport	4	0	14.4	5.8	9.4	8.3
10 East Gate	4	0	19.4	5.2	9.8	13.0
11 Well PM-1	4	1	10.8	6.0	7.7	4.5
12 Royal Crest Trailer Court	3	0	21.7	6.1	11.7	17.2
13 Piñon School	4	1	20.2	4.4	9.9	14.1
14 Pajarito Acres	1	0	8.8	8.8	8.8	
15 White Rock Fire Station	4	1	14.4	2.0	7.7	10.7
16 Nazarene Church	4	2	20.7	2.5	8.8	16.3
17 Bandelier National Monument	4	1	13.6	2.9	7.4	8.9
60 LA Canyon	1	0	7.4	7.4	7.4	
61 LA Hospital	2	0	21.0	13.0	17.0	11.3
62 Trinity Bible Church	2	0	9.5	8.1	8.8	1.9
63 Monte Rey South	2	1	8.6	3.9	6.3	6.7
Group Summary	59	11	21.7	2.0	9.3	5.4
On-Site Stations						
19 TA-21 DP Site	4	1	22.0	2.6	10.9	16.2
20 TA-21 Area B	4	0	25.2	6.4	14.2	18.3
21 TA-6	4	0	13.0	6.2	9.0	6.1
22 TA-53, LANSCE (formerly LAMPF)	4	0	10.4	4.2	7.0	6.3
23 TA-52, Beta Site	4	0	24.8	4.1	15.0	18.0
25 TA-16-450	4	1	19.3	5.0	10.7	13.3
26 TA-49	4	2	22.7	1.4	8.0	19.8
28 TA-33, HP Site	4	1	11.5	1.3	6.6	8.4
29 TA-2, Omega Site	3	0	42.2	3.9	19.4	40.4
30 Booster P-2	4	1	11.9	5.6	9.2	6.3
31 TA-3	3	0	14.3	7.7	10.5	6.8
32 TA-48	4	0	63.6	5.3	29.8	51.6
33 Area AB	1	0	11.4	11.4	11.4	
49 TA-36 Sludge Pond	3	0	33.4	8.9	20.2	24.7
Group Summary	50	6	63.6	1.3	13.0	12.8

Table 4-12. Airborne Uranium-234 Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Area G Stations						
27 TA-54, Area G	4	0	48.2	19.8	36.3	28.2
34 Area G-1, NE Corner	4	0	50.7	13.6	27.7	32.1
35 Area G-2, South Fence	4	0	21.1	6.9	12.4	12.6
36 Area G-3, Gate	4	0	50.4	20.0	35.2	30.8
37 Area G-4, Water Tank	4	0	21.7	5.4	11.0	14.6
44 Area G (S Perimeter)	3	0	42.5	21.8	29.0	23.4
45 Area G (SE Perimeter)	4	0	58.2	5.3	30.7	46.8
46 Area G (E Perimeter)	3	0	50.0	27.1	35.5	25.2
47 Area G (N Perimeter)	4	0	55.0	10.9	27.4	40.7
50 Area G	3	0	42.0	26.6	35.8	16.2
51 Area G	3	0	54.0	27.7	37.3	28.5
52 Area G	2	0	13.2	6.4	9.8	9.6
Group Summary	42	0	58.2	5.3	27.4	20.9
Decontamination and Decommissioning						
71 TA-21.01	4	0	10.8	4.3	8.8	6.1
72 TA-21.02	4	1	80.5	1.7	28.1	71.2
73 TA-21.03	4	0	33.2	15.0	22.4	17.2
74 TA-21.04	4	0	34.0	15.9	26.5	15.8
75 TA-21.05	4	0	29.7	10.2	20.7	16.5
Group Summary	20	1	80.5	1.7	21.3	15.2
TA-15 Firing Sites						
76 TA-15-41	4	1	6.6	5.6	6.0	1.0
77 IJ Site	4	0	49.4	12.8	22.3	36.1
78 TA-15-vacant	4	0	8.7	5.4	7.6	2.9
Group Summary	12	1	49.4	5.4	11.9	18.0

Concentration Guidelines.
Controlled Area DOE Derived Air Concentration Guide 20,000,000 aCi/m^3.
Uncontrolled Area DOE Derived Air Concentration Guide 90,000 aCi/m^3.
EPA 40 CFR 61 Concentration Guide 7,700 aCi/m^3.

Table 4-13. Airborne Uranium-235 Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Regional Stations						
01 Española	4	3	2.4	1.3	1.7	1.0
02 Pojoaque	4	1	3.8	1.4	2.2	2.2
03 Santa Fe	4	3	5.8	0.0	1.8	5.6
Group Summary	12	7	5.8	0.0	1.9	0.6
Pueblo Stations						
41 Pueblo of San Ildefopnso	4	3	2.9	0.0	1.4	2.4
42 Taos Pueblo	3	2	2.6	0.0	1.4	2.6
48 Jemez Pueblo	3	3	1.8	0.0	1.2	2.1
Group Summary	10	8	2.9	0.0	1.3	0.2
Perimeter Stations						
04 Barranca School	4	3	5.5	2.0	3.4	3.2
05 Urban Park	4	3	2.8	0.0	0.7	2.8
06 48th Street	4	4	1.4	0.0	0.6	1.5
07 Los Alamos Shell Station	4	3	1.5	0.0	1.0	1.4
08 McDonald's Restaurant	4	4	1.6	0.0	0.7	1.7
09 Los Alamos Airport	4	4	2.5	0.0	0.6	2.5
10 East Gate	4	2	2.8	0.0	1.7	2.6
11 Well PM-1	4	4	1.3	0.0	0.9	1.3
12 Royal Crest Trailer Court	3	3	1.3	0.0	0.4	1.5
13 Piñon School	4	3	2.8	0.0	1.4	2.3
14 Pajarito Acres	1	1	0.0	0.0	0.0	
15 White Rock Fire Station	4	3	1.2	0.0	0.6	1.3
16 Nazarene Church	4	3	2.5	0.0	1.4	2.1
17 Bandelier National Monument	4	4	1.2	0.0	0.3	1.2
60 LA Canyon	1	1	1.5	1.5	1.5	
61 LA Hospital	2	1	3.0	1.4	2.2	2.2
62 Trinity Bible Church	2	2	2.7	0.0	1.4	3.8
63 Monte Rey South	2	2	0.0	0.0	0.0	0.0
Group Summary	59	50	5.5	0.0	1.0	1.7
On-Site Stations						
19 TA-21 DP Site	4	2	4.4	0.0	2.1	3.7
20 TA-21 Area B	4	3	3.4	0.0	1.6	2.8
21 TA-6	4	3	2.9	0.0	1.1	2.8
22 TA-53, LANSCE (formerly LAMPF)	4	3	3.0	0.0	1.4	3.3
23 TA-52, Beta Site	4	4	3.0	1.3	1.8	1.6
25 TA-16-450	4	4	2.5	0.0	1.4	2.1
26 TA-49	4	3	3.8	0.0	1.6	3.1
28 TA-33, HP Site	4	4	1.5	0.0	1.0	1.4
29 TA-2, Omega Site	3	2	3.1	0.0	1.0	3.6
30 Booster P-2	4	3	1.8	0.0	0.9	2.0
31 TA-3	3	2	1.5	0.0	0.5	1.8
32 TA-48	4	4	3.5	0.0	1.5	3.0
33 Area AB	1	1	0.0	0.0	0.0	
49 TA-36 Sludge Pond	3	2	3.9	0.0	1.8	4.0
Group Summary	50	40	4.4	0.0	1.3	1.1

Table 4-13. Airborne Uranium-235 Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Area G Stations						
27 TA-54, Area G	4	2	3.1	1.3	2.2	1.7
34 Area G-1, NE Corner	4	3	2.0	1.4	1.8	0.7
35 Area G-2, South Fence	4	3	2.9	0.0	1.5	2.4
36 Area G-3, Gate	4	3	3.2	1.5	2.0	1.6
37 Area G-4, Water Tank	4	4	2.2	1.5	1.9	0.5
44 Area G (S Perimeter)	3	1	4.7	1.5	3.0	3.2
45 Area G (SE Perimeter)	4	3	4.5	0.0	2.0	3.7
46 Area G (E Perimeter)	3	3	1.9	1.6	1.7	0.2
47 Area G (N Perimeter)	4	3	3.1	0.0	1.6	2.6
50 Area G	3	2	2.5	1.4	1.8	1.3
51 Area G	3	1	2.8	1.3	1.9	1.7
52 Area G	2	1	1.3	1.1	1.2	0.3
Group Summary	42	29	4.7	0.0	1.9	0.9
Decontamination and Decommissioning						
71 TA-21.01	4	4	1.5	0.0	1.0	1.4
72 TA-21.02	4	2	5.9	1.3	2.5	4.5
73 TA-21.03	4	3	2.7	0.0	1.7	2.5
74 TA-21.04	5	3	4.6	0.0	1.9	4.0
75 TA-21.05	4	1	4.4	1.5	2.9	2.4
Group Summary	21	13	5.9	0.0	2.0	1.5
TA-15 Firing Sites						
76 TA-15-41	4	3	1.5	0.0	1.0	2.6
77 IJ Site	4	2	4.6	0.0	2.1	3.9
78 TA-15-vacant	4	4	2.8	–1.4[a]	1.1	3.5
Group Summary	12	9	4.6	–1.4	1.4	1.2

Concentration Guidelines.
Controlled Area DOE Derived Air Concentration Guide 20,000,000 aCi/m^3.
Uncontrolled Area DOE Derived Air Concentration Guide 100,000 aCi/m^3.
EPA 40 CFR 61 Concentration Guide 7,100 aCi/m^3.

[a] See Appendix B for a discussion of negative values.

Table 4-14. Airborne Uranium-238 Concentrations for 1995

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Regional Stations						
01 Española	4	0	22.0	13.0	16.2	8.0
02 Pojoaque	4	0	80.9	15.5	43.3	56.8
03 Santa Fe	4	0	43.7	5.9	24.3	31.5
Group Summary	12	0	80.9	5.9	27.9	27.8
Pueblo Stations						
41 Pueblo of San Ildefonso	4	0	24.7	13.7	17.8	10.1
42 Taos Pueblo	3	0	37.5	19.8	27.4	18.2
48 Jemez Pueblo	3	0	38.8	30.7	34.8	8.1
Group Summary	10	0	38.8	13.7	26.7	27.1
Perimeter Stations						
04 Barranca School	4	1	16.6	3.6	11.7	11.3
05 Urban Park	4	1	19.8	5.9	12.9	15.6
06 48th Street	4	2	7.4	1.2	4.5	6.2
07 Los Alamos Shell Station	4	0	11.1	7.2	9.1	3.2
08 McDonald's Restaurant	4	0	9.2	4.7	7.1	3.8
09 Los Alamos Airport	4	0	17.3	4.6	10.5	10.7
10 East Gate	4	0	28.1	8.4	13.9	19.1
11 Well PM-1	4	0	13.2	3.7	7.7	8.9
12 Royal Crest Trailer Court	3	0	14.0	6.1	9.7	8.0
13 Piñon School	4	1	14.8	5.4	10.2	7.8
14 Pajarito Acres	1	0	7.5	7.5	7.5	
15 White Rock Fire Station	4	0	14.4	5.1	9.7	9.4
16 Nazarene Church	4	0	12.7	5.9	9.1	6.9
17 Bandelier National Monument	4	1	11.1	3.7	6.2	6.8
60 LA Canyon	1	0	5.9	5.9	5.9	
61 LA Hospital	2	0	22.4	18.8	20.6	5.2
62 Trinity Bible Church	2	0	13.5	11.4	12.4	3.0
63 Monte Rey South	2	0	11.8	7.2	9.5	6.5
Group Summary	59	6	28.1	1.2	9.9	7.4
On-Site Stations						
19 TA-21 DP Site	4	0	16.5	6.5	11.2	8.3
20 TA-21 Area B	4	0	15.1	8.4	10.9	5.9
21 TA-6	4	0	14.1	7.1	10.5	6.0
22 TA-53, LANSCE (formerly LAMPF)	4	0	13.5	6.9	10.0	5.6
23 TA-52, Beta Site	4	0	98.3	3.9	30.7	90.9
25 TA-16-450	4	0	11.2	4.2	6.6	6.4
26 TA-49	4	1	8.8	2.6	5.0	5.9
28 TA-33, HP Site	4	0	12.2	5.2	9.4	6.4
29 TA-2, Omega Site	3	1	51.6	6.1	21.8	51.7
30 Booster P-2	4	0	16.9	8.4	11.9	7.8
31 TA-3	3	0	11.9	7.5	9.0	4.9
32 TA-48	4	0	56.5	2.1	19.0	51.1
33 Area AB	1	0	11.4	11.4	11.4	
49 TA-36 Sludge Pond	3	0	22.3	2.6	12.2	19.7
Group Summary	50	2	98.3	2.1	12.8	13.4

Table 4-14. Airborne Uranium-238 Concentrations for 1995 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	2s
Area G Stations						
27 TA-54, Area G	4	0	54.2	11.6	36.2	36.4
34 Area G-1, NE Corner	4	0	36.5	19.0	28.1	14.8
35 Area G-2, South Fence	4	1	15.9	2.8	11.3	12.0
36 Area G-3, Gate	4	0	42.6	18.0	30.3	20.5
37 Area G-4, Water Tank	4	1	19.5	4.3	11.7	13.0
44 Area G (S Perimeter)	3	0	42.5	22.7	30.3	21.3
45 Area G (SE Perimeter)	4	0	54.6	14.7	41.9	37.3
46 Area G (E Perimeter)	3	0	59.2	20.4	37.9	39.4
47 Area G (N Perimeter)	4	0	62.8	20.5	32.7	40.6
50 Area G	3	0	38.1	29.4	33.5	8.8
51 Area G	3	0	56.5	24.6	39.4	32.2
52 Area G	2	0	12.1	3.9	8.0	11.7
Group Summary	42	2	62.8	2.8	28.4	23.3
Decontamination and Decommissioning						
71 TA-21.01	4	0	10.8	5.5	7.4	4.8
72 TA-21.02	4	0	14.5	6.1	10.2	7.4
73 TA-21.03	4	0	22.3	5.8	11.7	14.6
74 TA-21.04	4	0	19.7	9.2	13.7	9.5
75 TA-21.05	4	0	21.9	10.4	13.8	10.9
Group Summary	20	0	22.3	5.5	11.0	5.4
TA-15 Firing Sites						
76 TA-15-41	4	1	9.9	5.6	7.3	4.0
77 IJ Site	4	0	328.6	28.1	120.7	279.2
78 TA-15-vacant	4	1	10.0	3.1	5.7	6.0
Group Summary	12	2	328.6	3.1	44.6	131.9

Concentration Guidelines.
Controlled Area DOE Derived Air Concentration Guide 20,000,000 aCi/m^3.
Uncontrolled Area DOE Derived Air Concentration Guide 100,000 aCi/m^3.
EPA 40 CFR 61 Concentration Guide 8,300 aCi/m^3.

Table 4-15. Airborne Uranium Concentration Conversion Factors

Multiply # of	by	to obtain # of
mCi/mL ^{234}U	1.60×10^{14}	pg/m^3 ^{234}U
mCi/mL ^{235}U	4.63×10^{17}	pg/m^3 ^{235}U
mCi/mL ^{238}U	2.98×10^{18}	pg/m^3 ^{238}U

Table 4-16. Estimated Air Concentrations of Depleted Uranium Resulting from Dynamic Experiments

Element	1995 Total Usage (Ci)	Fraction Released (%)	Annual Average Concentration (aCi/m^3) (4 km)	Annual Average Concentration (aCi/m^3) (8 km)	EPA Concentration Limit (aCi/m^3)
^{234}U	4.5×10^{-3}	10	5.2	1.8	7,700
^{235}U	7.8×10^{-4}	10	0.84	0.29	7,100
^{238}U	4.8×10^{-2}	10	49	17	8,300

Table 4-17. Analytical Chemistry Requirements for 1995 Stack Air Sampling

Analysis Required	1995 Samples Analyzed	Technique or Instrument	Typical Count Time	Target MDA[a]
Weekly Samples:				
Alpha	3,275	Proportional Counter	10 min	3 pCi
Beta	2,700	Proportional Counter	10 min	5 pCi
Tritium	2,550	Distillation and Liquid Scintillation	10 min	0.04 Ci/L[b]
Gamma Spec.	2,900	High-Purity Germanium	1,000 s	varies by isotope
Composites Samples:				
^{241}Am	125	Radiochemistry and Alpha Spec.	1,000 min	1 pCi
^{210}Pb	125	Radiochemistry and Proportional Counter	100–800 min	1 pCi
^{238}Pu	125	Radiochemistry and Alpha Spec.	1,000 min	0.5 pCi
$^{239,240}Pu$	125	Radiochemistry and Alpha Spec.	1,000 min	0.5pCi
^{90}Sr	125	Radiochemistry and Proportional Counter	100–800 min	0.5pCi
^{234}U	125	Radiochemistry and Alpha Spec.	1,000 min	1 pCi
^{235}U	125	Radiochemistry and Alpha Spec.	1,000 min	1 pCi
^{238}U	125	Radiochemistry and Alpha Spec.	1,000 min	1 pCi
Alpha	125	Radiochemistry and Proportional Counter	400 min	15 pCi
Beta	125	Radiochemistry and Proportional Counter	400 min	10 pCi

[a]MDA = minimum detectable activity.
[b]L refers to the volume (Liters) of ethylene glycol.

Table 4-18. Blank Sample Performance for 1995 Stack Composites

Analyte	Type of Blank	Number in 1995	Expected[a] Result	Average[a] Result (pCi)	Average MDA[b] Reported (pCi)
Alpha	Reagent Blank	14	0	–1	3
	Filter Blank	15	0	2	11
	Field Blank	2	0	9	17
Beta	Reagent Blank	14	0	–3	5
	Filter Blank	15	0	12	6
	Field Blank	2	0	37	4
^{241}Am	Reagent Blank	12	0	0.2	0.7
	Filter Blank	13	0	0.2	1.1
	Field Blank	2	0	0.3	0.5
^{210}Pb	Reagent Blank	13	0	0.1	0.4
	Filter Blank	14	0	0.4	0.7
	Field Blank	2	0	0.5	0.5
^{238}Pu	Reagent Blank	12	0	0.09	0.42
	Filter Blank	13	0	0.15	0.34
	Field Blank	2	0	0.30	0.54
^{239}Pu	Reagent Blank	12	0	0.02	0.19
	Filter Blank	13	0	0.05	0.25
	Field Blank	2	0	0.2	0.3
^{90}Sr	Reagent Blank	13	0	0.0	0.2
	Filter Blank	14	0	0.1	0.2
	Field Blank	2	0	0.1	0.2
^{234}U	Reagent Blank	12	0	0.7	0.4
	Filter Blank	12	0	1.0	0.3
	Field Blank	2	0	0.7	0.3
^{235}U	Reagent Blank	12	0	0.2	0.3
	Filter Blank	12	0	0.2	0.3
	Field Blank	2	0	0.1	0.2
^{238}U	Reagent Blank	12	0	0.2	0.4
	Filter Blank	12	0	0.4	0.4
	Field Blank	2	0	0.8	0.3

[a] Significant figures vary by isotope, but each is reported to the level justified by the repeatability (standard deviation) of the replicate analyses.
[b] MDA = minimum detectable activity.

Table 4-19. Percent Spike Recovery for 1995 Stack Air Emissions

Analyte[a]	Type of Spike	Number in 1995	Spike Added (pCi)	Average Spike[b] Recovery (pCi)	Percent Spike Recovery[b] Average% ± 1 Sigma%
Alpha	Reagent Spike	4	1,200	1,100	99 ± 9%
	Filter Spike	24	1,200	1,100	95 ± 15%
Beta	Reagent Spike	4	1,100	1,100	99 ± 4%
	Filter Spike	3	550	560	101 ± 2%
	Filter Spike	24	1,100	1,000	94 ± 7%
^{241}Am	Reagent Spike	4	75	73	97 ± 4%
	Filter Spike	8	72	72	101 ± 4%
	Filter Spike	37	75	75	100 ± 15%
^{210}Pb	Reagent Spike	4	24	27	110 ± 5%
	Filter Spike	24	24	26	105 ± 10%
	Filter Spike	10	29	30	102 ± 6%
	Filter Spike	2	49	49	99 ± 4%
^{239}Pu	Reagent Spike	4	65	72	112 ± 10%
	Filter Spike	26	65	71	109 ± 9%
^{234}U	Reagent Spike	4	103	109	106 ± 7%
	Filter Spike	32	103	104	101 ± 5%
^{238}U	Reagent Spike	5	103	110	107 ± 3%
	Filter Spike	31	103	108	104 ± 4%
^{90}Sr	Reagent Spike	5	29	28	99 ± 1%
	Filter Spike	33	30	30	101 ± 6%
	Filter Spike	2	59	49	83 ± 5%

[a]This laboratory does not spike with ^{238}Pu or ^{235}U because performance of the chemistry is believed to be adequtely characterized by use of any isotope of the particular element.

[b]Significant figures vary by isotope, but each is reported to the level justified by the repeatability (standard deviation) of the replicate analyses.

Table 4-20. Airborne Radioactive Emissions from Laboratory Buildings with Sampled Stacks in 1995 (Ci)[a]

TA-Bldg.	^{3}H[b]	^{241}Am	Total Pu[c]	Total U[d]	^{90}Sr	P/VAFP[e]	G/MAP[f]
TA-03-016	2.25 E + 00						
TA-03-029		4.01 E – 06	5.35 E – 05	1.30 E – 04	6.75 E – 06	9.38 E – 04	
TA-03-035				4.08 E – 07	1.46 E – 08		
TA-03-066				2.19 E – 05	2.55 E – 07		
TA-03-102			7.67 E – 11	1.56 E – 07	6.49 E – 10		
TA-03-141		6.65 E – 09	4.81 E – 08	4.21 E – 07	3.01 E – 08		
TA-16-205	8.90 E + 01						
TA-21-004				1.01 E – 06			
TA-21-005					5.36 E – 07		
TA-21-150				8.12 E – 08			
TA-21-155	4.75 E + 01						
TA-21-209	6.64 E + 02						
TA-21-257		7.72 E – 09	8.24 E – 09	3.57 E – 07	3.58 E – 09		
TA-21-313			3.63 E – 08	2.17 E – 07			
TA-21-314			6.91 E – 08		1.25 E – 07		
TA-21-315			5.27 E – 07	2.22 E – 08	3.18 E – 07		
TA-21-324			9.35 E – 11	2.11 E – 08	2.19 E – 09		
TA-33-086	1.09 E + 02						
TA-35-007		3.55 E – 08	2.97 E – 07	6.93 E – 07	9.73 E – 06	1.63 E – 06	
TA-41-001	4.05 E – 01		1.56 E – 08	9.02 E – 09	3.96 E – 08		
TA-41-004	7.81 E + 01						
TA-43-001		2.69 E – 07	5.72 E – 07	1.12 E – 06	1.72 E – 06		
TA-48-001		1.71 E – 06	3.10 E – 06	5.37 E – 07	4.06 E – 07	2.64 E – 02	
TA-50-001		6.26 E – 08	6.45 E – 07		3.09 E – 07		
TA-50-037					1.05 E – 08		
TA-50-066			6.29 E – 09		7.69 E – 09		
TA-50-069			6.99 E – 08		1.81 E – 08		
TA-53-003	1.98 E + 00					2.52 E – 01	4.26 E + 04
TA-53-007	1.19 E + 00					3.54 E – 02	1.02 E + 03
TA-54-002			8.48 E – 10				
TA-55-004	1.56 E + 01	5.45 E – 09	1.63 E – 08		8.79 E – 08		

[a] When a complete year of analysis data was not available, the measured emissions were adjusted to reflect a complete year of sampling.
[b] Includes both gaseous and oxide forms of tritium.
[c] Includes ^{238}Pu, ^{239}Pu and ^{240}Pu.
[d] Includes ^{234}U, ^{235}U and ^{238}U.
[e] P/VAFP—Particulate/vapor activation and fission products, excluding ^{90}Sr.
[f] G/MAP—Gaseous/mixed activation product.

Table 4-21. Detailed Listing of Fission/Activation Products from Laboratory Operations in 1995 (Ci)[a]

TA-Bldg.	Radionuclide	Emission
TA-03-029	^{72}As	2.13 E – 04
	^{7}Be	1.07 E – 04
	^{75}Se	6.18 E – 04
TA-35-007	^{137}Cs	1.63 E – 06
TA-48-001	^{72}As	2.34 E – 04
	^{73}As	1.01 E – 03
	^{74}As	2.55 E – 04
	^{7}Be	1.93 E – 05
	^{77}Br	1.91 E – 05
	^{68}Ge	3.09 E – 04
	^{86}Rb	2.76 E – 05
	^{75}Se	2.45 E – 02
TA-53-003	^{41}Ar	1.90 E + 02
	^{7}B	1.75 E – 02
	^{77}Br	7.70 E – 03
	^{82}Br	2.22 E – 01
	^{10}C	1.35 E + 03
	^{11}C	1.10 E + 04
	^{56}Co	1.02 E – 04
	^{57}Co	3.80 E – 04
	^{58}Co	4.36 E – 04
	^{60}Co	6.95 E – 05
	^{54}Mn	1.32 E – 04
	^{13}N	6.48 E + 03
	^{16}N	2.45 E + 02
	^{14}O	2.75 E + 02
	^{15}O	2.31 E + 04
	^{75}Se	1.61 E – 03
	^{182}Ta	2.15 E – 03
TA-53-007	^{41}Ar	1.58 E + 01
	^{82}Br	3.54 E – 02
	^{10}C	3.92 E – 01
	^{11}C	6.00 E + 02
	^{13}N	2.85 E + 02
	^{14}O	1.48 E + 00
	^{15}O	1.13 E + 02

[a] Excluding ^{90}Sr.

Table 4-22. Thermoluminscent Dosimeter (TLD) Measurements of External Radiation 1993–1995

	TLD Station ID #	Location	1995 Annual Dose (mrem)	1994 Annual Dose (mrem)	1993 Annual Dose (mrem)
Regional	1	Española	100 ± 12[a]	76 ± 13[a,b]	105 ± 12[a]
	2	Pojoaque	114 ± 10	118 ± 13	82 ± 10[b]
	3	Santa Fe	105 ± 10[b]	122 ± 13	109 ± 12
	4	Fenton Hill (TA-57)	51 ± 9[c]	152 ± 13	157 ± 12
	52	West Taos Pueblo	30 ± 10[d]	Out of Service	27 ± 6[d]
	53	Pueblo of San Ildefonso	104 ± 12	113 ± 13	50 ± 10[c]
	54	Jemez Pueblo	114 ± 12	110 ± 13	66 ± 8[c]
Perimeter	5	Barranca School, Los Alamos	139 ± 10	118 ± 13	112 ± 12
	6	Arkansas Avenue, Los Alamos	Discontinued 4th Quarter of 1992		
	7	Cumbres School, Los Alamos	131 ± 10	125 ± 10	124 ± 9
	8	48th Street, Los Alamos	135 ± 8	132 ± 10	126 ± 9
	9	Los Alamos Airport	114 ± 9	110 ± 10	79 ± 7[b]
	10	Bayo Canyon, Los Alamos	149 ± 11	145 ± 13	148 ± 12
	11	Shell Station, Los Alamos	137 ± 9	140 ± 10	174 ± 9
	12	Royal Crest Trailer Court, Los Alamos	127 ± 11	133 ± 13	117 ± 12
	13	White Rock	118 ± 9	124 ± 10	113 ± 11
	14	Pajarito Acres, White Rock	127 ± 11	122 ± 14	126 ± 12
	15	Bandelier National Monument Lookout Station	131 ± 9	143 ± 11	138 ± 9
	16	Pajarito Ski Area	122 ± 12	118 ± 13	120 ± 12
	20	Well PM-1 (SR4 and Truck Rt.)	157 ± 12	148 ± 13	154 ± 12
	41	McDonald's Restaurant, Los Alamos	134 ± 9	128 ± 10	121 ± 9
	42	Los Alamos Airport-South	125 ± 12	123 ± 13	116 ± 12
	43	East Gate Business Park, Los Alamos	126 ± 12	114 ± 13	104 ± 12
	44	Big Rock Loop, Los Alamos	142 ± 10	165 ± 13	147 ± 12
	45	Cheyenne Street, Los Alamos	83 ± 9[c]	160 ± 13	139 ± 12
	46	Los Pueblos Street, Los Alamos	156 ± 12	139 ± 13	82 ± 11[b]
	47	Urban Park, Los Alamos	130 ± 11	135 ± 13	82 ± 10[b]
	48	Los Alamos County Landfill	130 ± 12	122 ± 13	116 ± 12
	49	Piñon School, White Rock	132 ± 12	124 ± 13	103 ± 12
	50	White Rock Church of the Nazarene	93 ± 12	101 ± 13	81 ± 12
	51	Bayo Canyon Well, Los Alamos	155 ± 10	103 ± 12	112 ± 13
	55	Monte Rey South[e]	73 ± 8[c]	No Data	No Data
On-Site	17	TA-21 (DP West)	142 ± 11	153 ± 10	139 ± 9
	18	TA-6 (Two Mile Mesa)	128 ± 9	134 ± 10	82 ± 11
	19	TA-53 (LANSCE)	142 ± 9	152 ± 12	142 ± 12
	21	TA-16 (S-Site)	140 ± 12	99 ± 12[b]	129 ± 11
	22	Booster P-2	185 ± 12	144 ± 13	117 ± 12
	23	TA-3 East Gate of SM 43	105 ± 12	132 ± 13	109 ± 12
	24	State Highway 4	135 ± 11	98 ± 11[b]	147 ± 12
	25	TA-49 (Frijoles Mesa)	135 ± 9	119 ± 10	113 ± 9
	26	TA-2 (Omega Stack)	168 ± 12	135 ± 13	121 ± 11
	27	TA-2 (Omega Canyon)	157 ± 12	159 ± 13	201 ± 12
	28	TA-18 (Pajarito Site)	378 ± 13[f]	127 ± 13	128 ± 12
	29	TA-35 (Ten Site A)	128 ± 12	114 ± 13	91 ± 11[b]

Table 4-22. Thermoluminscent Dosimeter (TLD) Measurements of External Radiation 1993–1995 (Cont.)

	TLD Station ID #	Location	1995 Annual Dose (mrem)	1994 Annual Dose (mrem)	1993 Annual Dose (mrem)
On-Site (Cont.)	30	TA-35 (Ten Site B)	98 ± 11[b]	140 ± 13	119 ± 12
	31	TA-59 (Occupational Health Lab)	128 ± 12	138 ± 13	119 ± 9
	32	TA-3-16 (Van de Graaff)	137 ± 12	145 ± 13	123 ± 12
	33	TA-3-316 (Ion Beam Bldg.)	118 ± 12	142 ± 13	130 ± 12
	34	TA-3-440 (CAS)	104 ± 11[b]	129 ± 13	110 ± 12
	35	TA-3-420 (CMR Bldg. West Fence)	123 ± 12	115 ± 13	109 ± 12
	36	TA-3-102 (Shop)	131 ± 12	119 ± 13	116 ± 12
	37	TA-72 (Pistol Range)	151 ± 12	146 ± 13	135 ± 12
	38	TA-55 (Plutonium Facility South)	107 ± 11[b]	133 ± 13	143 ± 12
	39	TA-55 (Plutonium Facility West)	160 ± 12	140 ± 14	107 ± 10
	40	TA-55 (Plutonium Facility North)	119 ± 11	135 ± 13	150 ± 12

[a] The uncertainty of each measurement is the propagated error of the quarterly measurements.
[b] Annual doses is the sum of three quarters.
[c] Annual dose is the sum of two quarters.
[d] Data only available for one quarter.
[e] New station placed into operation quarter 3, 1995.
[f] Operational measurements from quarter 2 were included in annual dose and does not reflect potential public dose due to controlled access.

Table 4-23. Waste Disposal Area Measured Dose

		Annual Dose (mrem)					
Waste Disposal Area	Number of TLD Locations	1995 Maximum	1995 Minimum	1995 Mean	1995 Uncertainty[a]	1994 Mean	1994 Uncertainty[a]
TA-21, Area A	5	140	124	133	11	129	13
TA-21, Area B	14	171	140	153	11	135	13
TA-50, Area C	10	129[b]	108[b]	118[b]	11	113	13
TA-33, Area E	4	154	139	147	11	139	13
TA-6, Area F	4	77[c]	68[c]	72[c]	9	N/A[d]	—
TA-54, Area G	25	199	144	161	12	160	13
TA-21, Area T	7	273	132	159	12	159	14
TA-21, Area U	4	137	117	128	11	131	14
TA-21, Area V	4	142	129	134	11	105	12
TA-35, Area W	3	145	111	125	11	110	13
TA-49, Area AB	10	147	128	141	12	126	13

[a] Uncertainty is the propagated error of the quarterly measurements.
[b] Annual Doses for only three quarters, second quarter data not available due to equipment malfunction.
[c] Only monitored 3rd & 4th quarter because of geophysical study.
[d] N/A = not available.

Table 4-24. 1995 Precipitation (in.)

	North Community	TA-16	TA-6	TA-49	TA-53	TA-54	TA-74
January	1.00	1.41	1.34	1.22	1.11	0.80	0.89
February	1.05	1.26	1.01	0.85	0.79	0.49	0.55
March	1.05	1.40	1.11	0.93	0.74	0.47	0.36
April	2.13	1.91	1.82	1.44	1.63	1.29	1.42
May	2.08	1.97	2.68	2.64	2.33	1.61	1.66
June	2.56	2.92	1.67	1.69	1.46	1.10	0.96
July	1.85	1.28	1.28	0.95	1.32	0.73	0.67
August	4.83	7.10	3.53	3.57	2.26	3.21	1.57
September	1.56	2.78	2.36	2.11	2.64	2.72	2.24
October	0.00	0.00	0.00	0.00	0.00	0.00	0.00
November	0.38	0.47	0.35	0.19	0.27	0.10	0.17
December	0.66	0.78	0.61	0.44	0.44	0.27	0.33
TOTAL	19.15	23.28	17.76	16.03	14.99	12.79	10.82

Table 4-25. Estimated Concentrations of Toxic Elements Released by Dynamic Experiments

Element	Total Usage (kg)	Fraction Released (%)	Annual Concentration (1,500 m)[a]	Average ($\mu g/m^3$) (3,800 m)[b]	Applicable Standard ($\mu g/m^3$)
Beryllium (1994)[c]	4.4	2	3.8×10^{-6}	1.3×10^{-6}	0.01[d]
Lead (1994)[c]	11.8	100[e]	5.0×10^{-4}	1.7×10^{-4}	1.5[f]
Heavy Metals (1994)[g]	5,769	100[e]	2.4×10^{-1}	8.2×10^{-2}	10[d]
Heavy Metals (1995)[g]	3,345	100[e]	1.4×10^{-1}	4.8×10^{-2}	10[d]

[a] Distance downwind to nearest public access point.
[b] Distance downwind to nearest off-site receptor.
[c] No usage was reported for 1995.
[d] Standard for 30-day average, NM ACQR 201.
[e] No data is available; estimate was done assuming that a worst-case percentage was released into the air.
[f] Standard for 3-month average (40 CFR 50.12).
[g] Although lead is a heavy metal, it is listed separately because there is an air standard applicable to lead.

Table 4-26. Emissions by Source in 1995 (MMCF)

Source	PM	CO	NO_X	SO_X	VOC
TA-3 Power Plant	1.4	11.18	45.55	.17	.39
TA-16 Power Plant	2.2	5.63	22.51	.1	.45
TA-21 Power Plant	.46	1.17	4.67	.02	.09
Asphalt Plant	.13	.65	.05	.01	.03
Total	4.19	18.63	72.78	0.3	0.96

[a]MMCF: million cubic feet.

Table 4-27. Nonpoint Emissions from LANSCE

Year	Emissions (Ci)	Off-Site Dose (mrem)
1993	1420	1.0
1994	1000	0.8
1995	720	0.5

Table 4-28. 1995 Airborne Emmission From TA-21

Radionuclide	Stack Emissions (μCi)	Upper-bound Estimate for Diffuse Emissions (μCi)
^{234}U	0.5	50
^{235}U	0.009	5
^{239}Pu	0.2	30
^{241}Am	0.007	10

F. Figures

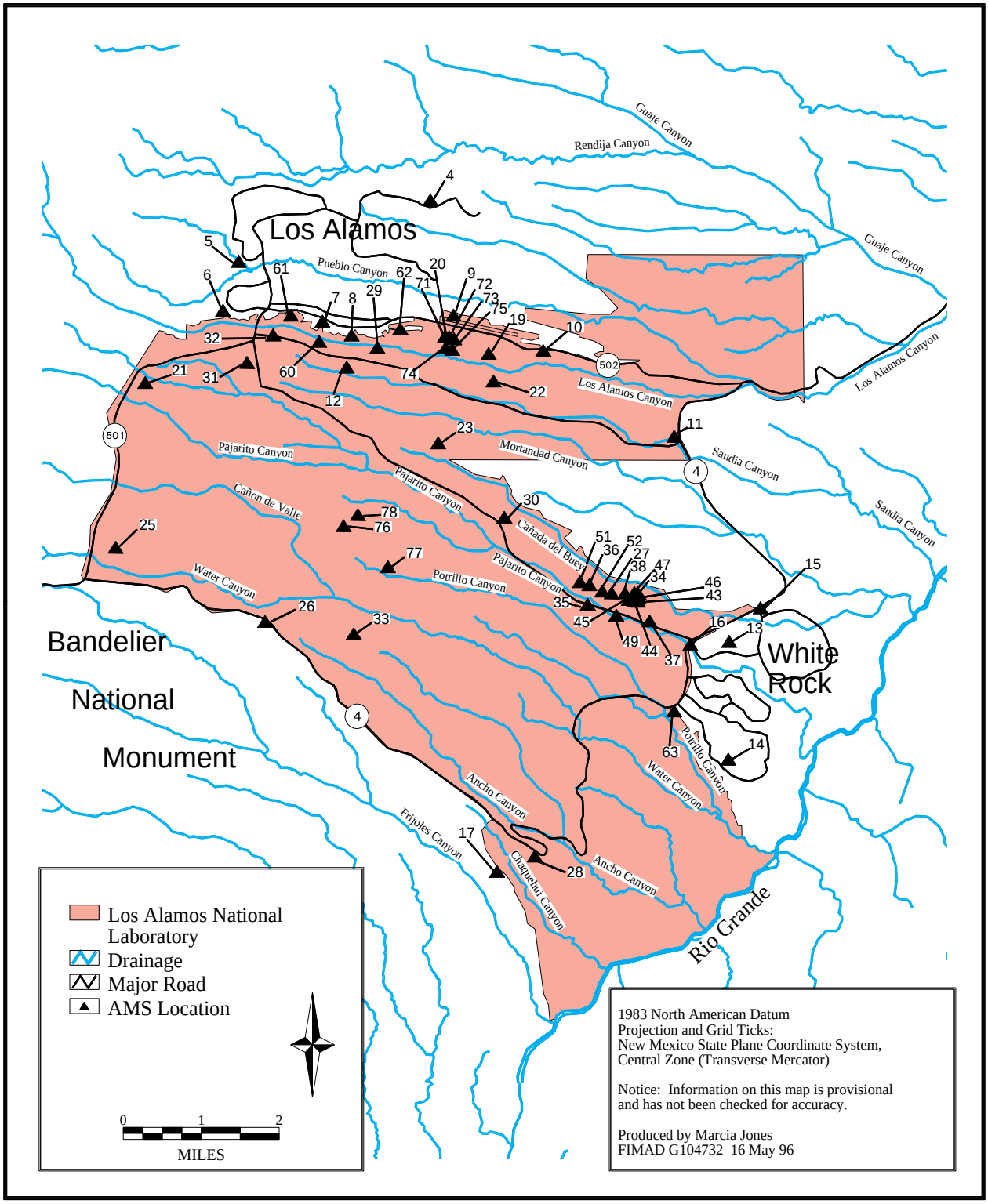

Figure 4-1. Off-site perimeter and on-site Laboratory AIRNET locations (does not show off-site regional stations).

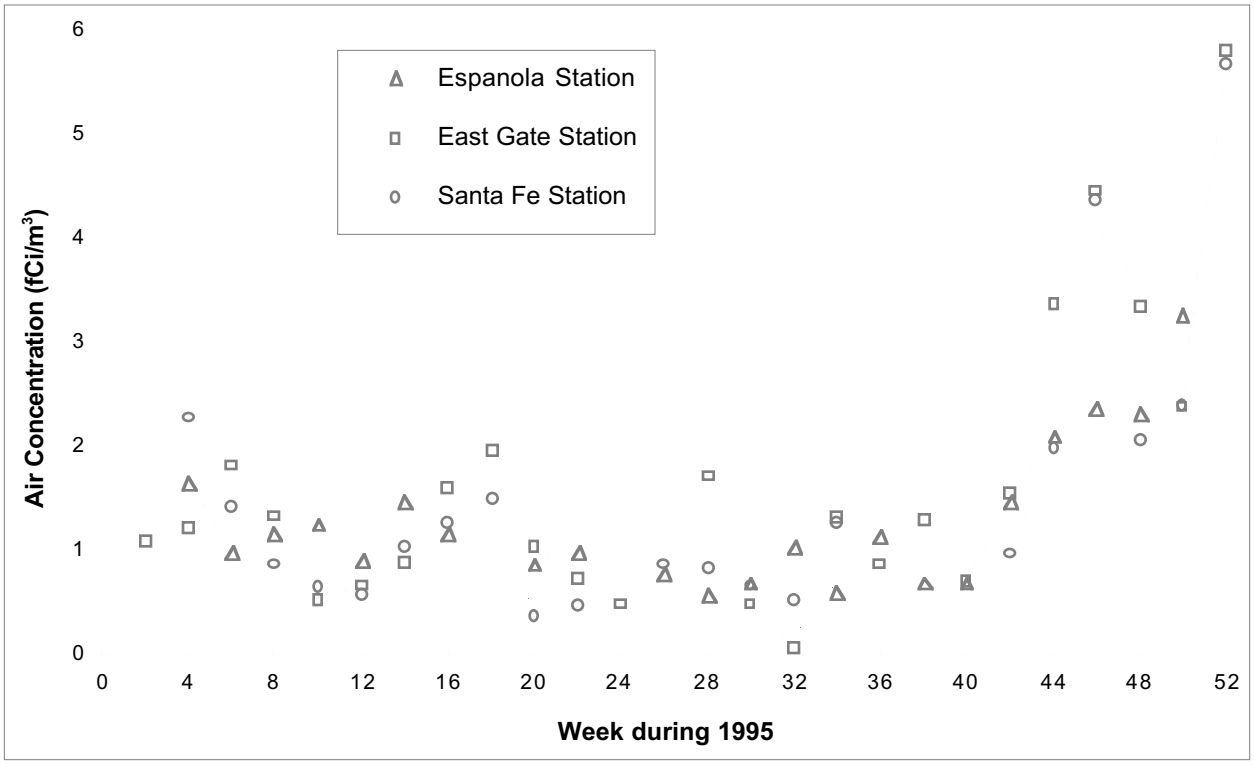

Figure 4-2. Gross alpha activity concentrations in air at two regional and one perimeter station.

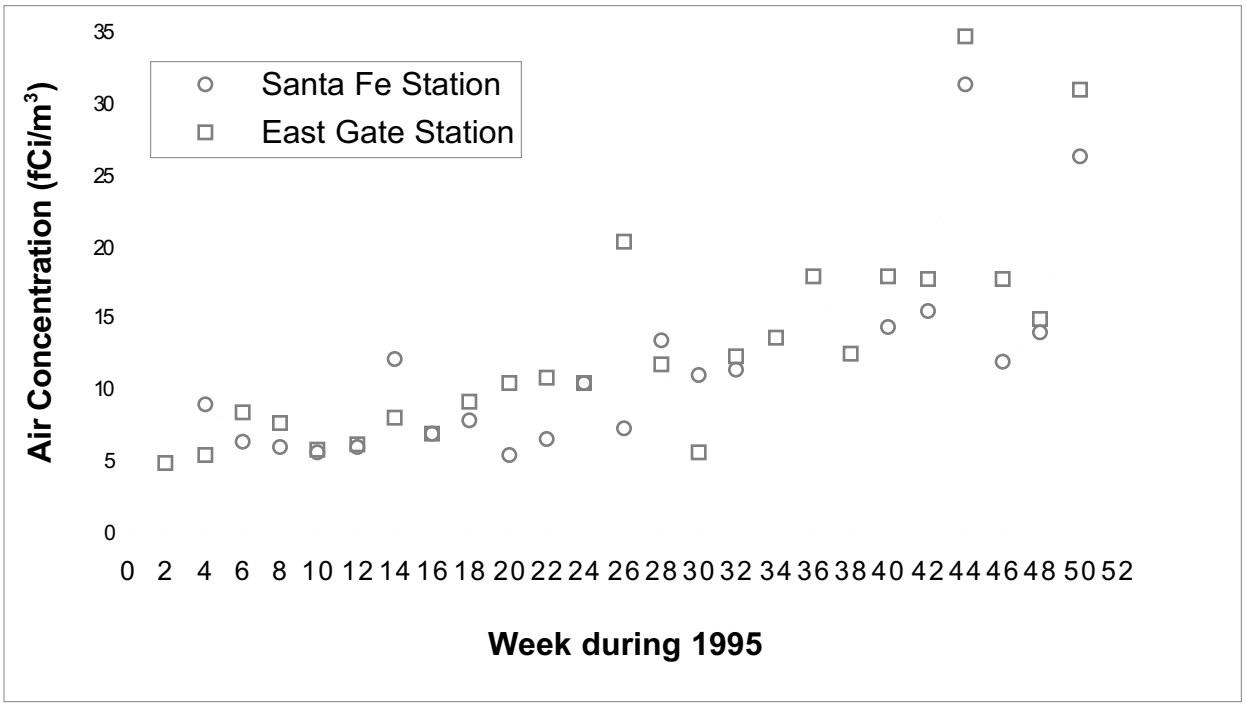

Figure 4-3. Gross beta activity concentrations in air at one regional and one perimeter station.

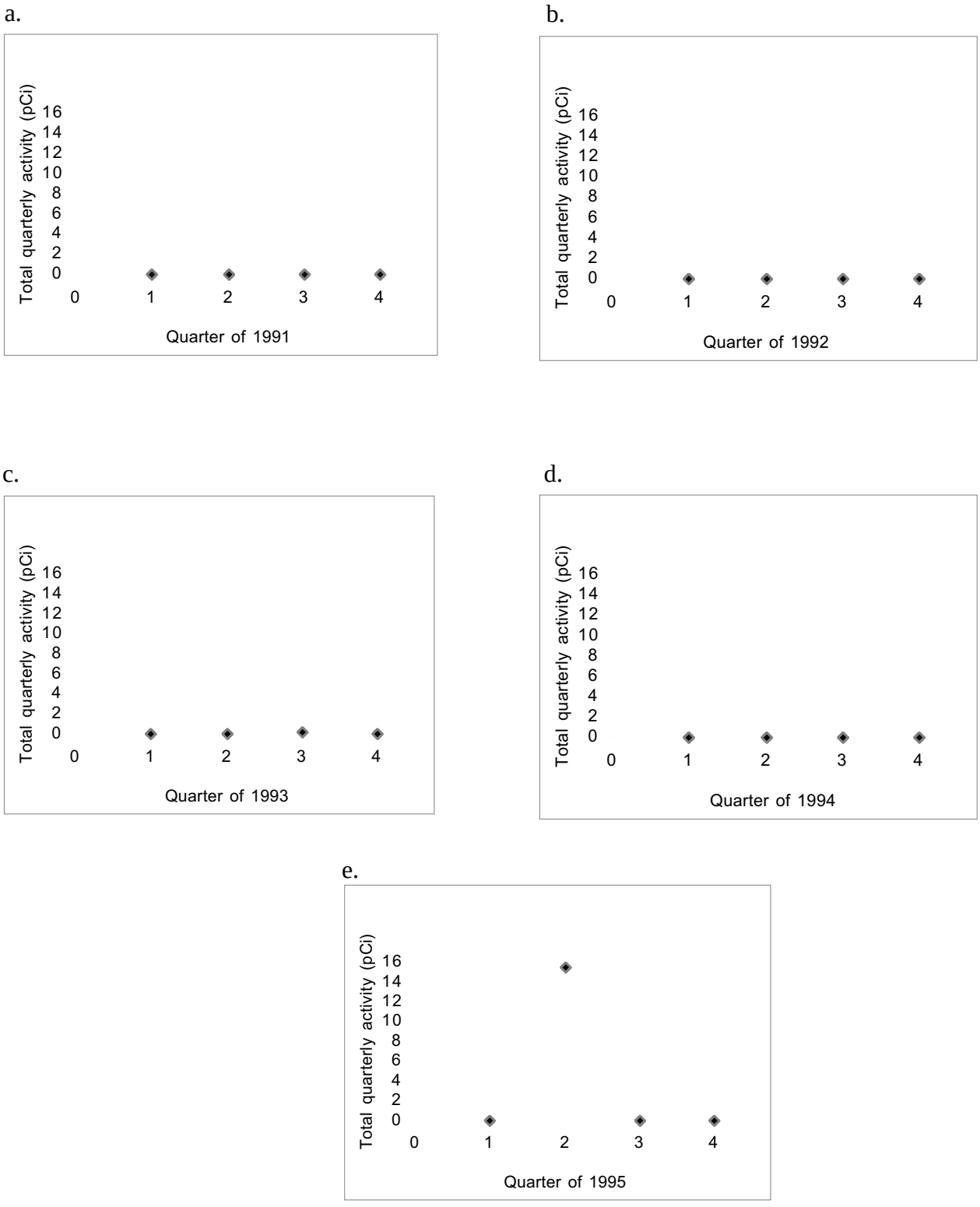

Figure 4-4. Comparison for 1991–1995 of plutonium-239 in samples from Española AIRNET.

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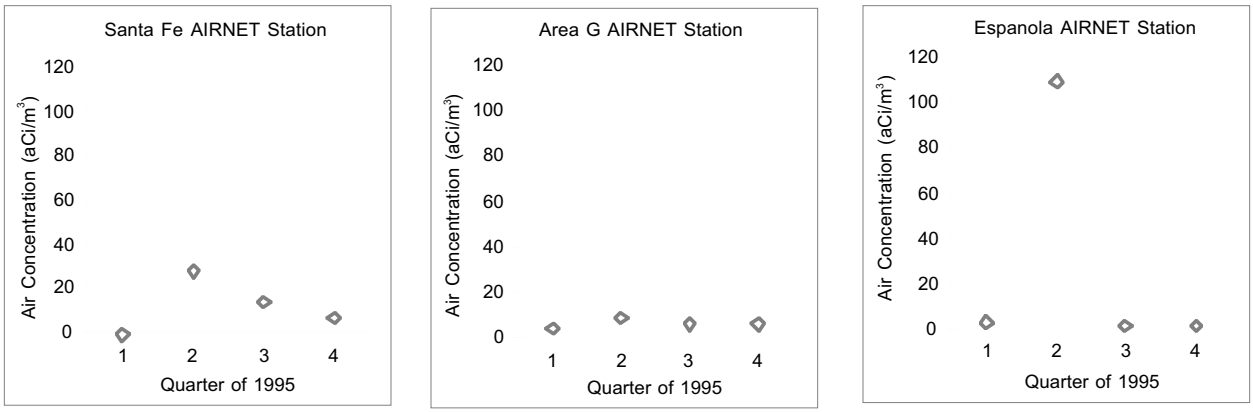
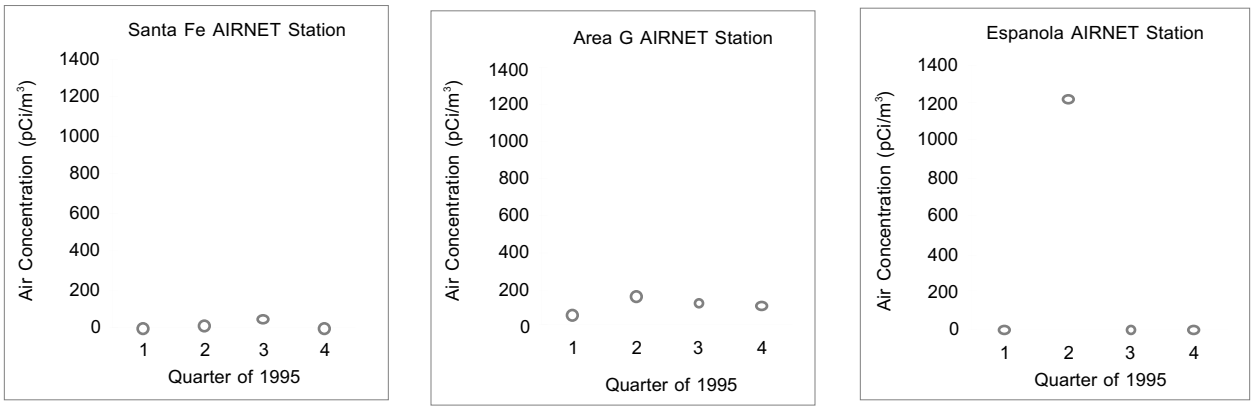
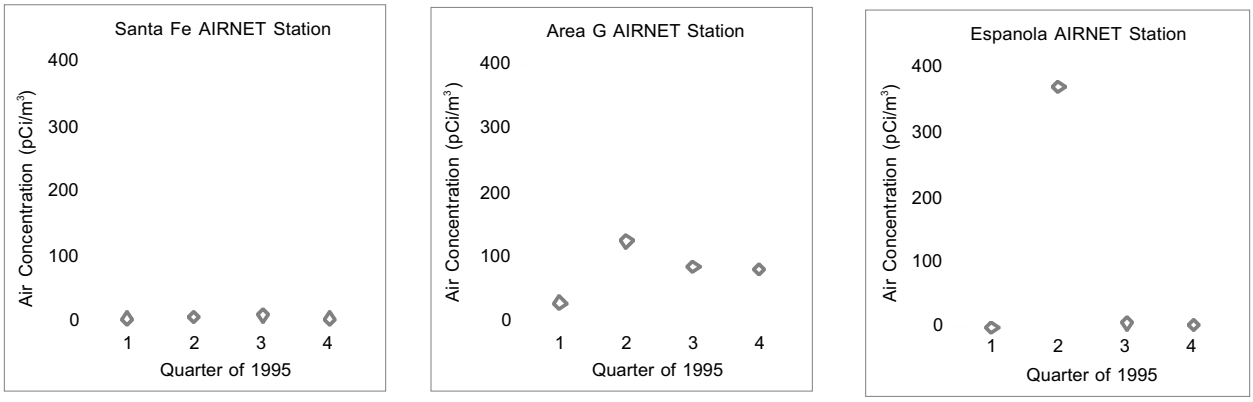
Note: For an explanation of the data spike shown in graph e. above, refer to Section 4.B.1.c. "Discussion of Validity of Second Quarter Plutonium and Americium Results for Española."



a. Plutonium-238



b. Plutonium-239



c. Americium-241

Figure 4-5. Plutonium-238, plutonium-239, and americium-241 in quarterly samples from three AIRNET stations.

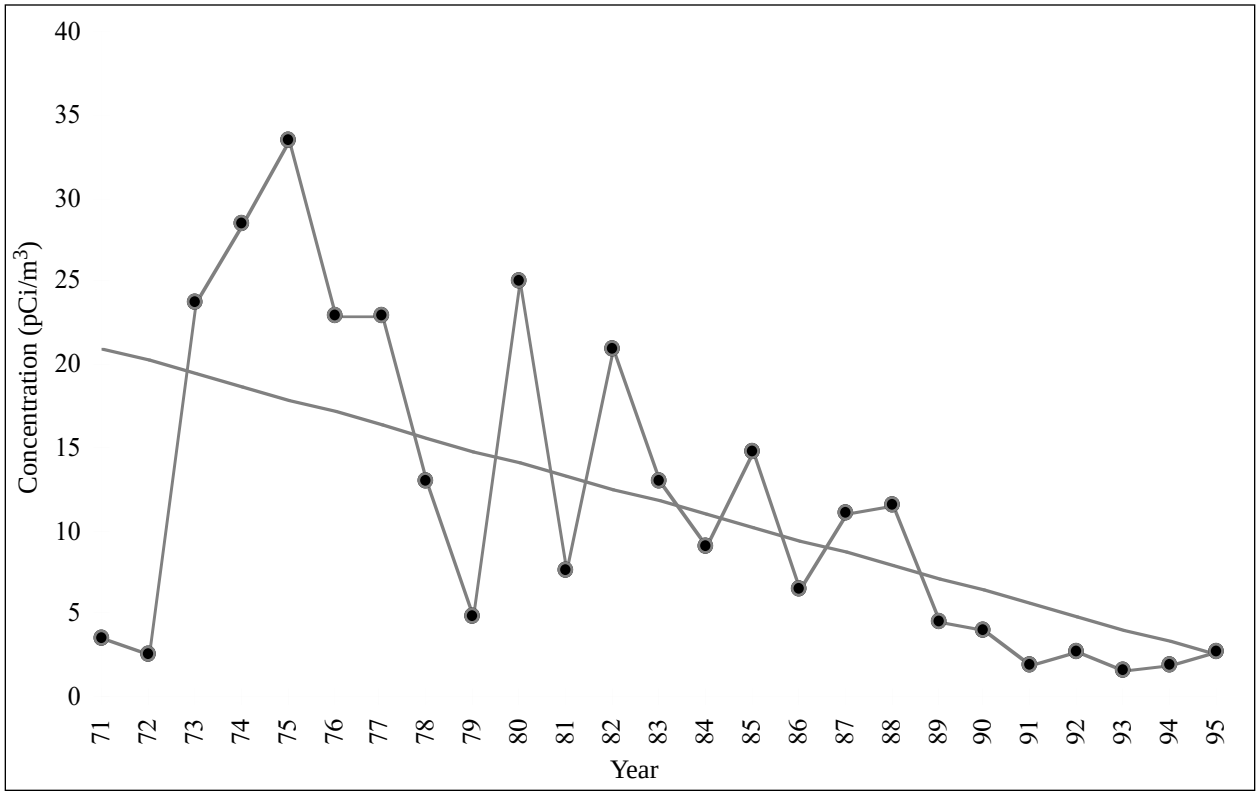


Figure 4-6. Annual mean concentration of tritium at Los Alamos National Laboratory perimeter sampling stations.

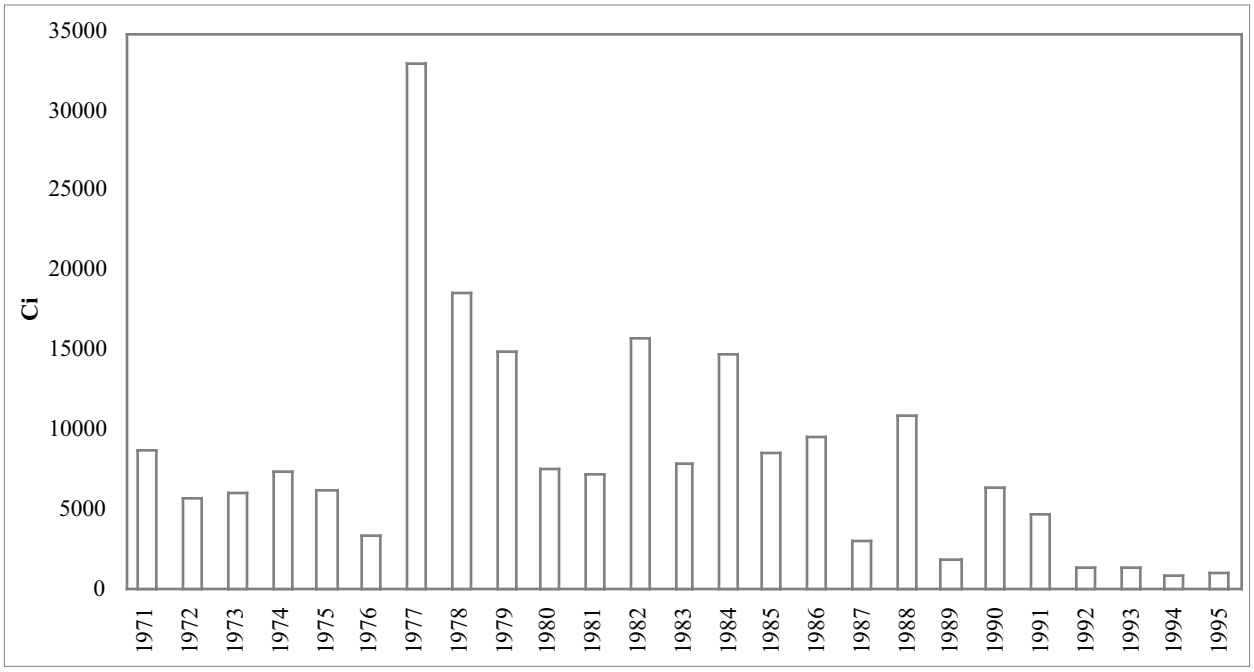


Figure 4-7. Tritium in Los Alamos National Laboratory air effluents from 1971 to 1995.

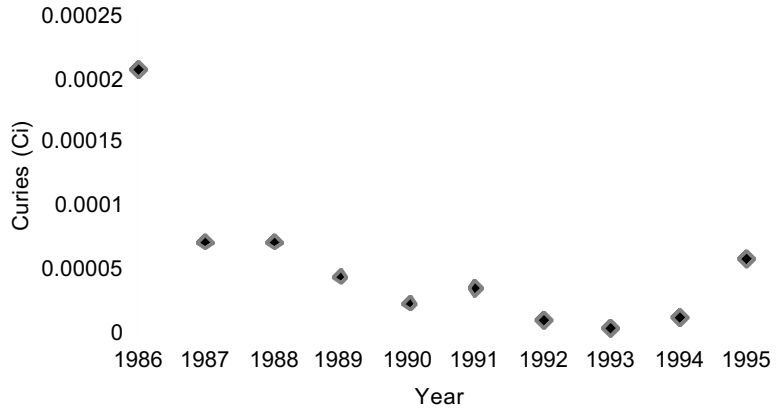


Figure 4-8. Plutonium emissions from sampled Laboratory stacks since 1986.

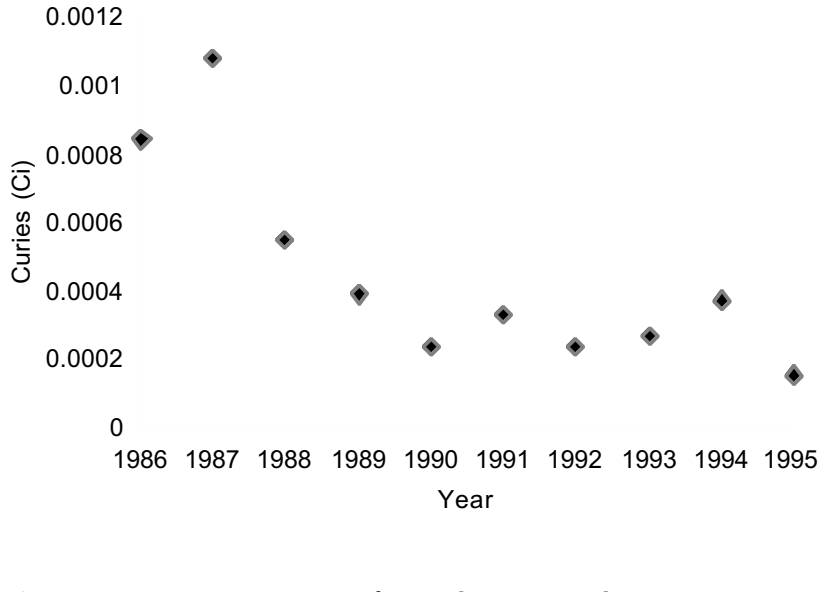


Figure 4-9. Uranium emissions from sampled Laboratory stacks since 1986.

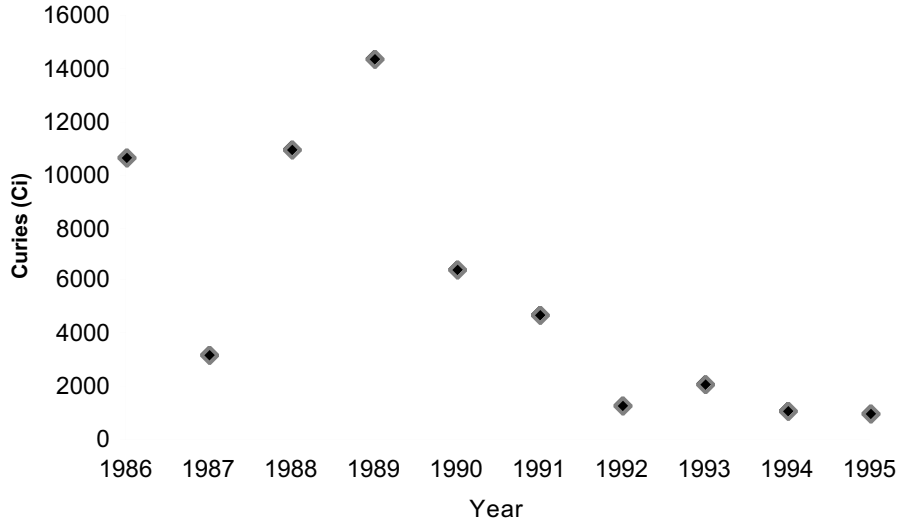


Figure 4-10. Tritium emissions from sampled Laboratory stacks since 1986.

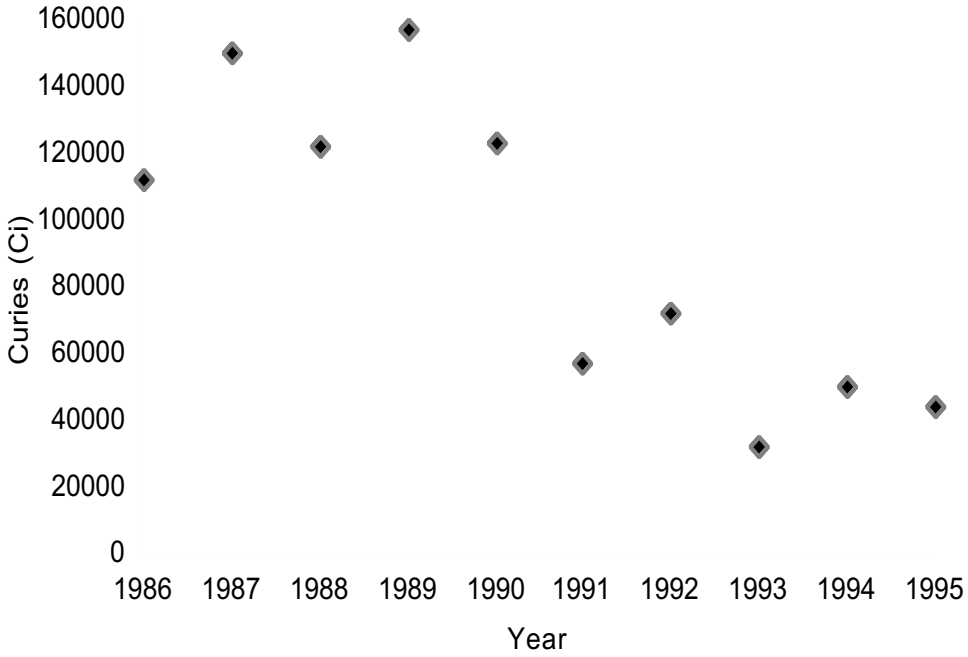


Figure 4-11. Gaseous mixed-action product emissions from sampled Laboratory stacks since 1986.

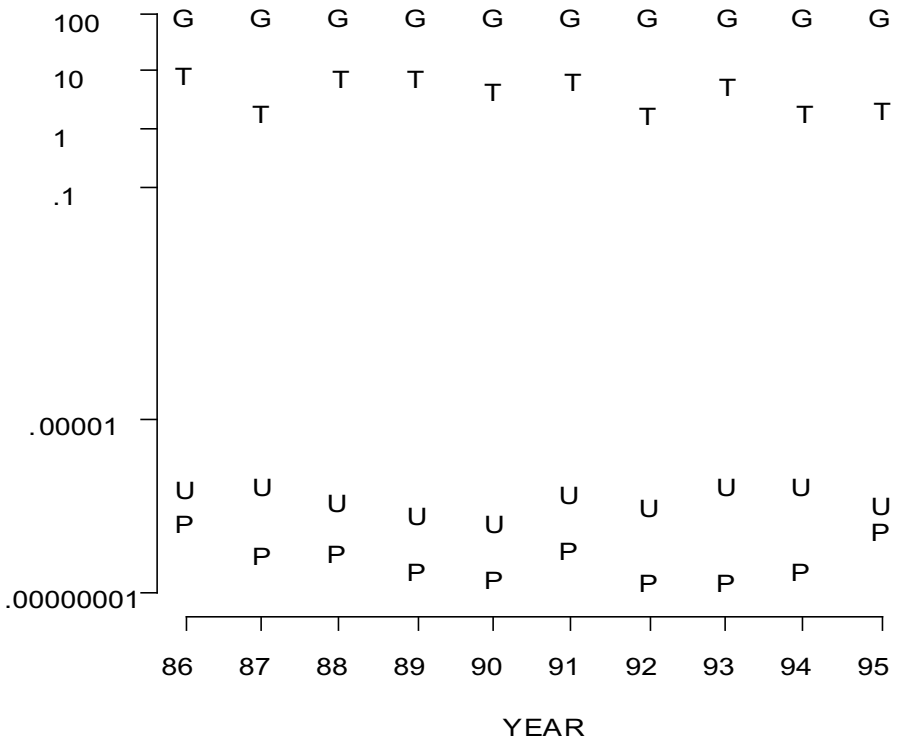


Figure 4-12. Percent of total emissions resulting from plutonium, uranium, tritium, and gaseous/mixed-fission activation products.

Note:
G = gaseous/mixed-fission activation products
T = tritium
U = uranium
P = plutonium

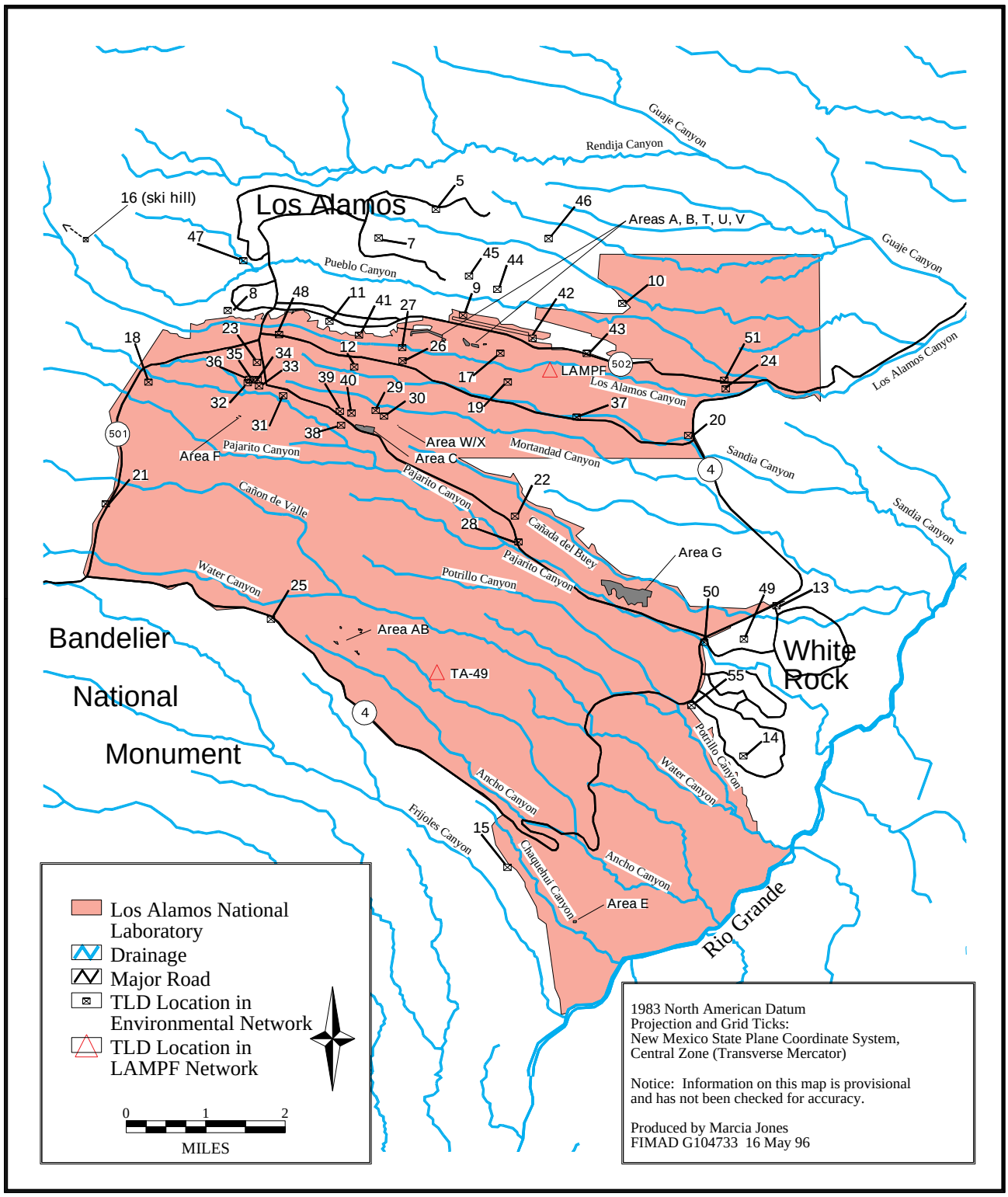


Figure 4-13. Off-site perimeter and on-site Laboratory TLD locations (does not show off-site regional stations).

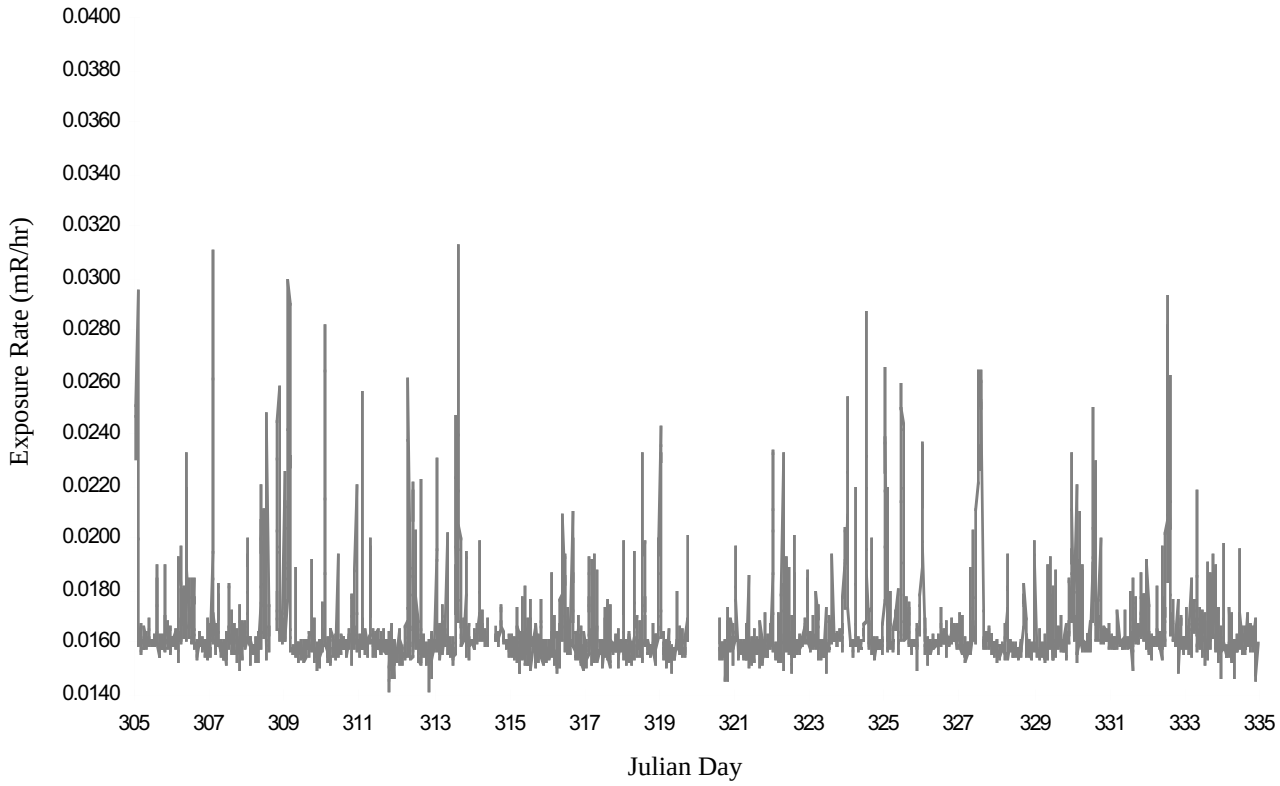


Figure 4-14. Typical TA-53 hourly radiation exposure rate at East Gate with Los Alamos Neutron Scattering Center in operation.

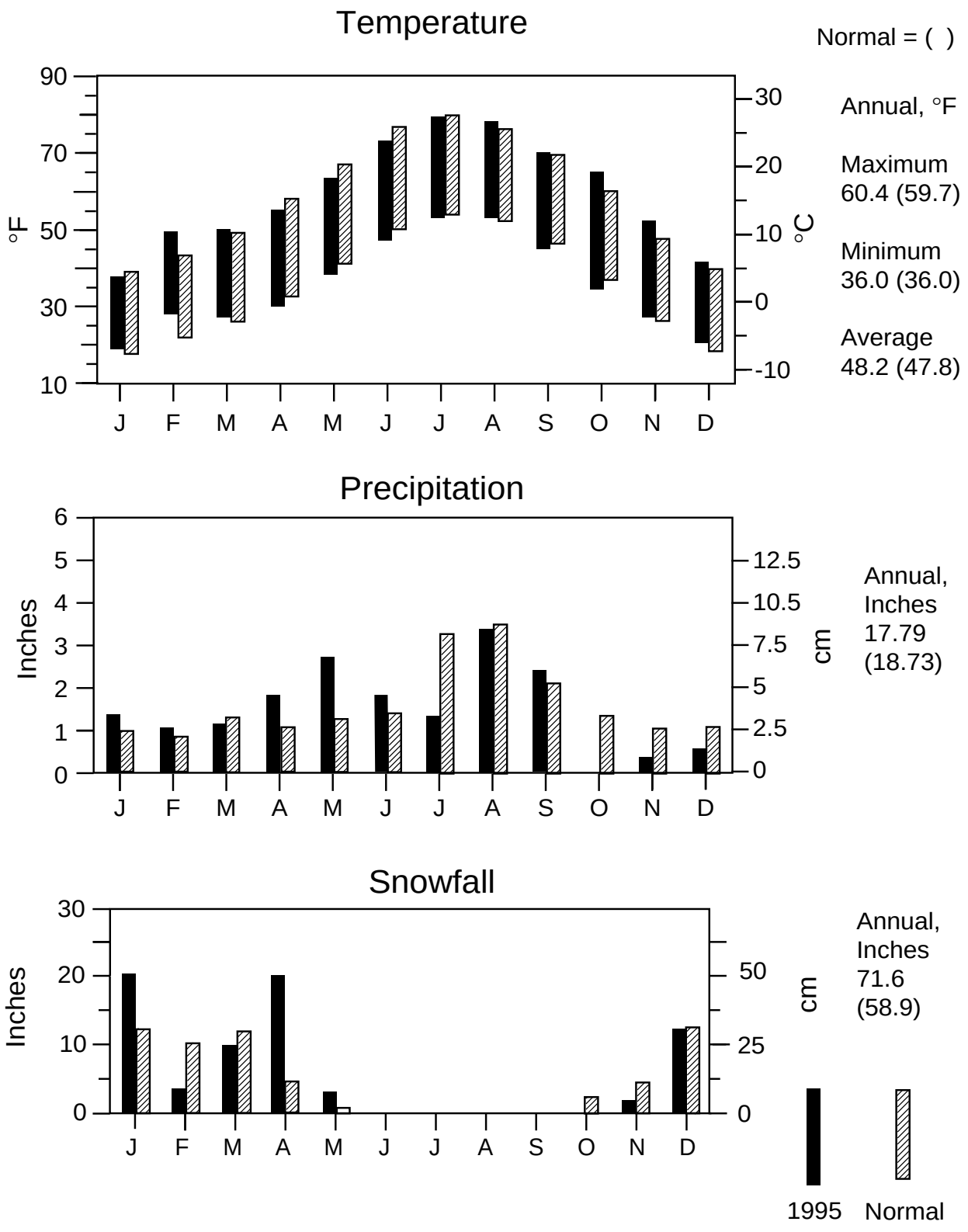


Figure 4-15. 1995 weather summary for Los Alamos.

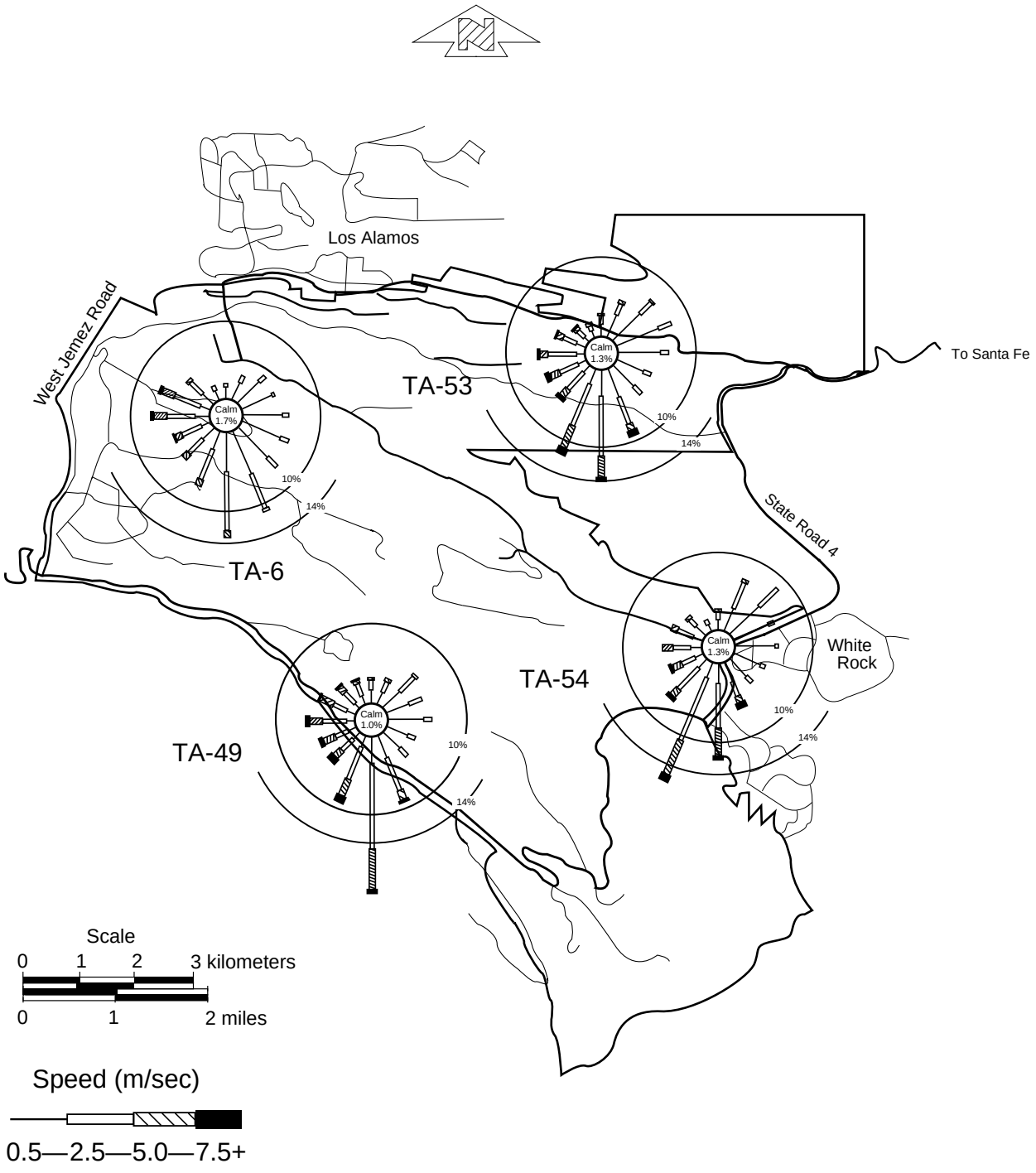


Figure 4-16. Wind roses for daytime winds observed at 11 m (36 ft) at TA-6, TA-49, TA-53, and TA-54.

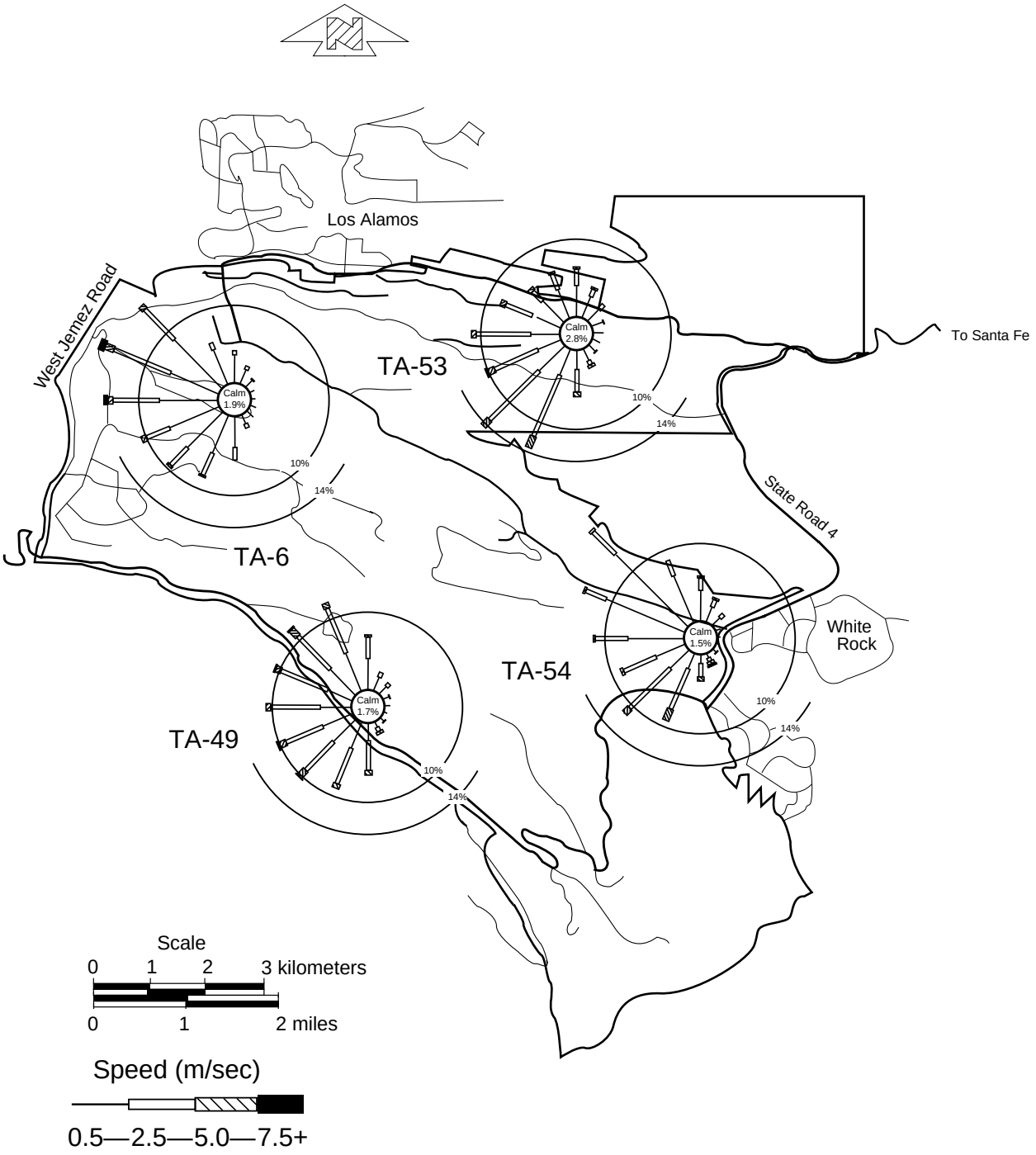


Figure 4-17. Wind roses for nighttime winds observed at 11 m (36 ft) at TA-6, TA-49, TA-53, and TA-54.

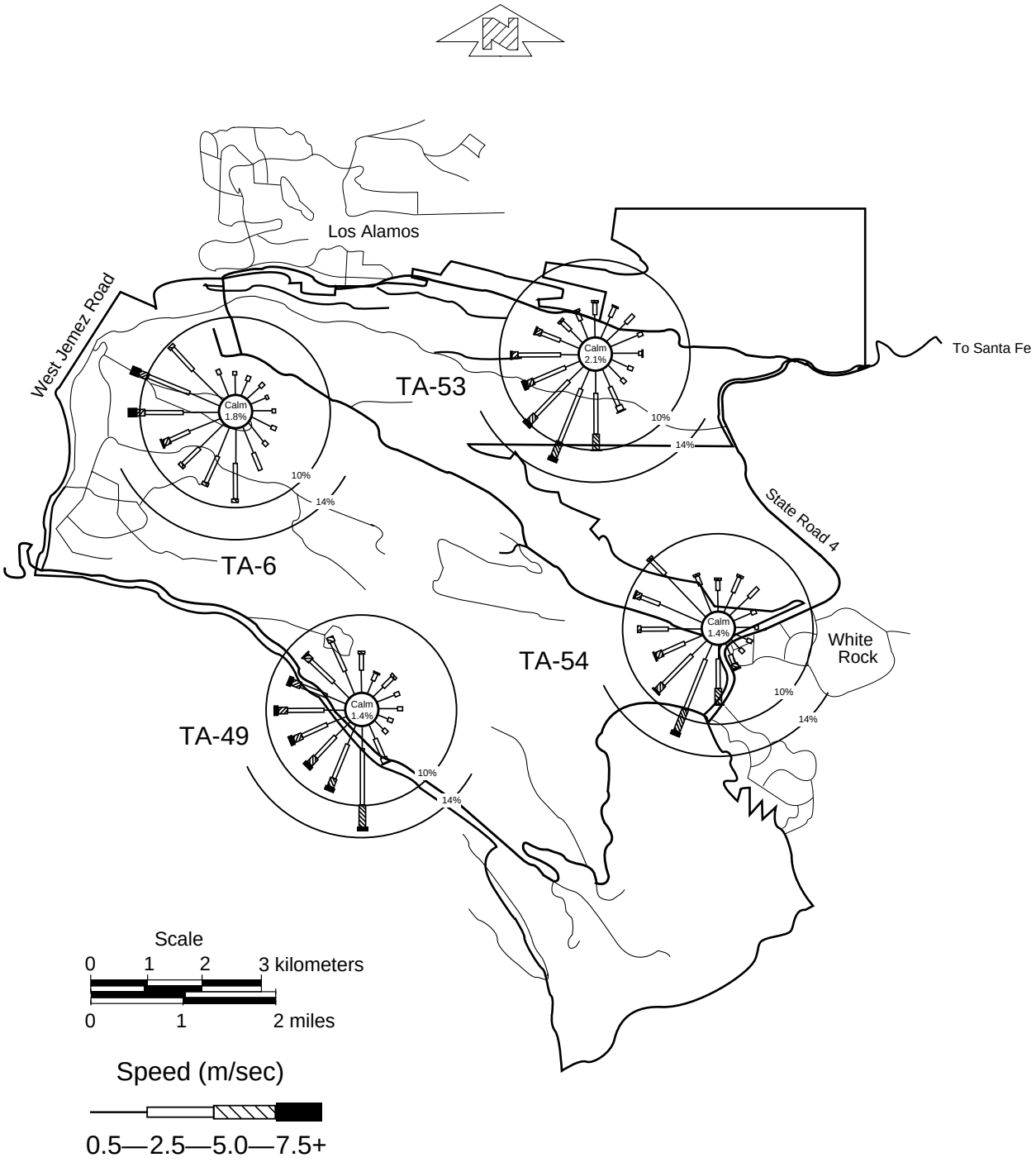


Figure 4-18. Total wind roses for daytime and nighttime winds observed at 11 m (36 ft) at TA-6, TA-49, TA-53, and TA-54.

G. References

AQG 1996: Air Quality Group, "US Department of Energy Report - 1995 LANL Radionuclide Air Emissions," Los Alamos National Laboratory (June 17, 1996).

Bevington 1969: P. R. Bevington, *Data Reduction and Error Analysis for the Physical Sciences* (McGraw-Hill, New York, 1969).

Dahl 1977: D. A. Dahl and L. J. Johnson, "Aerosolized U and Be from LASL Dynamic Experiments," Los Alamos Scientific Laboratory document LA-UR-77-681 (1977).

Dewart 1995: J. Dewart, "Quality Management Plan for the Air Quality Group," Air Quality Group document ESH-17-QMP (November 1995).

DOE 1989: US Department of Energy, "General Design Criteria," US Department of Energy Order 6430.1a (April 1989).

DOE 1991a: US Department of Energy, "Quality Assurance," US Department of Energy Order 5700.6C, II (August 1991).

DOE 1991b: US Department of Energy, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," US Department of Energy report DOE/EH-0173T (January 1991).

Durrer 1995: R. Durrer, "QA Project Plan for Thermoluminescent Dosimeter Project," Air Quality Group document ESH-17-TLDNET (November 1995).

EARE 1995a: Environmental Assessments and Resource Evaluations Group, "Environmental Surveillance at Los Alamos during 1993," Los Alamos National Laboratory report LA-12973-ENV (October 1995).

EARE 1995b: Environmental Assessments and Resource Evaluations Group, "Environmental Monitoring Plan," Los Alamos National Laboratory document LA-UR-95-3770-ENV (1995).

EG 1996: Ecology Group, "Environmental Surveillance at Los Alamos during 1994," Los Alamos National Laboratory report LA-13047-ENV (July 1996).

EPA 1989: US Environmental Protection Agency, "National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Title 40, Part 61, Subpart H (December 15, 1989).

EPA 1991: US Environmental Protection Agency, "Guidelines Establishing Test Procedures for Analysis of Pollutants," *Code of Federal Regulations*, Title 40, Part 136 (1991).

EPA 1992: US Environmental Protection Agency, "Ambient Air Quality Surveillance," *Code of Federal Regulations*, Title 40, Part 58, AP-E (July 1992).

EPA 1994a: US Environmental Protection Agency, "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations," US EPA QA/R-5, Interim Final (January 1994).

EPA 1994b: US Environmental Protection Agency, "Guidance for the Data Quality Objectives Process," US EPA QA/G-4, Interim Final (September 1994).

EPA 1995: US Environmental Protection Agency, "Compilation of Air Pollutant Emission Factors," Vol. 1, 4th Edition, (Updates through Supplement F, 1995).

ESG 1978: Environmental Surveillance Group, "Environmental Surveillance at Los Alamos During 1977," Los Alamos Scientific Laboratory report LA-7263-MS (April 1978).

Fuehne 1996: D. P. Fuehne, "Effect of Engineering Controls on Radiation Air Emissions from the Los Alamos Neutron Science Center," Los Alamos National Laboratory document LA-UR-96-1469 (May 1996).

ICRP 1970: International Commission on Radiological Protection, "Protection Against Ionizing Radiation from External Sources," International Commission on Radiological Protection report No. 15 (Pergamon Press, New York, 1970).

Kathern 1984: R. L. Kathern, *Radioactivity in the Environment* (Harwood Academic Publishers, New York, 1984).

Lochamy 1995: J. Lochamy, "QA Project Plan for Unmonitored Point Source Radioactive Air Emissions," Air Quality Group document ESH-17-UMS (June 1995).

Lochamy 1996: J. Lochamy, "QA Project Plan for the Los Alamos Neutron Science Center Radioactive Air Emissions Monitoring," Air Quality Group document ESH-17-UMS (May 1996).

Merkey 1995a: J. Merkey, "QA Project Plan for Radioactive Particulate and Vapor Stack Emissions Monitoring," Air Quality Group document ESH-17-PARTIC (December 1995).

Merkey 1995b: J. Merkey, "QA Project Plan for Tritium Stack Emissions Monitoring," Air Quality Group document ESH-17-TRIT (December 1995).

Miller 1995: S. Miller, "Elevated Release at TA-3-29, FE-24," Los Alamos National Laboratory memorandum (January 27, 1995).

Morgan 1995: T. Morgan, "QA Project Plan for Radiological Air Sampling Network," Air Quality Group document ESH-17-AIRNET (December 1995).

Natrella 1963: M. G. Natrella, "Experimental Statistics," in *National Bureau of Standards Handbook 91* (National Bureau of Standards, Washington, DC, 1963).

NCRP 1975: National Council on Radiation Protection and Measurements, "Natural Background Radiation in the United States," National Council on Radiation Protection and Measurements report 45 (November 1975).

NCRP 1987: National Council on Radiation Protection and Measurements, "Ionizing Radiation Exposure of the Population of the United States," National Council on Radiation Protection and Measurements report 93 (September 1987).

Olsen 1993: W. Olsen, "Program Plan for Meteorological Monitoring," Environmental Surveillance Group document (March 1993).

Oviatt 1995: H. S. Oviatt, "Los Alamos National Laboratory Meteorological Audit Report - 1995," TRC Environmental Corporation, Project No. 01115 (September 1995).

Shapiro 1990: J. Shapiro, "Radiation Protection," Third Edition, Harvard University Press, Cambridge, MA (1990).

Stone 1995: G. Stone, D. Holt, J. Baars, M. Coronado, S. Kreiner, W. Olsen, "Meteorological Monitoring at Los Alamos," Los Alamos National Laboratory document LA-UR-95-3697 (October 1995).