Los Alamos
NATIONAL LABORATORY

Los Alamos, New Mexico 87545

A US Department of Energy Laboratory

Environmental Surveillance at Los Alamos during 1997

LA-13487-ENV

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NATIONAL LABORATORY

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The following four Los Alamos National Laboratory groups in the Environmental, Safety, and Health (ESH) Division perform enviromental surveillance, ensure environmental compliance, and provide environmental data for this report:

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The beginning of each chapter credits the primary authors.

Previous reports in this series are LA-12973-ENV, LA-13047-ENV, LA-13210-ENV, and LA-13343-ENV.

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Environmental Surveillance at Los Alamos reports are prepared annually by the Los Alamos National Laboratory (the Laboratory), Environment, Safety, and Health Division, as required by US Department of Energy Order 5400.1, *General Environmental Protection Program*, and US Department of Energy Order 231.1, *Environment, Safety, and Health Reporting*.

These annual reports summarize environmental data that comply with applicable federal, state, and local environmental laws and regulations, executive orders, and departmental policies. Additional data, beyond the minimum required, are 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.

Chapter 1 provides an overview of the Laboratory's major environmental programs. Chapter 2 reports the Laboratory's compliance status for 1997. Chapter 3 provides a summary of the maximum radiological dose a member of the public could have potentially received from Laboratory operations. The environmental data are organized by environmental media (Chapter 4, air; Chapter 5, water; and Chapter 6, soils and foodstuffs) in a format to meet the needs of a general and scientific audience. A glossary and a list of acronyms and abbreviations are in the back of the report. 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 booklet, *Overview of Environmental Surveillance during 1997* that briefly explains important concepts, such as radiation, and provides a summary of the environmental programs, monitoring results, and regulatory compliance.

Inquiries or comments regarding these annual reports may be directed to

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http://lib-www.lanl.gov/pubs/la-13487.htm

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1. Introduction

primary author:

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Abstract

This report presents environmental data that characterize environmental performance and addresses compliance with environmental standards and requirements at Los Alamos National Laboratory (LANL or the Laboratory) during 1997. The Laboratory routinely monitors for radiation and for radioactive and nonradioactive materials at Laboratory sites, as well as at sites in the surrounding region. LANL uses the monitoring results to determine compliance with appropriate standards and to identify potentially undesirable trends. Data were collected in 1997 to assess external penetrating radiation and concentrations of chemicals and radionuclides in stack emissions, ambient air, surface waters and groundwaters, the drinking water supply, soils and sediments, and foodstuffs. Using comparisons with standards and regulations, 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. Laboratory operations were in compliance with all major environmental regulations.

A. Laboratory Overview

1. Introduction to Los Alamos National Laboratory

In March 1943, a small group of scientists came to Los Alamos 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 is managed by the Regents of the University of California (UC); the contract is administered through the Department of Energy (DOE) Los Alamos Area Office and the Albuquerque Operations Office.

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 National Laboratory is a multiprogram laboratory with the central mission of reducing the global nuclear danger by utilizing five major elements:

- stockpile stewardship activities ensure that the United States has safe, secure, and reliable nuclear weapons;
- stockpile management projects provide capabilities ranging from the dismantlement to the remanufacture of existing nuclear weapons;
- nuclear materials management ensures the availability or safe disposal of plutonium, highly enriched uranium, and tritium;
- effective nonproliferation and counterproliferation technologies help to deter, detect, and respond to the proliferation of weapons of mass destruction; and
- environmental stewardship projects provide for the remediation and reduction of wastes from the nuclear weapons complex.

The Laboratory will continue its role in defense, particularly in nuclear weapons technology, and will increasingly use its multidisciplinary capabilities to solve important civilian problems (including initiatives in the areas of health, national infrastructure, energy, education, and the environment) and perform industrial collaborations (LANL 1997).

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 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe (Figure 1-1). The 43-square mile Laboratory 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. Mesa tops range in elevation from approximately 7,800 feet on the flanks of the Jemez Mountains to about 6,200 feet 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 Appendix C and Figure 1-2). 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.

3. Geology and Hydrology

Most of the finger-like mesas in the Los Alamos area (Figure 1-3) are formed from Bandelier Tuff, which includes ash fall, ash fall pumice, and rhyolite tuff. The tuff is more than 1,000 feet thick in the western part of the plateau and thins to about 260 feet 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.

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 in the central plateau and near the Rio Grande. Chino Mesa basalts interfinger with the conglomerate along the river. These formations overlie the sediments of the Santa Fe Group, which extend across the Rio Grande Valley and are more than 3,300 feet thick.

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.

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.

The main aquifer of the Los Alamos area is the only aquifer in the area capable of serving as a municipal water supply. Water in the main aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande (Purtymun and Johansen 1974). The source of recharge to the aquifer is presently uncertain. 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 et al., 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 11.5-mile reach of the river in White Rock Canyon between Otowi Bridge and the mouth of Rito de los Frijoles receives an estimated 4,300 to 5,500 acre-feet annually from the aquifer.

4. Ecology and Cultural Resources

The Pajarito Plateau is a biologically diverse and archaeologically rich area. The plants and animals found on or near LANL property include approximately 500 plant species, 29 mammal species, 200 bird species, 19 reptile species, 8 amphibian species, and hundreds of insect species. Roughly 20 plant and animal species are designated as a threatened species, an endangered species, or a species of concern at the federal and/or state level.

Approximately 70% of DOE land in Los Alamos County has been surveyed for prehistoric and historic cultural resources, and about 1,400 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 5,800 and 7,100 feet in elevation. Almost three-quarters of all ruins are found on mesa tops.

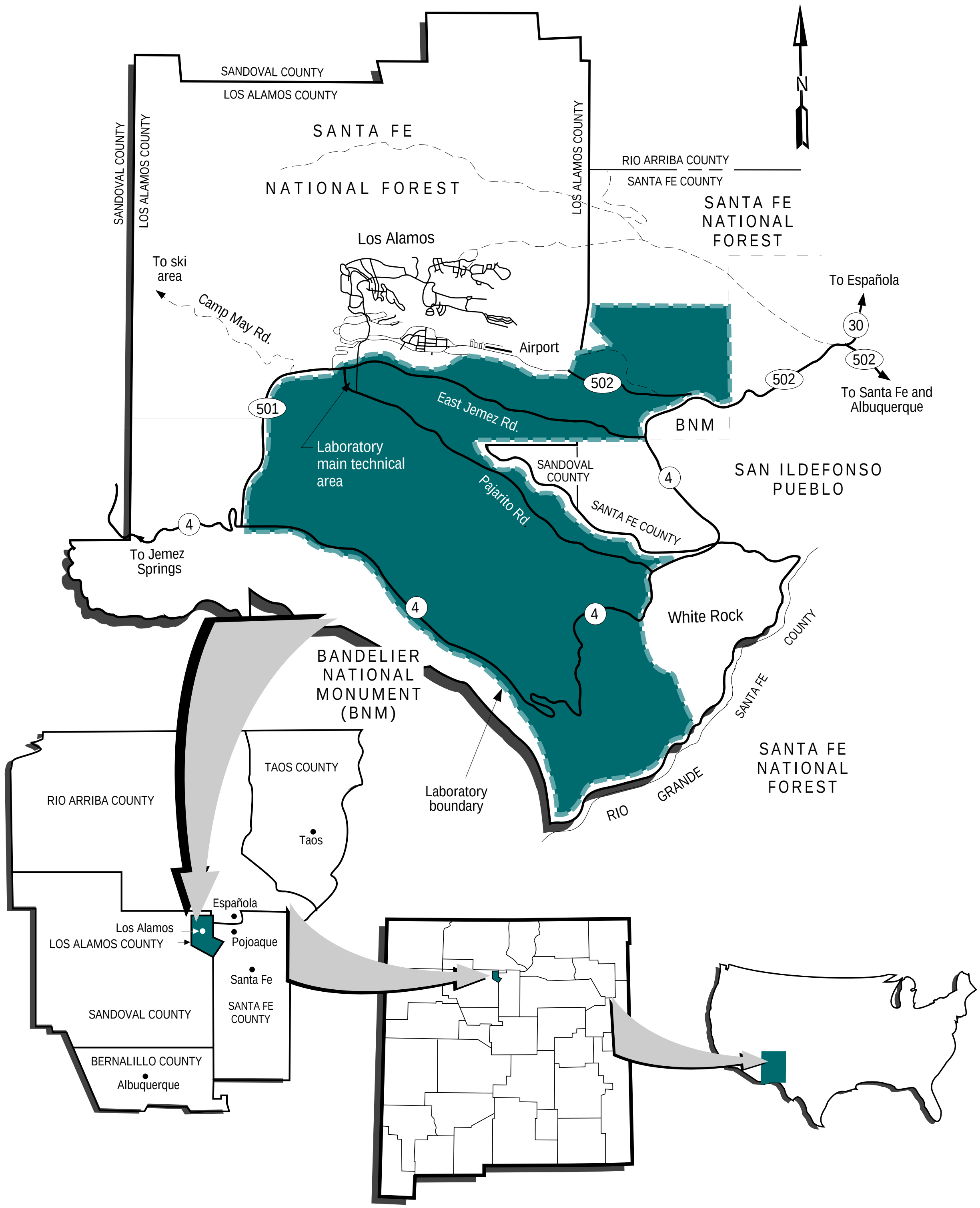


Figure 1-1. Regional location of Los Alamos National Laboratory.

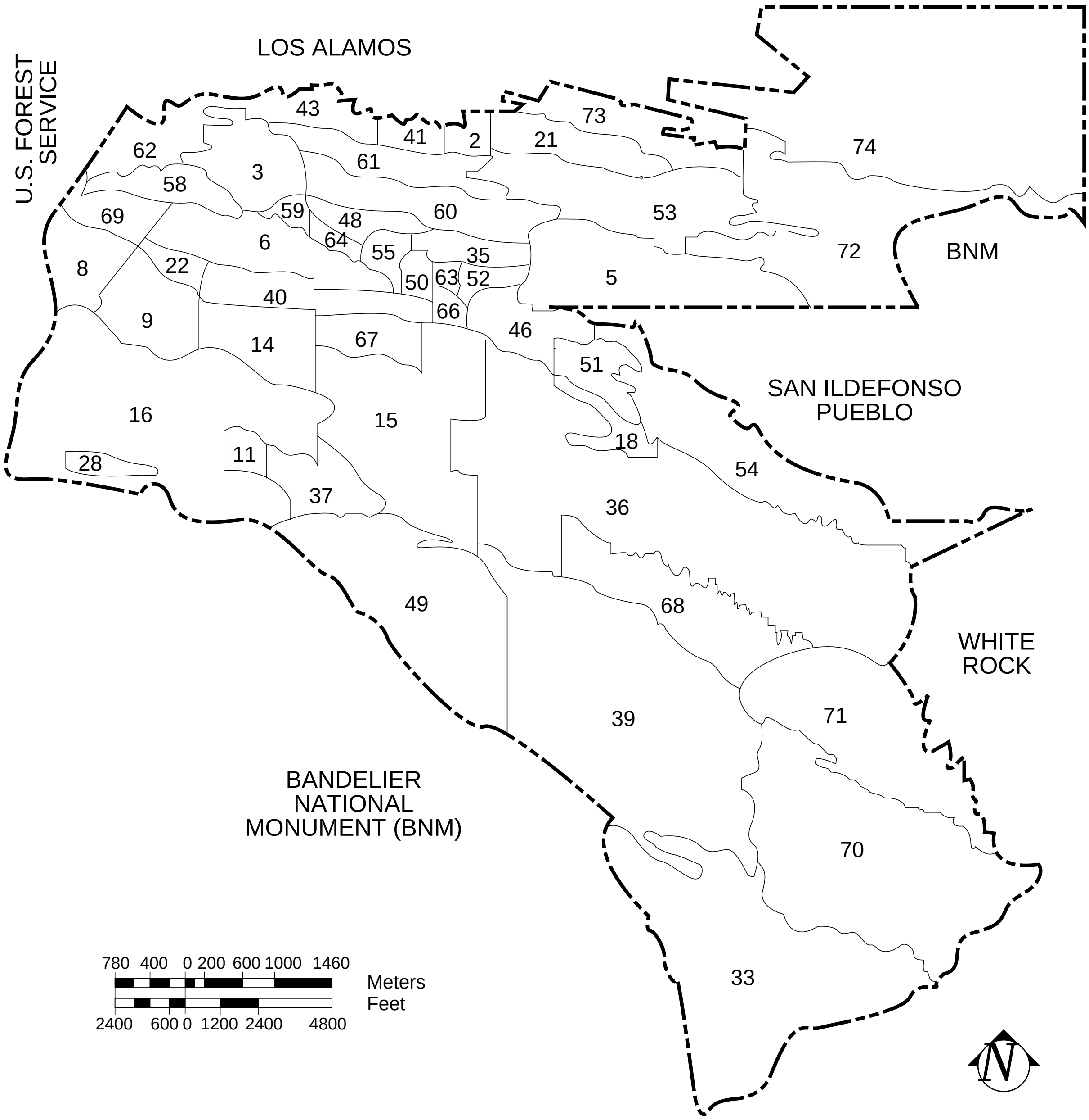
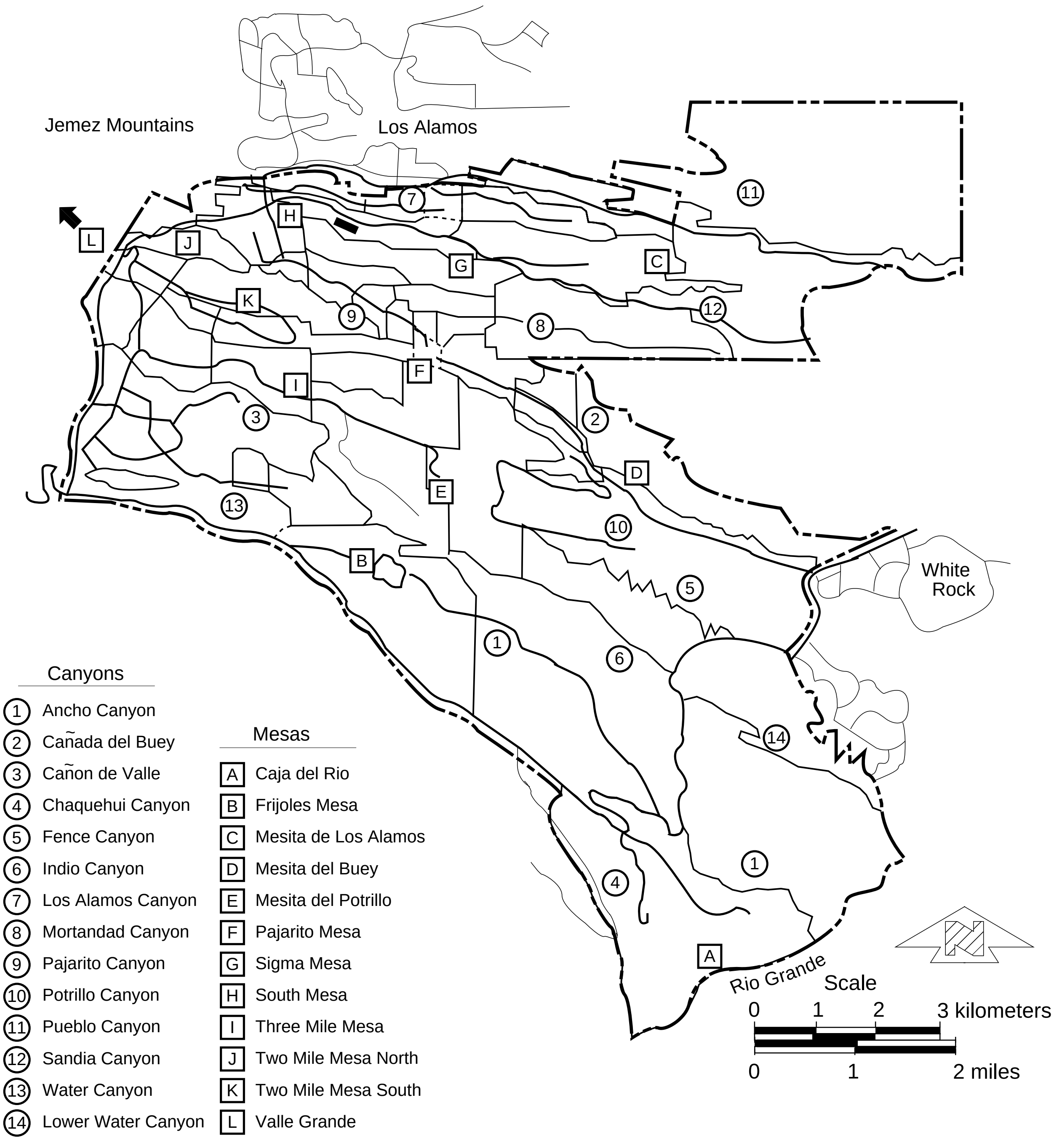


Figure 1-2. Technical areas of Los Alamos National Laboratory in relation to surrounding landholdings.



1990 Los Alamos National Laboratory Site Development Plan

Figure 1-3. Major canyons and mesas.

Approximately 500 buildings and structures are being evaluated for eligibility to be placed on the National Historic Register.

B. Environmental Management Systems

1. Introduction

The Laboratory Director is ultimately responsible for all Laboratory activities, including all environmental protection activities. Technical and administrative responsibility and authority have been delegated to the Environment, Safety, and Health (ESH) Division for environmental monitoring, surveillance, and compliance and to the Environmental Management (EM) Program for environmental restoration and waste management responsibilities.

2. Environmental Protection Program

The ESH Division is in charge of performing environmental monitoring, surveillance, and compliance activities to help ensure that Laboratory operations do not adversely affect public health or the environment. The Laboratory conforms to applicable environmental regulatory requirements and reporting requirements of DOE Orders 5400.1 (DOE 1988), 5400.5 (DOE 1990), and 231.1 (DOE 1995).

The 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 (HWA), as documented in Chapter 2 of this report. 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. ESH Division is responsible for communicating environmental policies to Laboratory employees and for ensuring that appropriate environmental training programs are available. The environmental surveillance program consists of four groups in ESH Division—Air Quality (ESH-17), Water Quality and Hydrology (ESH-18), Hazardous and Solid Waste (ESH-19), and Ecology (ESH-20)—that initiate and promote Laboratory programs for environmental assessment and are responsible for environmental surveillance and regulatory compliance.

Approximately 600 sampling locations are used for routine environmental monitoring. The general location of monitoring stations is presented in maps in this report. For 1997, over 250,000 analyses for chemical and radiochemical constituents were performed on more than 12,000 environmental samples. Samples of air particles and gases, water, soils, sediments, and foodstuffs are routinely collected at the monitoring stations and then analyzed. The results of these analyses help identify impacts of LANL operations on the environment. Additional samples are collected and analyzed to obtain information about particular events, such as major surface water runoff events, nonroutine releases, or special studies. Methods and procedures for acquiring, analyzing, and recording data are presented later in this report in Chapters 2, 3, 4, 5, and 6. Information about environmental standards is presented in Appendix A.

a. Air Quality. ESH-17 personnel assist Laboratory organizations in their efforts to comply with federal and state air quality regulations. ESH-17 personnel report on the Laboratory's compliance with the air quality standards and regulations discussed in Chapter 2. Various environmental surveillance programs are conducted to evaluate the potential impact of Laboratory emissions on the local environment and public health. These programs include measuring direct penetrating radiation, meteorological conditions, and stack emissions, and sampling for ambient air contaminants. Chapter 4 contains a detailed exploration of the methodologies and results of the ESH-17 air monitoring and surveillance program for 1997. Personnel from ESH-17 monitor meteorological conditions to assess the transport of contaminants in airborne emissions to the environment and to aid in forecasting local weather conditions; Chapter 4 summarizes meteorological conditions during 1997 and provides a climatological overview of the Pajarito Plateau.

Dose Assessment. ESH-17 personnel calculate the radiation dose assessment that is presented in Chapter 3, including the methodology and assessments for specific pathways to the public and the environment.

b. Water Quality and Hydrology. Personnel from ESH-18 are responsible for providing environmental monitoring activities to demonstrate regulatory compliance and to help ensure that Laboratory operations do not adversely affect public health or the environment.

ESH-18 provides technical and regulatory support for the Laboratory to achieve compliance with the following major state and federal regulations: Clean Water Act, National Pollutant Discharge Elimination System (NPDES); Safe Drinking Water Act; New Mexico Drinking Water Regulations; New Mexico

Water Quality Control Commission Regulations; Federal Insecticide, Fungicide, and Rodenticide Act; and New Mexico Pesticide Control Act. Surveillance programs and activities include groundwater, surface water, and sediments monitoring; water supply reporting for Los Alamos County; and the Groundwater Protection Management Program. Chapter 2 contains documentation on the Laboratory's compliance status with water quality regulations and includes an update of the NPDES Federal Facilities Compliance Agreement. Chapter 5 presents results of the data collected and analyzed by ESH-18 personnel from surveillance monitoring.

c. Hazardous and Solid Waste. ESH-19 personnel provide services in developing and monitoring permits under hazardous and solid waste rules, RCRA/HWA, Solid Waste Act (SWA), and letters of authorization for landfilling polychlorinated biphenyls (PCB) solids contaminated with radionuclides under the Toxic Substances Control Act (TSCA); providing technical support, regulatory interpretation, and Laboratory policy on hazardous, toxic, and solid waste issues and underground storage tank regulations to Laboratory customers; and documenting conditions at past waste sites. The Laboratory's compliance status with hazardous and solid waste regulations is presented in Chapter 2, including updates on the status of federal facility compliance orders and agreements on mixed waste and storage of radioactively contaminated PCB wastes.

d. Ecology. Personnel in ESH-20 investigate and document biological and cultural resources within the Laboratory boundaries; prepare environmental reports, including Environmental Assessments required under NEPA; and monitor the environmental impact of Laboratory operations on soil and foodstuffs. Chapter 2 documents the 1997 work in the areas of NEPA reviews and biological and archaeological reviews of proposed projects at the Laboratory. Chapter 6 contains information on the results and trends of the soil, foodstuff, and biota monitoring programs at the Laboratory.

3. Waste Management Program

a. Waste Management Activities. Waste management activities are 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. 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 low-level radioactive waste, transuranic waste, mixed waste, hazardous waste, and nonhazardous waste.

b. Pollution Prevention. The Laboratory's Environmental Stewardship Office coordinates the integrated Laboratory pollution prevention program. Specific amounts of source material reduction and recycling are provided in Section 2.B.1.h. Other waste management activities that reduce waste generation include the following:

- continuing financial incentives for waste reduction and innovative pollution prevention ideas,
- developing databases and automated procedures for purchases that could minimize waste or use recycled materials, and
- providing pollution prevention expertise to Laboratory organizations in construction projects, site remediation, and decontamination and decommissioning projects.

The *1997 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1* and additional information concerning waste minimization are located at *http://twilight.saic.com/WasteMin/default.asp* on the World Wide Web.

4. Environmental Restoration Project

The Environmental Restoration (ER) Project within the DOE Office of Environmental Management is responsible for assessing, cleaning up, decontaminating, and decommissioning sites at DOE facilities and sites formerly used by DOE. The ER Project at the Laboratory augments 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. 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 project, operating out of the EM Program also oversees for decontamination and decommissioning of surplus facilities at the Laboratory.

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 offers a reference for remediating sites at the Laboratory that contain certain hazardous substances not covered by RCRA. The Hazardous and Solid Waste Amendments (HSWA) to RCRA mandate that certain facilities, including the Laboratory, that store, treat, and dispose of hazardous wastes operate under a formal permit system. The corrective action provisions of the RCRA permit are contained in Module VIII of the Laboratory's Hazardous Waste Permit. The Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) regulate the Laboratory's corrective action program under RCRA. The DOE has oversight for those sites not subject to RCRA and for the decommissioning program. A summary of ER Project activities completed in 1997 is presented in Section 2.B.1.j of this report.

C. Community Involvement

The Laboratory continues to encourage public access to information about environmental conditions and the environmental impact of operations at the Laboratory. Although the Community Involvement Office (CIO) has a responsibility to help coordinate activities between the Laboratory and northern New Mexico, many organizations at the Laboratory are active in working with the public. Frequently, the subject of these interactions is related to environmental issues because of concerns regarding the Laboratory's potential impact on local safety, health, and the environment.

Some examples of how the Laboratory distributes and makes environmental information available to the public is listed below.

Public Meetings

DOE is required to have public meetings and comment periods when it undertakes an activity that could have a significant impact on the environment. It is the Laboratory's responsibility to assist DOE in activities that relate to the LANL site. During 1997, the DOE and the Laboratory Director entered into a Consent Decree and Settlement Agreement with the Concerned Citizens for Nuclear Safety in conjunction with the Laboratory's air monitoring program (see Section 2.D.1). Part of the consent decree stipulated that LANL begin quarterly public meetings on environmental issues. The first of these meetings took place on June 17, 1997, and three more were held during 1997. The meetings covered the topics of air and water quality, the latest statistics on brain tumor and thyroid cancers in Los Alamos, and environmental restoration and waste management. In addition, the Laboratory held other public meetings including a meeting on the environmental surveillance report on May 7, 1997.

Outreach Centers

During 1997, CIO operated three outreach centers located in Los Alamos, Española, and Taos. Approximately 250 people visited the centers each month. Access to environmental information is available at all the outreach centers.

Tribal Interactions

During 1997, executive and staff meetings were held with Cochiti Pueblo, Jemez Pueblo, the Pueblo of San Ildefonso, and Santa Clara Pueblo along with DOE and Laboratory personnel. Subjects for the meetings included DOE-funded environmental programs, environmental restoration, environmental surveillance, cultural resource protection, emergency response, and other environmental issues. In the fall of 1997, the new Laboratory Director, John Browne, signed Reaffirmations of Cooperative Agreements with governors from the Pueblos of Cochiti, Jemez, Santa Clara, and San Ildefonso. An amendment to the cooperative agreements calls for Laboratory-Pueblo development of educational initiatives with the UC. Meetings with Cochiti Pueblo and the Pueblo of San Ildefonso were also held to discuss radiological analyses about Cochiti Reservoir sediment studies using new Laboratory technologies.

Bradbury Science Museum

Because many of the Laboratory's facilities are closed to the public, the Bradbury Science Museum provides a way for the public to learn about the kinds of work the Laboratory does, whether it is showing how lasers are used to assess air pollution or demonstrating ecology concepts. In 1997, the museum hosted approximately 115,000 visitors.

The World Wide Web

In response to the ever-growing interest in using electronic communications media, the Laboratory has made information available at *http://www.lanl.gov/external/* on the World Wide Web. Search engines for Laboratory environmental information (as well as for other topics) are available through the community pages.

Inquiries

In 1997, CIO—with the assistance of a wide variety of Laboratory organizations—responded to hundreds of public inquiries, many of which had an environmental theme. These inquiries came to CIO by letter, phone, fax, e-mail, and personal visits. Addresses and phone/fax numbers for the various CIO facilities are listed below.

Community Involvement & Outreach Office
Los Alamos National Laboratory
P. O. Box 1663, Mail Stop A117
Los Alamos, NM 87545
Phone: (505) 665-4400 or 1-800-508-4400;
Fax: (505) 665-4411
cio@lanl.gov

Española Outreach Center
1002 N. Oñate
Española, NM 87532
Phone: (505) 753-3682; Fax: (505) 753-4679

Los Alamos Outreach Center
1350 Central, Suite 101
Los Alamos, NM 87544
Phone: (505) 665-2127 or 1-800-985-7232;
Fax: (505) 667-3111

Santa Fe Outreach Center (Scheduled to open June 1998)
1640 Old Pecos Trail
Santa Fe, NM 87505
Phone: (505) 982-3761; Fax: (505) 982-9743

Bradbury Science Museum
1350 Central Avenue
Los Alamos, NM 87544
Phone: (505) 667-4444; Fax: (505) 665-6932

D. Assessment Programs

1. Overview of Los Alamos National Laboratory Environmental 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. The Quality Assurance Support Group (ESH-14) provides support for QA functions at the Laboratory. ESH-14 personnel perform 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 manages and coordinates the effort to become a customer-focused, unified Laboratory.

Each monitoring activity sponsored by the ESH Division has its own QAP or operating procedure. These plans and procedures 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), 5400.5 (DOE 1990), and 5700.6C (DOE 1991). Each QAP must address the criteria for management, performance, and assessments. Monitoring activities for each environmental program performed by groups in ESH Division have been included in the LANL Environmental Monitoring Plan for 1996–1998 (EARE 1995).

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

During 1997, the Laboratory was evaluated by the UC and DOE based on mutually negotiated performance measures. The performance measure rating periods are from July to June. The environmental components of these performance measures include the following categories:

- radiation protection of workers;
- radiation protection of the public;
- release incidents;
- permit exceedances;
- environmental violations, fines, and penalties;
- status of regulatory commitments and milestones; and
- waste minimization and pollution prevention.

Specific information on the categories and the assessment scoring can be obtained at *http://labs.ucop.edu/library.html* on the World Wide Web.

3. Department of Energy Audits and Assessments

The DOE Office of Oversight, Environment, Safety, and Health, published a "Profile of Los Alamos National Laboratory" in October 1997. The profile documents how effectively DOE and Laboratory line management have implemented safety management and environment, safety, and health programs. Numerous aspects of ESH were evaluated, including portions of the environmental programs. The environmental programs covered by external regulations were determined to be effective. This profile can be accessed at *http://www.tis.eh.doe.gov/web/eh2/profiles/index.html* through the World Wide Web.

Additional information on DOE audits and assessments of LANL ESH programs is available through the DOE home page on the World Wide Web.

4. Cooperative and Independent Monitoring

DOE and the Laboratory have signed agreements with the State of New Mexico and four surrounding Pueblos that enable independent environmental monitoring at and near the Laboratory. The main agreements are the following:

- **Agreement-In-Principle** between DOE and the State of New Mexico.
- **Accords** between the individual Pueblos of San Ildefonso, Cochiti, Jemez, and Santa Clara and DOE.
- **Cooperative Agreements** between the individual Pueblos of San Ildefonso, Cochiti, Jemez, and Santa Clara and UC.

The main purposes of these agreements are to build more open and participatory relationships, to improve communications, and to cooperate on issues of mutual concern. The agreements have allowed access to monitoring locations and encouraged cooperative sampling activities, improved data sharing, and enhanced communications on technical subjects. The agreements also provide frameworks for grant support that allow development of independent monitoring programs. In addition, environmental monitoring at and near the Laboratory involves other state and federal agencies such as the NMED's DOE Oversight Bureau (see Section 2.C.2 for more information), the Defense Nuclear Facilities Safety Board, the Agency for Toxic Substances and Disease Registry, the Bureau of Indian Affairs, and the US Geological Survey.

The Laboratory also works directly with residents on cooperative and independent monitoring programs. Part of the Consent Decree and Settlement Agreement to resolve a lawsuit filed by Concerned Citizens for Nuclear Safety (CCNS) stipulated that the Laboratory present a five-day course on radiation exposure and protection to representatives of CCNS, the Four Accord Pueblos, and regional city/county government officials. The Laboratory purchased radiation monitoring equipment that is available to the course trainees for independent monitoring in their communities.

In addition, DOE calibrated the Neighborhood Environmental Watch Network (NEWNET) stations located in northern New Mexico in 1997 (see Section 2.D.1). Data from NEWNET monitors are recorded every 15 minutes and can be accessed through the World Wide Web.

E. References

Blake et al., 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).

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

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

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Purtymun and Johansen 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).

2. Compliance Summary

primary authors:

Bob Beers, Bruce Gallaher, Jackie Hurtle, Julie Johnston, Tony Ladino, Karen Lyncoln, Mike Saladen, Dianne Wilburn

Highlights from 1997

Los Alamos National Laboratory (LANL or the Laboratory) staff frequently interacted with regulatory personnel during 1997 regarding Resource Conservation and Recovery Act and New Mexico Hazardous Waste Act requirements and compliance activities. The New Mexico Environment Department (NMED) conducted its annual inspection intermittently between July and December and noted 52 apparent findings of noncompliance during its inspection of the Laboratory's hazardous waste storage areas and walkthroughs of approximately 95% of perimeter areas. NMED has not yet issued a formal Compliance Order; based on knowledge of apparent findings, the Laboratory believes it has taken appropriate corrective actions.

Laboratory operations were in compliance with all federal and state nonradiological air quality requirements. Radioactive emissions generated at the Laboratory during 1997 were in compliance with the Environmental Protection Agency's (EPA's) effective dose equivalent (EDE) limitation of less than 10 mrem per year to members of the public from airborne emissions. The EDE is calculated to be 3.51 mrem using EPA-approved methods. During 1997, the Department of Energy (DOE) and the Director of the Laboratory entered into a Consent Decree and a Settlement Agreement to resolve the lawsuit filed by the Concerned Citizens for Nuclear Safety that alleged that LANL was not in full compliance with the National Emission Standards for Radionuclides under the Clean Air Act.

In 1997, the Laboratory was in compliance with its on-site liquid discharge requirements in 99.4% of the samples from its sanitary effluent outfalls and in 99.5% of the samples from its industrial effluent outfalls. The Laboratory was in compliance with its on-site liquid discharge requirements in 99.9% of the water quality parameter samples collected at sanitary and industrial outfalls (August 1, 1996 through July 31, 1997). Concentrations of chemical, microbiological, and radioactive constituents in the drinking water system remained within federal and state drinking water supply standards.

In 1997, Laboratory staff reviewed 254 proposed projects for compliance with the National Environmental Policy Act (NEPA) and sent 137 NEPA Environmental Review Forms to DOE. In addition, Laboratory archaeologists evaluated 751 proposed actions for possible effects on cultural resources, which required 28 intensive field surveys. Laboratory biologists reviewed more than 750 proposed actions for potential impacts to threatened and endangered species; 75 of the actions required additional study.

To Read About . . . **Turn to Page . . .**

2. Compliance Summary

A. Introduction

Many activities and operations at Los Alamos National Laboratory (LANL or the Laboratory) involve or produce liquids, solids, and gases that contain radioactive and/or nonradioactive hazardous materials. Laboratory policy implements Department of Energy (DOE) requirements by directing its employees to protect the environment and meet compliance requirements of applicable federal and state environmental protection regulations.

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, soil, and water resources. Regulations provide specific requirements and standards to ensure maintenance of environmental qualities. The Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) are the principal administrative authorities for these laws. DOE and its contractors are also subject to DOE-administered requirements regarding control of radionuclides. The environmental permits issued by these organizations and the specific operations and/or sites affected are presented in Table 2-1.

B. Compliance Status

1. Resource Conservation and Recovery Act

a. Introduction. The Laboratory produces a wide variety of hazardous wastes, most of which are produced in small quantities relative to industrial facilities of comparable size. The Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, creates a comprehensive program to regulate hazardous wastes, from generation to ultimate disposal. The HSWA emphasize reducing the volume and toxicity of hazardous waste. Regulation 40 Code of Federal Regulations (CFR) 268 requires treatment of hazardous waste before land disposal.

EPA or an authorized state issues RCRA permits to specifically regulate the storage, treatment, or disposal of hazardous waste and the hazardous component of radioactive mixed waste that is stored, treated, or disposed of on-site. 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 (RCRA hazardous waste management areas). 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 Hazardous Waste Facility permit. The RCRA Part B permit application consists of a detailed narrative description of all facilities and procedures related to hazardous or mixed waste management, including contingency, training, and inspection plans. The DOE and the University of California (UC) were issued the current Hazardous Waste Facility Permit on November 8, 1989, from the State of New Mexico.

b. Resource Conservation and Recovery Act Permitting Activities. The RCRA Hazardous Waste Facility Permit for the waste management operations at Technical Areas (TAs) 50, 54, and 16 is due to be renewed. The 10-year permit expires in November 1999, and NMED has asked the Laboratory to submit the application for renewal by the end of 1998. The extensive permit application development process was initiated in late 1997.

The Hazardous and Solid Waste Group (ESH-19) submitted permit applications for the waste management organizations during 1997 to support compliance-related activities, to continue converting existing mixed waste management units to RCRA-permitted status, and to obtain new unit permits for ongoing project expansions. These permit applications and modifications were submitted using the permitting approach proposed in 1995 under which NMED intends to issue permits for the individual TAs where hazardous or mixed waste management activities are conducted. By late 1997, ESH-19 was discussing a modified approach with NMED that involved separate modules of the facility permit for each TA.

LANL proposed that the permitting process could be facilitated by the availability of a LANL General Part B information submittal, subject to approval by NMED, which would provide common references for Laboratory documents that could be incorporated into permit modification packages without requiring repetitive NMED reviews. Final approval of the General Part B application is expected to occur as part of the 1998 permit renewal process.

By the end of 1997, some permit modification approvals related to the December 10, 1993, Consent Agreement for Compliance Orders New Mexico Hazardous Waste Act (HWA) 93-01, 93-02, 93-03, and 93-04 had been received from NMED. Waste characterization temporary storage areas at the TA-50 Waste Characterization, Reduction, and Repackaging Facility and the TA-54 Radioassay and Nondestructive Testing Facility were approved in February 1997. Two other

Table 2-1. Environmental Permits or Approvals under which the Laboratory Operated during 1997

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
RCRA Hazardous Waste Facility	Hazardous and mixed waste storage, and treatment permit	November 1989	November 1999	NMED
	RCRA mixed waste Revised Part A application	submitted October 1993	– – –	NMED
	RD&D application-Electrochemical Treatment Unit	submitted September 6, 1996	– – –	NMED
HSWA	RCRA Corrective Activities	March 1990	December 1999	NMED
TSCA[a]	Disposal of PCBs at TA-54, Area G	June 25, 1996	None	EPA
CWA/NPDES[b], Los Alamos	Discharge of industrial and sanitary liquid effluents	August 1, 1994	October 31, 1998	EPA
	Storm water associated with industrial activity	September 29, 1992	September 9, 1997[c]	EPA
	DP Storage Area	April 26, 1996	September 4, 1997	EPA
	Tar Remnant Remediation	May 26, 1995	September 27, 1997	EPA
	TA-32	March 11, 1996	September 4, 1997	EPA
	Hot Shots	May 23, 1996	August 27, 1997	EPA
	Storm water associated with construction activity			
	TRU Dome/TWISP Facility	January 2, 1995	January 8, 1997	EPA
	TA-53 Sanitary Pipeline	October 1, 1992	September 5, 1997	EPA
	US West Communications Ductbank	October 1, 1992	September 5, 1997	EPA
	DARHT Facility	May 20, 1994	September 5, 1997[c]	EPA
	Small Arms Firing Range	August 18, 1994	August 27, 1997	EPA
	TA-9 and 16 Steam System Upgrade	September 1, 1995	September 5, 1997[c]	EPA
	RLW Cross Country Line	July 25, 1996	September 5, 1997[c]	EPA
	Guaje Well Field	June 5, 1997	September 5, 1997[c]	EPA
	Wildlands Fire Management	September 5, 1996	September 5, 1997[c]	EPA
CWA/NPDES, Fenton Hill	Discharge of industrial liquid effluents	October 15, 1979	December 29, 1997[d]	EPA

Table 2-1. Environmental Permits or Approvals under which the Laboratory Operated during 1997 (Cont.)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
CWA Sections 404/401 Permits	Guaje Canyon/Utility Line Discharges	September 9, 1997	September 9, 1999	COE[e]/NMED
	Guaje Canyon/Road Crossings	September 9, 1997	September 9, 1999	COE/NMED
	Guaje Canyon/Headwaters and Isolated Water	September 9, 1997	September 9, 1999	COE/NMED
	Pueblo Canyon/Wetland/Riparian Activities	September 8, 1997	September 8, 1999	COE/NMED
	Pueblo Canyon/Headwaters and Isolated Water	September 18, 1997	September 18, 1999	COE/NMED
	LA Canyon, Ancho Canyon, DP Canyon/Utility Line Discharges	November 14, 1997	November 14, 1999	COE/NMED
Groundwater Discharge Plan, Fenton Hill	Discharge to groundwater	June 5, 1995	June 5, 2000	NMOCD[f]
Groundwater Discharge Plan, TA-46 SWSC Plant[g]	Discharge to groundwater	January 7, 1998	January 7, 2003	NMED
Groundwater Discharge Plan, Sanitary Sewage Sludge Land Application	Land application of dry sanitary sewage sludge	June 30, 1995	June 30, 2000	NMED
Groundwater Discharge Plan, TA-50, Radioactive Liquid Waste Treatment Facility	Discharge to groundwater	submitted August 20, 1996 approval pending		NMED
Air Quality Operating Permit Application (20 NMAC[h] 2.70)	LANL air emissions	submitted December 1995		NMED
Air Quality (NESHAP)[i]	Beryllium machining at TA-3-39	March 19, 1986	None	NMED
	Beryllium machining at TA-3-102	March 19, 1986	None	NMED
	Beryllium machining at TA-3-141	September 8, 1987	None	NMED
	Beryllium machining at TA-35-213	April 26, 1989	None	NMED
	Beryllium machining at TA-55-4	July 28, 1994	None	NMED

Table 2-1. Environmental Permits or Approvals under which the Laboratory Operated during 1997 (Cont.)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
Open Burning (20 NMAC 2.60) Operational Burning	Burning of jet fuel and wood for ordnance testing, TA-11 Burning of HE-contaminated[j] materials, TA-14 Burning of HE-contaminated materials, TA-16 Burning of scrap wood from experiments, TA-36 Fuel Fire Burn of wood or propane TA-16, Site 1409	August 18, 1997	None	NMED
Open Burning (20 NMAC 2.60) Prescribed Burning	Prescribed Open Burning TA-15, TA-36	October 22, 1996	April 3, 1997	NMED

[a]Toxic Substances Control Act.
[b]National Pollutant Discharge Elimination System.
[c]Administratively extended by EPA.
[d]Permit discontinued by EPA.
[e]Army Corps of Engineers
[f]New Mexico Oil Conservation Division.
[g]Sanitary Wastewater Systems Consolidation.
[h]New Mexico Administrative Code.
[i]National Emission Standards for Hazardous Air Pollutants.
[j]High explosive.

related permit modifications, including an application for the retrieval of mixed transuranic (TRU) waste at TA-54, Area G (pads 1, 2, and 4, and storage at domes 229, 230, 231, and 232) and for waste characterization staging areas at the TA-50 Radioactive Materials Research, Operations, and Demonstration Facility were pending at the end of 1997.

A permit modification to allow mixed waste treatment residuals for wastes generated at LANL to be allowed back onto the LANL facility, if necessary for treatment to support Site Treatment Plan (STP) requirements, was approved on May 19, 1997. Approval of two additional mixed waste storage areas at TA-54, structures/pads 36 and 58, used to support related mixed waste segregation activities, was received in January 1997.

The Laboratory submitted permit modifications to NMED for existing hazardous and mixed waste management facilities. Part B permit applications for two TRU mixed waste container storage areas in TA-3, Building 29, were submitted in May 1997.

NMED requested a revision for TRU mixed waste characterization to the LANL hazardous waste analysis plan as a condition for approval of the Transuranic Waste Inspectable Storage Project (TWISP). The revised TRU mixed waste analysis plan was submitted to NMED on March 31, 1995. NMED issued a notice of deficiency (NOD) on May 24, 1996, requesting more information on specific waste characterization and certification procedures, which were provided by the Laboratory on July 12, 1996. LANL had not received word from NMED on this revision by the end of 1997.

The Laboratory responded to an NOD with regard to the technical adequacy of the Part B permit application submitted in September 1996 for open burning/open detonation units at TA-14. The NOD was issued on June 10, 1997, and the Laboratory responded within the 30-day deadline.

An application for the proposed LANL Electrochemical Treatment Unit, a RCRA Research, Development, and Demonstration (RD&D) project, was submitted to NMED on September 6, 1996. LANL had not received word from NMED on this application by the end of 1997. The research objective of the work to be conducted under this permit was to experimentally define waste streams amenable for an electrochemical treatment process developed at LANL, to determine treatment conditions for these waste streams, and to assess the feasibility of processing batch waste quantities larger than those allowed under RCRA treatability studies.

c. Resource Conservation and Recovery Act Closure Activities. Closure activities for container storage areas at TA-21, Building 61 continued during 1997. Closure certifications were submitted in 1997 for RCRA RD&D permits for the TA-9 Hydrothermal Processing Unit and the TA-35 Packed Bed Reactor/ Silent Discharge Plasma Unit, which were never operational for hazardous or mixed waste studies. A closure certification report for the TA-50 Controlled Air Incinerator was submitted to NMED in 1997.

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. The history of RCRA closures is presented in previous environmental surveillance reports (ESP 1997, ESP 1996). The 1997 status of these sites is given below.

- TA-35 surface impoundments—An amended closure plan was approved by NMED on September 19, 1996. The Laboratory completed Phase VI verification sampling at TA-35, TSL-85 during July 1996. At the end of 1997, the Laboratory had not received a response from NMED on the amended closure certification report that LANL submitted on September 30, 1996.
- TA-16, landfill at MDA-P—NMED approved the closure plan for MDA-P on February 18, 1997. Storm water collection trenches were constructed as part of premobilization activities. The remediation contractor excavated a series of pits into the landfill to better characterize it. Detonable high explosives and high barium concentrations were found in some of the pits. Excavation of the landfill will begin in 1998.
- TA-53 surface impoundments—On July 21, 1997, NMED notified DOE and the Laboratory that the change in status of the three surface impoundments at TA-53 from treatment, storage, and disposal units to corrective action units under HSWA had been approved. A closure plan for the impoundments is no longer necessary. A RCRA Facility Investigation (RFI) work plan for the impoundments was submitted on January 21, 1998.

d. Other Resource Conservation and Recovery Act Activities. In 1995, ESH-19 began the self-assessment program in cooperation with waste management coordinators to assess the Laboratory's performance in the proper storage and handling of hazardous and mixed waste to meet federal and state regulations, DOE orders, and Laboratory policy. The findings of the assessment are communicated to waste generators, waste management coordinators, and management to help line managers implement appropriate corrective actions to ensure continual improvement in LANL's hazardous waste program. In 1997, ESH-19 completed 1,070 quarterly assessments.

In 1996, EPA adopted new standards, under the authority of RCRA, as amended, and commonly called "Subpart CC" standards. These standards apply to air emissions from certain tanks, containers, less-than-90-day storage facilities, and surface impoundments used to manage hazardous waste capable of releasing volatile organic compounds (VOCs) at levels that can harm human health and the environment. LANL is currently assessing its performance in meeting these new standards through its internal audit program.

e. Resource Conservation and Recovery Act Compliance Inspection. NMED conducted its annual hazardous waste compliance inspection from July intermittently through December 1997 (Table 2-2). In addition to visiting approximately 680 hazardous and mixed waste satellite accumulation areas, less-than-90 day storage areas, and permitted or interim status storage and treatment facilities located throughout the Laboratory, NMED inspectors walked through 95% of the Laboratory visiting general storage areas, laboratories, and perimeter spaces. Although a formal Compliance Order has not yet been issued, NMED noted 52 apparent findings of noncompliance, the majority which were found in perimeter areas rather than in the Laboratory's permitted storage areas. The majority of the findings were administrative in nature, involving training and paperwork documentation. Fourteen of the apparent findings were related to the lack of a proper waste determination, and 10 of the findings cited abandonment of waste, i.e., waste illegally stored in lieu of disposal or proper storage. The Laboratory has taken corrective actions where appropriate.

f. Underground Storage Tanks. The Laboratory's underground storage tanks (USTs) are regulated under the New Mexico Administrative Code, Title 20, Chapter 5 (20 NMAC 5). At the end of calendar year (CY) 97, the Laboratory had six USTs in use. The Laboratory plans to close five of those six USTs by the end of CY98.

Seven USTs were removed in CY97. On August 20, 1997, UST TA-3-36-2 was removed; this UST at one time held 5,038 gal. of unleaded gasoline. UST-TA-3-36-1, removed on August 21, 1997, previously held 10,152 gal. of unleaded gasoline. On August 17, 1997, minor petroleum contamination was discovered as soil staining at or near the east fuel dispenser

Table 2-2. Environmental Inspections and Audits Conducted at the Laboratory during 1997

Date	Purpose	Performing Agency
January 31, 1997	Open Burn Permit Inspection	NMED
March 31, 1997	DOE Audit	DOE/IG Office
April 10, 1997	Beryllium Inspection	NMED
May 16–17, 1997	Compliance Evaluation Inspection (NPDES)	NMED/SWQB[a]
June 23, 1997	FFCA Compliance Audit	RAC[b]
June 24, 1997	Asbestos Inspection	NMED
July–December 1997	Hazardous Waste Facility Inspection	NMED
July 9, 1997	Open Burn Permit Inspection	NMED
July 15, 1997	TA-54 Area J Commercial/Special Waste Landfill	NMED
September 22, 1997	Burns Swale Spill Site, Fenton Hill	NMOCD[c]
November 12, 1997	Asbestos Inspection	NMED

[a] New Mexico Environment Department/Surface Water Quality Bureau.
[b] Radiological Assessments Corporation.
[c] New Mexico Oil Conservation Division.

island. Elevated total recoverable petroleum hydrocarbon (TRPH) concentrations of 370 ppm and total aromatic hydrocarbon (BTEX) concentrations of 0.22 ppm were detected. Soil samples collected beneath the two USTs show no petroleum contamination. Analytical data collected from the October 1997 subsurface drilling campaign to determine the extent of petroleum contamination found no detectable petroleum in the subsurface. The surface soil that showed elevated petroleum levels was excavated and is being land farmed at TA-60.

Five USTs located at the TA-60 tank farm were removed in CY97. On October 20, 1997, USTs TA-3-TF-1 and TA-3-TF-2, which held 10,152 gal. of kerosene and 25,560 gal. of diesel fuel respectively, were removed. UST TA-3-TF-3, which held 15,228 gal. of unleaded gasoline, was removed on October 21, 1997. On October 27, 1997, USTs TA-3-TF-4 and TA-3-TF-5, both of which held 25,560 gal. of unleaded gasoline, were removed. A total of 14 soil samples was collected from the bottom of the 5 UST excavations. Soil samples were analyzed for TRPH and BTEX using EPA SW-846 modified method 8015 and method 8020 respectively. The analytical results indicate no TRPH or BTEX contamination.

NMED did not conduct a UST inspection during 1997.

g. Solid Waste Disposal. The Laboratory has a commercial/special waste landfill located at TA-54, Area J, that is subject to New Mexico Solid Waste Act (SWA) regulations. In CY97, the TA-54, Area J landfill received and disposed 127 yd^3 of solid waste. On July 15, 1997, the NMED Solid Waste Bureau conducted an inspection at the Laboratory's commercial/special waste landfill. No violations of the management regulations were found during the inspection. In CY97, LANL completed and delivered the required Solid Waste Facility annual report for the previous year (CY96) to DOE.

LANL also disposes of sanitary solid waste (trash), concrete/rubble, and construction and demolition debris at the Los Alamos County landfill on East Jemez Road. DOE owns the property; it is leased to Los Alamos County under a special use permit. Los Alamos County owns and operates this landfill and is responsible for obtaining all related permits for this activity from the state. The landfill is registered with NMED Solid Waste Bureau. NMED has not requested a permit to be filed for this facility but is expected to do so in the next two to five years. LANL contributed 10.5% (2,497 tons) of the total volume of trash landfilled at this site during CY97, with the remainder contributed by Los Alamos County and the City of Española. LANL also sent 5,296 tons of concrete/rubble, 636 tons of construction and demolition debris, 136 tons of brush for composting, and 77 tons of metal for recycling to the landfill.

h. Waste Minimization. In order to comply with the HSWA Module of the RCRA, RCRA Subtitle A, DOE Order 5400.1, and other regulations, the Laboratory must have a waste minimization and pollution prevention program.

Section 1003 of the Waste Disposal Act 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, recycling, and reuse; and treatment as alternatives to land disposal of hazardous waste.

The amounts of routine, nonroutine, and total RCRA-hazardous, low-level, and mixed low-level wastes generated by Laboratory operations during CY97 are provided in *1997 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1* (Wilburn 1998). A copy of this report and additional information concerning waste minimization can be found at *http://twilight.saic.com/WasteMin/default.asp* on the World Wide Web.

In CY97, source reduction and recycling activities reduced the following amounts of waste or pollutants:

Criteria Air Pollutants	95 tons
TRU waste	32.2 m^3
Low-level waste	1,415.5 m^3
Mixed low-level waste	63.4 m^3
RCRA-hazardous waste (chemicals, lead, solvents, etc.)	225.5 m^3
Sanitary waste (paper, phone books, construction materials, rubble, metals, etc.)	10,209.8 mt
State-regulated waste (used tires, waste oil, etc.)	2,684.9 mt
Toxic Substances Control Act (TSCA) waste	12.9 mt

i. Resource Conservation and Recovery Act Training. The RCRA training program, as described in the RCRA Hazardous Waste Facility Permit, is complete and only experienced minor modifications and revisions in 1997 to reflect regulatory, organizational, and/or programmatic changes.

During 1997, 131 workers completed RCRA Personnel Training, 303 workers completed RCRA Refresher Training, and 565 workers completed Waste Generation Overview. RCRA Refresher Training for treatment, storage, and disposal workers and for less-than-90-day storage workers had previously been incorporated into Hazardous Waste Operations (HAZWOPER) Refresher Training. Of the 303 workers who required RCRA Refresher Training during 1997, approximately 234 met this requirement through completing the combined course.

The following RCRA courses were revised by the Environment, Safety, and Health Training Group (ESH-13) during 1997:

RCRA Refresher Training

HAZWOPER: Refresher for Environmental Restoration Workers

HAZWOPER: Refresher for Treatment, Storage, and Disposal Workers

Waste Documentation Forms

j. Hazardous and Solid Waste Amendments Compliance Activities. In 1997, the Environmental Restoration (ER) Project remained in compliance with Module VIII of the RCRA permit. The Laboratory's ER Project originally consisted of approximately 2,100 potential release sites (PRSs). At the end of FY97, there were approximately 756 PRSs remaining that require investigation and/or remediation and 118 buildings awaiting decontamination and decommissioning (D&D). The Laboratory's ER Project is scheduled for completion in 2006.

In FY97, the LANL ER Project activities included remedial site assessments, site remediations, and the decommissioning of surplus facilities. The assessment portion of the ER Project included submission of 24 RFI reports to NMED and RFI field work on numerous sites. Remedial activities conducted in FY97 included cleanup of seven sites including a surface disposal area, septic systems, an abandoned manhole, a lead storage area, and a firing site. In addition, during the evaluation of other potential remedial sites, 151 sites were determined by human health risk assessments not to require remedial action. Seven contaminated facilities were demolished, including radioactively contaminated facilities from TA-21 DP West and Phases II and III at the TA-35 Phase Separator Pit.

2. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the SARA of 1986 mandates actions for certain releases of hazardous substances into the environment. The Laboratory is not listed on the EPA's National Priority List but follows 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. The Laboratory is required to comply with the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 and Executive Order (EO) 12856, the Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements.

b. Compliance Activities. In 1997, the Laboratory submitted two annual reports to fulfill its requirements under EPCRA, as shown on Table 2-3 and described below.

Emergency Planning Notification. Title III, Sections 302-303, of EPCRA, as modified by EO 12856, requires all federal facilities to prepare emergency plans for more than 360 extremely hazardous substances when they are stored in amounts above threshold limits. The Laboratory is required to notify state and local emergency planning committees if the Laboratory's emergency planning coordinator changes and/or if the Emergency Response Plan has changed. During 1997, there were no changes at the Laboratory requiring notification of the state and local emergency planning committees.

Emergency Release Notification. Title III, Section 304 of EPCRA, requires facilities to provide emergency release notification of leaks, spills, and other releases of specified chemicals into the environment over a specified reporting quantity. Releases are to be reported immediately to the state and local emergency planning committees and to the National Response Center. In 1997, there were no leaks, spills, or other releases of specific chemicals into the environment that required reporting.

Material Safety Data Sheet/Chemical Inventory Reporting. Title III, Sections 311-312, of EPRCA, requires facilities to provide an annual inventory on the quantity and location of hazardous chemicals present at the facility above specified

Table 2-3. Compliance with Emergency Planning and Community Right-to-Know Act during 1997

Statute		Reporting required and reported	Reporting required and not reported	Reporting not required
EPCRA 302-303:	Emergency Planning Notification			×
EPCRA 304:	Emergency Release Notification			×
EPCRA 311-312:	Material Safety Data Sheet/ Chemical Inventory Reporting	×		
EPCRA 313:	Toxic Release Inventory Reporting	×		

thresholds; the inventory includes the material safety data sheet for each chemical. In 1997, the Laboratory submitted a report to the state emergency response commission, the local emergency planning committee, and the Los Alamos County Fire Department; the report listed 39 chemicals and explosives present in quantities exceeding threshold limits.

Toxic Release Inventory Reporting. Title III, Section 313, of EPRCA, as modified by EO 12856, requires all federal facilities to submit an annual Toxic Chemical Release Inventory report every July for the preceding calendar year. Nitric acid was the only chemical used in 1996 that met the reportable threshold limit of 10,000 lb. The 1996 Toxic Chemical Release Inventory reported that approximately 41,741 lb of nitric acid were used in plutonium metal processing, which resulted in air emissions of 573 lb of nitric acid, 72 lb of nitrogen oxide, and 214 lb of nitrogen dioxide.

c. Emergency Planning. 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 incorporating the provision of DOE Order 151.1 is scheduled for completion in February 1998 and is currently being reviewed by applicable Laboratory senior management for final approval. In accordance with DOE Order 151.1, 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. In 1997, 567 employees received training as a result of Emergency Management Plan requirements and the Emergency Management & Response organization's internal training program.

4. Toxic Substances Control Act

Because the Laboratory's activities are in the realm of research and development and do not involve introducing chemicals into commerce, the polychlorinated biphenyls (PCB) regulations (40 CFR 761) have been the Laboratory's main concern under the 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, sanitary treatment solids from the Sanitary Wastewater Systems Consolidation (SWSC) Plant, 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 50 ppm.

In 1997, the Laboratory had 25 off-site shipments of PCB waste. The total weight of PCB in those shipments was 21,029 kg. PCB wastes are sent to EPA-permitted disposal and treatment facilities. The quantities of waste types disposed were 3 containers of capacitors, 41 containers of light ballast, 3 containers of water, 10 kg of PCB-contaminated soil, and 2,265 kg of PCB oil. All wastes are managed in accordance with 40 CFR 761 manifesting, record keeping, and disposal requirements. Light ballast is sent off-site for recycling. Section 2.B.8.b describes the status of sanitary sewer sludge from the TA-46 SWSC Plant in which low-level PCB (less than 5 ppm) have been detected.

The Laboratory generates radioactively contaminated PCB in three forms: in 1997, a total of 6,197 kg of liquids, 93 kg of media (mixtures of liquid and solid materials), and 1,108 kg of solids. Nonliquid wastes containing greater than 50 ppm PCB and PCB contaminated with radioactive constituents are disposed of at the Laboratory's EPA-authorized TSCA landfill located at TA-54, Area G. No nonliquid nonradioactive or radioactive PCB wastes were disposed of on-site in 1997. Radioactively-contaminated PCB liquid wastes are stored at the TA-54, Area L, TSCA-authorized storage facility. Many of these items have exceeded TSCA's one-year storage limitation and are covered under the Federal Facility Compliance Agreement for Stored Polychlorinated Biphenyls (PCB FFCAgreement) (see Section 2.C.1.b for a full discussion of the agreement).

The primary compliance documents related to 40 CFR 761.180 are the annual PCB report submitted to EPA, Region 6 and an annual report submitted to DOE required by the PCB FFCAgreement. EPA did not conduct an audit of the Laboratory's PCB management program during 1997.

5. Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates the manufacturing of pesticides, with requirements for 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 requirements for certification of workers who apply pesticides. The Laboratory is also regulated by the New Mexico Pesticide Control Act, administered by the New Mexico Department of Agriculture (NMDA). NMDA did not conduct an annual inspection of the Laboratory's pesticide application program during 1997.

6. Federal Clean Air Act

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

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

All of these requirements, 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. The requirements adopted by the State of New Mexico are discussed in Section 2.B.7, New Mexico Air Quality Control Act.

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 continue to track new regulations written to implement the act, determine their effects on Laboratory operations, and develop programs as needed.

b. Compliance Activities.

Radionuclide NESHAP. Under 40 CFR 61, Subpart H, EPA limits the effective dose equivalent to any member of the public from radioactive airborne releases from a DOE facility, including LANL, to 10 mrem per year. The 1997 effective dose equivalent (as calculated using EPA-approved methods) was 3.51 mrem per year, primarily from the Los Alamos Neutron Science Center (LANSCE) operations. Any new construction or modifications undertaken at LANL that will increase airborne radioactive emissions causing a potential increase in the dose of 0.1 mrem per year must be approved by EPA. In 1997, approximately 60 projects were reviewed by the Air Quality Group (ESH-17) for regulatory requirements; none required EPA preconstruction approval.

Stratospheric Ozone Protection. The CAA contains specific sections establishing regulations and requirements for ozone-depleting substances (ODS) for which LANL has to comply. The sections include Section 608, National Recycling and Emission Reduction Program, implemented by 40 CFR 82 Subpart F, which prohibits individuals from knowingly venting ODS into the atmosphere during maintenance, operation, service, repair, or disposal of air conditioning or refrigeration equipment; Section 609, Servicing of Motor Vehicle Air Conditioners, implemented by 40 CFR 82 Subpart B, which includes standards and requirements for recycling equipment used to service motor vehicle air conditioners and for training and certification of maintenance and repair technicians; Section 611, Labeling of Products Using ODS, implemented by 40 CFR 82 Subpart E, which establishes requirements to attach warning labels to products containing or manufactured with Class I or II ODS.

LANL complies by using certified personnel and equipment while maintaining, servicing, repairing, and disposing of air conditioning and refrigeration equipment; by contracting automotive repair work to local automotive repair shops and Johnson Controls Northern New Mexico (JCNNM); and by ensuring that products containing ODS and ODS-containing waste that are shipped off-site are properly labeled.

7. New Mexico Air Quality Control Act

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

b. Compliance Summary.

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. No excess emissions were reported for 1997.

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 plant operated by JCNNM is subject to this regulation. The plant is in compliance with an emission limit of 34 lb of particulate matter per hour.

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 per year per unit. The TA-3 steam/power plants have the capacity to operate at this level, although they never have. The Operating Permit Application proposed compliance by setting a voluntary federal enforceable term that limits the operation of the units to less than 1×10^{12} Btu per year per unit.

20 NMAC 2.34—Oil Burning Equipment, Nitrogen Dioxide. This regulation requires oil burning equipment built before January 10, 1972, to meet an emission standard of 0.3 lb of nitrogen dioxide per million Btu when the units operate at a heat input of greater than 1×10^{12} Btu per year. The TA-3 steam/power plants have the capacity to operate at this level, although they never have. The Operating Permit Application proposed a voluntary federally enforceable term that limits the operation of these units to less than 1×10^{12} Btu per year per unit.

20 NMAC 2.60—Open Burning. This regulation controls the open burning of materials. Open burning of explosive materials is allowed when transport of these materials to other facilities may be dangerous. Research projects require open burn permits. On August 17, 1997, the Laboratory consolidated open burn permits into a single permit for operational burns as listed in Table 2-1. The Laboratory also had a burn permit for prescribed burns as a preventive measure against wildfires for the first part of 1997.

20 NMAC 2.61—Smoke and Visible Emissions. This regulation limits visible emissions from various combustion sources, including 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. However, oil is used as a backup fuel for the boilers. To ensure that the backup system is working properly, the boilers must be periodically switched to oil. The Laboratory boilers may exceed the opacity standard while switching from gas to oil. An NMED-certified opacity observer reads the opacity while the switches are being made. If the Laboratory exceeds the opacity standard during the switch over, 20 NMAC 2.07 notification procedures are then followed. There were no exceedances of these standards during 1997.

20 NMAC 2.70—Operating Permits. This regulation requires major sources of air pollution to obtain an operating permit from NMED. Because of LANL's large potential to emit regulated air pollutants (primarily nitrogen dioxide from the steam/power plants), LANL is considered a major source. The permit application specifies the operational terms and limitations required to meet all federal and state air quality regulations. The Laboratory submitted its permit application to NMED in December 1995 and does not expect to receive a final permit for several years.

20 NMAC 2.71—Operating Permit Emission Fees. As part of the new operating permit program, the State of New Mexico collects fees from emission sources that are required to obtain an operating permit. Fees depend on the allowable emission rates or the potential to emit. Laboratory fees for 1996, paid in 1997, totaled $14,165.50.

20 NMAC 2.72—Construction Permits. Provisions of 20 NMAC 2.72 require permits for any new or modified source of air pollutants. The Laboratory reviews plans for 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 construction permits are required. During 1997, over 150 source reviews were conducted. None of these sources required permits under 20 NMAC 2.72.

20 NMAC 2.73—Notice of Intent and Emissions Inventory Requirements. Provisions of 20 NMAC 2.73 require that notices of intent be filed with NMED for new or modified stationary sources with a potential emission rate greater than 10 tons of any regulated air contaminant per year or 1 ton of lead per year. In addition, the provisions of 20 NMAC 2.73 specify requirements for annual emission inventories for regulated contaminants. The 1997 inventory will be submitted to NMED on April 30, 1998. Emissions data are presented in Section 4.D.4.

20 NMAC 2.74—Permits, Prevention of Significant Deterioration (PSD). This regulation has stringent requirements that must be addressed before the construction of any new, large stationary emission source can begin. Wilderness areas, national parks, and national monuments receive special protection under this regulation. This affects the Laboratory because of the proximity of Bandelier National Monument's Wilderness Area. Each new or modified source at the Laboratory is reviewed for applicability with this regulation and compared to overall emissions from the Laboratory as documented in the Operating Permit application. None of the new or modified sources in 1997 have resulted in emission increases that would cause the Laboratory to exceed the PSD emission threshold limits.

20 NMAC 2.78—Emission Standards for Hazardous Air Pollutants. In this regulation, NMEIB adopted by reference all of the federal NESHAPs, except those for radionuclides. 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 1997, 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 or 80 lin m or 1 m^3 of asbestos waste 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 waste disposal (both small and large jobs) on a quarterly basis, which includes any material contaminated with radionuclides. Radioactively contaminated material is disposed of on-site in a designated radioactive asbestos burial area at TA-54, Area G. Nonradioactive asbestos is transported off-site to designated asbestos disposal areas.

During 1997, small-job activity accounted for 133 m^3 of asbestos waste. Several large demolition jobs accounted for 109 m^3 of asbestos waste. From the large and small jobs combined, 12 m^3 of radioactively contaminated asbestos waste were disposed of on-site.

Beryllium. The beryllium NESHAP includes requirements for notification, emission limits, and stack performance testing for beryllium sources. The Laboratory has previously received five beryllium permits from NMED (Table 2-1) 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. All beryllium operations meet the permitted emission limits set by NMED.

8. Clean Water Act

a. National Pollutant Discharge Elimination System Outfall Program. 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 outfall permit establishes 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.

The UC and DOE are copermittees of the NPDES permits covering Laboratory operations. 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 1997, the Laboratory's NPDES outfall permit for Los Alamos included 2 sanitary wastewater treatment facilities and 86 industrial outfalls. By the end of 1997, the Laboratory had eliminated the outfall for the sanitary treatment plant at TA-21 and 22 permitted industrial outfalls from the NPDES permit. The NPDES permit for the geothermal facility at

Fenton Hill includes only one industrial outfall. This outfall did not discharge during 1997, and at the request of the DOE and the Laboratory, the permit was discontinued by EPA on December 29, 1997 (Table 2-1).

Under the Laboratory's NPDES outfall permit, samples are collected for analysis weekly, monthly, quarterly, and annually depending upon the outfall, and results are reported to EPA and NMED at the end of the monitoring period for each respective outfall category. During 1997, effluent limits were exceeded once in the 166 samples collected from the sanitary wastewater outfalls and 6 times in the 1,115 samples collected from the industrial outfalls (see Table 2-4). Overall compliance for the sanitary and industrial wastewater discharges during 1997 was 99.4% and 99.5%, respectively. The water quality parameter for vanadium was exceeded once out of 822 samples collected (99.9% compliance) in 1997 (see Table 2-4). A summary of these outfalls and a listing of the permit's monitoring limits are presented in Table A-4. The annual water quality parameters for sanitary and industrial outfalls are presented in Table A-5.

The following is a summary of the corrective actions taken by the Laboratory during 1997 to address permit noncompliances.

TA-53, Cooling Towers 62 and 64 (NPDES Outfalls 03A048 and 03A049). There were two arsenic exceedances (daily maximum) at TA-53 cooling towers 62 and 64 on January 16, 1997. The operating division is currently monitoring the arsenic levels in the cooling tower basins. Short-term corrective actions include using untreated redwood in cooling tower repair, operational sampling, controlling the cycles of concentration (reducing the number of times water is cycled through the cooling tower), and/ or routing the wastewater through an ion-exchange treatment system for further treatment if needed. The

Table 2-4. National Pollutant Discharge Elimination System Permit Monitoring of Effluent Quality and Water Quality Parameters at Industrial and Sanitary Outfalls: Exceedances during 1997[a]

EPA ID	Outfall Type	Technical Area	Date	Parameter		Results/Limits	
January							
03A048	Industrial	TA-53-62	01/16/97	As[b]	(daily max)	0.05/0.04	mg/L
03A049	Industrial	TA-53-64	01/16/97	As	(daily max)	0.05/0.04	mg/L
February							
03A113	Industrial	TA-53-293	02/20/97	Cl_2[c]	(daily max)	2.5/0.5	mg/L
03A113	Industrial	TA-53-293	02/20/97	Cl_2	(daily avg)	0.6/0.2	mg/L
March							
13S	Sanitary	TA-46 SWSC	03/20/97	BOD[d]	(daily max)	73/45	mg/L
April							
051	Industrial	TA-50-1	04/08/97	pH	(min)	5.9/6.0	s. u.
October							
03A181	Industrial	TA-55-6	10/30/97	pH	(daily max)	9.3/9.0	s. u.
03A181	Industrial	TA-55-6	10/30/97	V[e]	(daily max)	0.28/0.10	mg/L

Note: During May, June, July, August, September, November, and December there were no exceedances.

[a] Effluent quality limits are presented in Table A-4; water quality parameters are presented in Table A-5.
[b] Arsenic.
[c] Chlorine.
[d] Biochemical oxygen demand.
[e] Vanadium, a water quality parameter.

long-term corrective action is to replace the two wooden cooling towers with new units constructed of steel, fiberglass, and plastic pipe.

TA-53, Cooling Towers 293, 365, 1032 (NPDES Outfall 03A113). There were two chlorine exceedances (daily average/daily maximum) at NPDES Outfall 03A113 on February 20, 1997. Upon discovery of the elevated chlorine levels, the operating group immediately shut off and locked out the blow-down valves. The cooling tower basin (structure #293) that was overchlorinated was treated with a neutralizing agent and returned to service on February 24, 1997. The facility returned to the original treatment method of placing a mesh bag containing bromine/chlorine tablets in the cooling tower basin, which allows for slow dissolution.

TA-46, Sanitary Wastewater Systems Consolidation (SWSC) Plant (NPDES Outfall 13S). There was one biochemical oxygen demand (BOD) exceedance at the TA-46 SWSC Plant on March 20, 1997. Initial operational data suggested that the problem was due to the MIOX™ system (an on-site mixed oxidants generator used to disinfect effluent) increasing BOD at the outfall. The MIOX™ system was pilot tested in February 1997 and permanently installed in March 1997 to replace the existing chlorine gas system. The SWSC Plant operating engineer believed that the exceedance was caused by factors other than the MIOX™ system and conducted a separate investigation. The exact cause of the noncompliance has not been identified.

TA-50, Building 1 (NPDES Outfall 051). There was one pH noncompliance (minimum) at NPDES Outfall 051 on April 8, 1997. The exact cause of the noncompliance was not identified. The operating group suspects the compliance meter malfunctioned, although no problems with the meter were found. An operator failed to follow established procedures by not being present in the control room to respond to the pH alarm. The low pH of 5.9 s.u. occurred for approximately two minutes. The operating group installed a computerized system programmed to automatically stop the effluent discharge pump when the system's alarm is activated.

TA-55, Cooling Tower at Building 6 (NPDES Outfall 03A181). There was one pH exceedance (maximum) and one vanadium noncompliance (daily maximum) at NPDES Outfall 03A181 on October 30, 1997. Upon discovery of the noncompliant condition, the discharge was stopped. Because of safety and equipment damage concerns, the discharge was resumed after the pH was adjusted within permit limits using hydrochloric acid. Operators at the site indicated that the cooling tower monitoring equipment was not operating correctly and was not properly calibrated or maintained. The operating group has repaired the monitoring equipment, which has reduced the number of cycles of concentration in the cooling tower operations to lower pH and reduce vanadium concentrations in the cooling tower basin.

b. National Pollutant Discharge Elimination System Sanitary Sewage Sludge Management Program. On July 31, 1997, the Laboratory requested approval from the EPA Region 6 to formally change its sewage sludge disposal practices from land application under 40 CFR Part 503 regulations to landfill disposal as a PCB-contaminated waste. This change was necessary because of the repeated detection of low-level PCB (less than 5 ppm) in the SWSC Plant sewage sludge. The EPA approved the Laboratory's request and in September 1997 the Laboratory disposed of approximately 67 dry tons of sewage sludge as PCB-contaminated waste at a TSCA-permitted landfill in California. In November 1997, the Laboratory formally adopted the following interim management practice: All sewage sludge generated at the SWSC Plant will, until further notice, be handled, sampled, and disposed of in accordance with TSCA regulations for 50-499 ppm PCB-contaminated waste.

c. National Pollutant Discharge Elimination System Compliance Inspection. On May 15 and 16, 1997, the NMED Surface Water Quality Bureau conducted a Compliance Evaluation Inspection (CEI) at the SWSC Plant (NPDES Outfall 13S). NMED submitted the CEI report to the EPA and the Laboratory on January 23, 1998.

The CEI report documented the following concerns. Most deficiencies noted are administrative in nature and all concerns have been addressed by the Laboratory. Final resolution of the CEI had not been received from NMED by the end of 1997.

(1) Sludge management and disposal problems. The Laboratory disagrees with NMED's findings concerning record keeping and reporting, sampling, storage, and disposal under 40 CFR Part 503. The last time the Laboratory disposed of sludge by land application under 40 CFR Part 503 was November 1995. In September 1997, EPA approved LANL's request to manage and dispose of SWSC Plant sludge as PCB-contaminated waste.

(2) Issues concerning NPDES Outfall 001 and deleted Outfall 01S (both located in Sandia Canyon), and Outfall 13S (the SWSC Plant). The Laboratory also disagrees with these findings. NMED raised concerns that the deleted Outfall 01S has not been sampled. The NPDES permit does not require monitoring at the outfall. The Laboratory collects the NPDES compliance samples at the end of the chlorine contact chamber, as required by the NPDES permit for Outfall 13S. Outfall 13S effluent is then reused in cooling operations and discharges to Outfall 001 or through the deleted Outfall 01S to Sandia Canyon. The Laboratory's NPDES permit requires the Laboratory to utilize best management practices in such a manner as to enhance and maintain wetland areas in Sandia Canyon and Cañada del Buey. During 1997, Outfall 13S did not discharge into Cañada del Buey. The Laboratory is addressing wetlands maintenance below NPDES Outfall 001 through physical improvements to be installed by the Laboratory in 1998 designed to slow the water down.

(3) Deficiency in sample collection for fecal coliform. The Laboratory has changed its NPDES sampling procedures and sampling techniques for fecal coliform collection.

(4) Illegal discharge into a drainage located next to the SWSC Plant. The Laboratory has completed corrective actions to eliminate the discharge of treated effluent used in irrigation at the SWSC Plant from entering Cañada del Buey.

(5) Discharge of grease balls from the TA-46 SWSC Plant discharge (13S). The Laboratory has developed a waste acceptance criteria (WAC) for the discharge of oil and grease. SWSC operators conduct weekly inspections and cleaning of the chlorine contact chamber.

(6) Incorrect EPA method cited on the laboratory benchsheet. The analytical laboratory benchsheets have been updated to reference the currently approved EPA method.

d. National Pollutant Discharge Elimination System: Waste Stream Characterization Program and Corrections Project. The Water Quality and Hydrology Group (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. The Waste Stream Corrections Project was completed on March 31, 1997. Each of the 7,602 deficiencies identified in the WSC Final Reports was addressed by construction of physical improvements, by implementation of administrative controls, or by three modified permit applications submitted to the EPA on March 13, 1997.

During the Waste Stream Corrections project, operational safety reviews of completed construction were conducted by the Laboratory's Industrial Hygiene and Safety Group. As a result of these reviews, approximately 50 drains that were previously plugged to prevent noncomplying discharges from entering the environment were opened or rerouted in order to mitigate potential safety hazards.

On April 1, 1997, the Laboratory submitted the final Quarterly Progress Report (January 1, 1997 through March 31, 1997) to EPA certifying completion of the Waste Stream Corrections project in compliance with AO Docket No. VI-96-1236. All completed corrective actions have been tracked and verified by use of a database developed by the Laboratory. Information collected in this database will be used for preparation of the Laboratory's NPDES permit reapplication, which is due for submittal to the EPA in May 1998.

e. National Pollutant Discharge Elimination System Storm Water Program. NPDES permits are also required for storm water discharges. During 1997, the Laboratory had 14 NPDES permits for its storm water discharges (see Table 2-1). One permit is for the Laboratory site and includes storm water discharges related to industrial activity such as hazardous waste treatment, storage, and disposal 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 and electric power generating facilities. Five NPDES storm water permits are for the remediation of ER Project sites off of DOE property. The other eight permits are for construction activities that disturb more than five acres. The NPDES storm water permits expired on September 9, 1997, and under EPA guidance, the Laboratory applied for and received an administrative extension.

The NPDES permit requires the development and implementation of a Storm Water Pollution Prevention (SWPP) Plan. During 1997, the Laboratory developed and implemented over 70 SWPP Plans.

Under the NPDES storm water permit, monitoring activities are required at landfills and EPCRA, Section 313 facilities. In 1997, monitoring was conducted at TA-54, Areas G and J, and at TA-55. The monitoring data were submitted to EPA in the form of a Discharge Monitoring Report (DMR). The Laboratory submitted DMRs to EPA on October 28, 1997, for landfills and on January 27, 1998, for EPCRA, Section 313, facilities.

As part of the NPDES Storm Water Program, the Laboratory is operating stream monitoring stations on the canyons entering and leaving the Laboratory. In 1997, there were 19 stations on watercourses at the Laboratory. The discharge information for 1997 is reported in "Surface Water Data at Los Alamos National Laboratory: 1997 Water Year" (Shaull et al., 1998).

f. Spill Prevention Control and Countermeasures Program. The Laboratory's Spill Prevention Control and Countermeasures (SPCC) Plan, as required by the CWA, was developed in accordance with 40 CFR 112 and is a comprehensive plan developed to meet the requirements of EPA and NMED that regulate water pollution from oil spills. The purpose of the SPCC Plan is to ensure that adequate prevention and response measures are provided to prevent oil spills from reaching a watercourse. Prevention measures include maintenance and inspection of facilities to ensure the integrity of the oil and chemical handling equipment and proper operator training.

A triennial review of the SPCC Plan was completed by the Laboratory in March 1997. From this review, only oil storage tanks greater than 660 gal. are required to have a site-specific SPCC Plan. In keeping with the site-specific SPCC Implementation Plan approach, the operating conditions for each location are addressed and, as these change, only the individual site-specific SPCC Implementation Plan is revised.

g. Dredge and Fill Permit Program. Under Section 404 of the CWA, the Laboratory is required to obtain permits from the Army Corps of Engineers (COE) to perform work within perennial or intermittent watercourses. Projects involving excavation or fill below the normal high water mark must be performed with attention to the water quality and riparian habitat preservation requirements of the act. The Corps has issued a number of nationwide permits that cover specific activities. Each nationwide permit contains conditions that must be met by the permittee to protect water quality. Section 401 of the CWA requires states to certify that 404 permits issued by the Corps will not prevent attainment of state-mandated stream standards. The NMED reviews Section 404 permit applications and issues separate Section 401 certification letters, which include additional permit requirements to meet state stream standards for individual projects at the Laboratory.

As shown on Table 2-1, the Laboratory has six nationwide permits under the Sections 404/401 program; discharge activities permitted include utility lines, road crossings, headwaters and isolated waters, and wetland/riparian areas.

9. Safe Drinking Water Act

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 wellheads 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.

The particular locations within the water system where SDWA compliance samples are collected are specified in the regulations for each contaminant or group of contaminants. In 1997, the monitoring network for SDWA compliance sampling consisted of the following 4 location groups within the water system:

(1) wellhead sampling from the water supply wells in operation at the time of sampling (Guaje wells G-1, G-1A, G-2, G-4, G-5, G-6; Pajarito Mesa wells PM-1, PM-2, PM-3, PM-4, PM-5; and Otowi wells O-4, O-1);

(2) the 5 entry points into the distribution system (Pajarito Booster station #2, Guaje Booster station #2, PM-1 and PM-3 wellheads, and Otowi Booster station # 2 (formerly Los Alamos Booster station #4);

(3) the 6 total trihalomethane (TTHM) sampling locations within the distribution system; and

(4) the 41 microbiological sampling sites located throughout the Laboratory, Los Alamos County, and Bandelier National Monument.

The sampling program for drinking water quality is designed to meet or exceed regulatory requirements under the federal SDWA (see Table A-6) and the New Mexico Environmental Improvement Act. Sampling locations, frequencies, preservation, handling, and analyses follow the requirements specified in federal and state regulations. Chemical and radiological sampling is performed by Laboratory staff and submitted for analysis to the New Mexico Health Department's Scientific Laboratory Division (SLD) in Albuquerque. Dioxin analyses are performed by Triangle Laboratories, Inc., of Durham, NC. Microbiological sampling and analysis are performed by the JCNNM Environmental (JENV) laboratory. The JENV laboratory is certified by NMED for microbiological compliance analysis. Certification requirements include proficiency samples, maintenance of an approved quality assurance/quality control program, and periodic audits by NMED. Laboratory and JENV staff are certified by NMED to perform drinking water compliance sampling.

All data collected from SDWA compliance testing are submitted to the NMED's Drinking Water and Community Services Bureau for review and filing. The SLD and JENV laboratory report their analytical results directly to NMED. ESH-18 maintains both electronic and hard-copy files of all data collected from SDWA compliance testing.

b. Radiochemical Analytical Results. As required by the SDWA, in 1997, the Laboratory collected drinking water samples at the five entry points into the distribution system to determine the radiological quality of the drinking water. As shown in Table 2-5, the concentrations of gross alpha and gross beta activity were less than the screening limits. When gross alpha and beta activity measurements are below the screening limits, the Laboratory does not need to perform further isotopic analyses or perform dose calculations under the SDWA program. However, it should be noted that comprehensive monitoring of the water supply wells for radiochemical constituents is conducted annually by ESH-18 (see Table 5-22).

In 1997, the Laboratory conducted baseline sampling on the new Otowi well O-1. Baseline sampling is conducted for four consecutive quarters and is required by the SWDA for all new sources of water in a drinking water supply system. The three quarters of baseline sampling conducted in 1997 at the Otowi well O-1 were in compliance with the SWDA screening levels for gross alpha and gross beta activities.

Radon is a naturally occurring radionuclide produced during the decay of geological sources of uranium. In 1997, radon sampling was performed at the 13 operating water supply wellheads and the 5 entry points into the distribution system. This sampling was done to collect information before the issuance of final EPA regulations governing radon in drinking water. As shown in Table 2-6, the concentrations ranged from 109 to 647 pCi of radon per liter of water. On July 30, 1997, EPA withdrew the proposed MCL of 300 pCi of radon per liter of water. Congress has directed EPA to propose a new MCL for radon by August 1999 and promulgate a final rule by August 2000.

c. Nonradiological Analytical Results. In 1997, TTHM samples were collected during each quarter from six locations in the Laboratory and Los Alamos County water distribution systems. As shown in Table 2-7, the annual average for samples in 1997 was 6.3 µg of TTHM per liter of water, less than the SDWA MCL of 100 µg of TTHM per liter of water.

In 1997, inorganic constituents in drinking water were sampled at the 13 operating water supply wellheads. As shown in Table 2-8, all locations and all inorganic constituents were less than the MCLs.

In 1997, VOC samples were collected at the 13 operating water supply wellheads. No VOCs were detected at any of the sampling locations with the exception of 13.3 µg of chloroform per liter of water at Otowi well O-1 on April 18, 1997. The SWDA MCL for chloroform is 80 µg of chloroform per liter of water. Chloroform is a byproduct of chlorine disinfection. It is believed that the source of chloroform found in the sample was the chlorine used in disinfecting the well in the weeks before sampling. Chloroform was not detected during repeat sampling at Otowi well O-1 conducted on September 8 and November 14, 1997.

In 1997, synthetic organic compound (SOC) samples were collected at the 13 operating water supply wellheads. Baseline sampling at Otowi well O-1 for SOCs was conducted during the last three quarters of 1997. No SOCs were detected at any of the sampling locations.

In 1997, sampling for the presence of lead and copper from residential taps was not required by the SDWA. Sampling for lead and copper will resume in 1999.

Table 2-5. Radioactivity in Drinking Water (pCi/L) during 1997

	Gross Alpha			Gross Beta		
Sample Location	**Calibration Std.**	**Value**	**(Uncertainty)**	**Calibration Std.**	**Value**	**(Uncertainty)**
Wellheads:						
Otowi Well O-1	^{241}Am	2.6	(0.6)	^{137}Cs	2.4	(1.0)
(2nd Qtr 1997)	Natural U	2.9	(0.6)	^{90}Sr, ^{90}Y	2.3	(0.9)
Otowi Well O-1	^{241}Am	2.7	(0.7)	^{137}Cs	1.3	(0.8)
(3rd Qtr 1997)	Natural U	3.1	(0.8)	^{90}Sr, ^{90}Y	1.3	(0.8)
Otowi Well O-1	^{241}Am	2.6	(0.6)	^{137}Cs	1.9	(0.8)
(4th Qtr 1997)	Natural U	2.9	(0.7)	^{90}Sr, ^{90}Y	1.8	(0.8)
Entry Points:						
Pajarito Booster #2	^{241}Am	0.2	(0.3)	^{137}Cs	3.4	(0.9)
	Natural U	0.2	(0.3)	^{90}Sr, ^{90}Y	3.4	(0.9)
Guaje Booster #2	^{241}Am	1.1	(0.5)	^{137}Cs	2.9	(0.9)
	Natural U	1.3	(0.6)	^{90}Sr, ^{90}Y	2.8	(0.9)
Pajarito Well PM-1	^{241}Am	2.3	(0.6)	^{137}Cs	3.6	(0.9)
	Natural U	2.7	(0.6)	^{90}Sr, ^{90}Y	3.4	(0.8)
Pajarito Well PM-3	^{241}Am	1.3	(0.5)	^{137}Cs	3.6	(0.8)
	Natural U	1.6	(0.6)	^{90}Sr, ^{90}Y	3.4	(0.7)
Otowi Booster #2	^{241}Am	1.0	(0.6)	^{137}Cs	5.5	(1.3)
(formerly LA Booster #4)	Natural U	1.2	(0.7)	^{90}Sr, ^{90}Y	5.3	(1.2)
EPA Maximum Contaminant Level		15			none	
EPA Screening Level		5			50	

d. Microbiological Analyses of Drinking Water. Each month during 1997, an average of 46 samples was collected from the Laboratory, Los Alamos County, and Bandelier National Monument's water distribution systems to determine the free chlorine residual available for disinfection and the microbiological quality of the drinking water. Of the 552 samples analyzed during 1997, 2 indicated the presence of total coliforms. None of the samples indicated the presence of fecal coliforms. Noncoliform bacteria were present in 29 of the microbiological samples. Noncoliform bacteria are not regulated, but their presence in repeated samples may serve as indicators of stagnation and biofilm growth in water pipes. A summary of the monthly analytical data is presented in Table 2-9.

e. Long-Term Trends. The Los Alamos water system has never incurred a violation for a SDWA regulated chemical or radiological contaminant. The water supply wells have, on occasion, exceeded proposed SDWA MCLs for arsenic and radon because of their natural occurrence in the main aquifer. Violations of the SDWA MCL for microbiological constituents occurred in 1993 and 1994. Both of these violations were attributed to localized contamination in the distribution system and not microbiological contamination of the main aquifer.

f. Drinking Water Inspection. The District II Field Office of the NMED did not conduct an inspection of the drinking water system during 1997.

Table 2-6. Radon in Drinking Water (pCi/L) during 1997

Sample Location	Value	(Uncertainty)
Entry Points:		
Pajarito Booster #2	472	(28)
Guaje Booster #2	194	(17)
Pajarito Well-PM1	263	(18)
Pajarito Well-PM3	338	(22)
Otowi Booster #2	322	(21)
Wellheads:		
Pajarito Well-PM1	263	(18)
Pajarito Well-PM2	647	(36)
Pajarito Well-PM3	338	(22)
Pajarito Well-PM4	490	(29)
Pajarito Well-PM5	452	(27)
Guaje Well-G1A	377	(25)
Guaje Well-G1	398	(25)
Guaje Well-G2	392	(25)
Guaje Well-G4	398	(26)
Guaje Well-G5	338	(23)
Guaje Well-G6	423	(27)
Otowi Well-O4	440	(26)
Otowi Well-O1	109	(10)

Table 2-7. Total Trihalomethanes in Drinking Water (μg/L) during 1997

	1997 Quarters			
Sample Location	**First**	**Second**	**Third**	**Fourth**
Distribution Sites:				
Los Alamos Airport	2.9	10.1	17.5	10.0
White Rock Fire Station	<0.5	<0.5	<0.5	<0.5
North Community Fire Station	0.7	5.4	5.7	4.9
S-Site Fire Station	<0.5	5.7	10.7	5.5
Barranca Mesa School	<0.5	2.3	12.5	1.3
TA-39, Bldg. 02	8.9	13.7	15.6	15.1
1997 Average of 6.3 μg/L				
EPA Maximum Contaminant Level			100.0	
Sample Detection Limit			0.5	

Table 2-8. Inorganic Constituents in Drinking Water (mg/L) during 1997

Sample Location	As	Ba	Be	Cd	Cr	F	CN	Hg	Ni	NO_3 (as N)	Se	Sb	Tl
Wellheads:													
Pajarito Well-PM1	0.002	<0.1	<0.001	<0.001	0.003	<0.40	<0.005	<0.0002	<0.01	0.50	<0.005	<0.001	<0.001
Pajarito Well-PM2	0.001	<0.1	<0.001	<0.001	0.003	<0.40	<0.005	<0.0002	<0.01	0.30	<0.005	<0.001	<0.001
Pajarito Well-PM3	0.002	<0.1	<0.001	<0.001	0.003	<0.40	<0.005	<0.0002	<0.01	0.50	<0.005	<0.001	<0.001
Pajarito Well-PM4	0.002	<0.1	<0.001	<0.001	0.005	<0.40	<0.005	<0.0002	<0.01	0.30	<0.005	<0.001	<0.001
Pajarito Well-PM5	0.001	<0.1	<0.001	<0.001	0.005	<0.40	<0.005	<0.0002	<0.01	0.30	<0.005	<0.001	<0.001
Guaje Well-G1A	0.015	<0.1	<0.001	<0.001	0.007	0.70	<0.005	<0.0002	<0.01	0.40	<0.005	<0.001	<0.001
Guaje Well-G1	0.007	<0.1	<0.001	<0.001	0.005	0.40	<0.005	<0.0002	<0.01	0.40	<0.005	<0.001	<0.001
Guaje Well-G2	0.038	<0.1	<0.001	<0.001	0.008	0.80	<0.005	<0.0002	<0.01	0.40	<0.005	<0.001	<0.001
Guaje Well-G4	0.003	<0.1	<0.001	<0.001	0.002	<0.40	<0.005	<0.0002	<0.01	0.60	<0.005	<0.001	<0.001
Guaje Well-G5	0.003	<0.1	<0.001	<0.001	0.002	<0.40	<0.005	<0.0002	<0.01	0.60	<0.005	<0.001	<0.001
Guaje Well-G6	0.003	<0.1	<0.001	<0.001	0.002	<0.40	<0.005	<0.0002	<0.01	0.50	<0.005	<0.001	<0.001
Otowi Well-O4	0.002	<0.1	<0.001	<0.001	0.003	<0.40	<0.005	<0.0002	<0.01	0.30	<0.005	<0.001	<0.001
Otowi Well-O1 (4/97)	0.005	<0.1	<0.001	<0.001	0.010	<0.40	<0.005	<0.0002	<0.01	1.00	<0.005	<0.001	<0.001
Otowi Well-O1 (11/97)										0.44			
EPA Maximum Contaminant Levels	0.05[a]	2.0	0.004	0.005	0.1	4.0	0.2	0.002	0.1	10.0	0.05	0.006	0.002

[a] Proposed SDWA Primary Drinking Water Standard.

10. Groundwater

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

DOE Order 5400.1 requires the Laboratory to prepare a Groundwater Protection Management Program Plan (GWPMPP) that 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.

Module VIII of the RCRA Hazardous Waste Facility Permit, i.e., 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.

New Mexico Water Quality Control Commission (NMWQCC) regulations control liquid discharges onto or below the ground surface to protect all groundwater in the State of New Mexico. Under the regulations, when required by the NMED, 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 discharge plan.

The Laboratory has three approved groundwater discharge plans to meet NMWQCC regulations (Table 2-1): one for TA-57 (Fenton Hill); one for the SWSC Plant; and one for the land application of dried sanitary sewage sludge from the SWSC Plant. On April 10, 1997, the Laboratory submitted an application to renew the SWSC Plant groundwater discharge plan that was scheduled to expire on July 20, 1997. On January 7, 1998, the NMED approved the renewal application for a period of five years. At the request of NMED, on August 20, 1996, the

Table 2-9. Bacteria in Drinking Water at Distribution System Taps during 1997

Month	No. of Samples Collected	No. of Positive Tests		
		Coliform	**Fecal Coliform**	**Noncoliform**
January	50	1	0	4
February	45	0	0	1
March	46	0	0	1
April	45	0	0	0
May	49	1	0	3
June	46	0	0	0
July	45	0	0	6
August	44	0	0	1
September	46	0	0	1
October	45	0	0	5
November	46	0	0	3
December	45	0	0	4
Total 1997	552	2	0	29
Maximum Contaminant Level (MCL)		[a]	[b]	[c]

[a]The MCL for coliforms is positive samples not to exceed 5% of the monthly total.
[b]The MCL for fecal coliforms is no coliform positive repeat samples following a fecal coliform positive sample.
[c]There is no MCL for noncoliforms.

Laboratory submitted a groundwater discharge plan application for the Radioactive Liquid Waste Treatment Facility at TA-50. As of December 31, 1997, approval of the plan by NMED was still pending.

b. Compliance Activities. The Laboratory's revised GWPMPP was approved by DOE in March 1996. The plan provides general management goals and direction to activities pertaining to groundwater quality and quantity.

In March 1997, the NMED approved a proposed comprehensive hydrogeologic characterization and groundwater monitoring plan for the Laboratory. The plan was developed in response to NMED's denial of the Laboratory's RCRA groundwater monitoring waiver demonstrations. The plan proposes a major long-term drilling and hydrologic analysis program to broadly characterize the hydrogeology of the Pajarito Plateau and to assess in detail the potential for groundwater contamination to occur from individual waste disposal operations. The plan contains a prioritized list of activities and studies addressing the above.

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. Studies by various Laboratory programs are integrated by the GWPMPP administered by ESH-18. Some key 1997 activities are listed below.

(1) The "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G" was completed in March by the Waste Management Program. This report includes several studies reflecting our understanding of groundwater flow and transport beneath mesa top settings at the Laboratory. The report estimates dose to the public for a 1,000-yr period beginning after assumed facility closure in 2044. The analysis showed that TA-54, Area G is expected to meet these and other required performance objectives. The calculated dose for all pathways was 0.0001 mrem per year (compared to a 25 mrem per year limit). The calculated dose for groundwater was 0.000035 mrem per year (compared to a 4 mrem per year limit).

(2) In September 1997, the ER Project began drilling the first deep characterization borehole, as required by the Hydrogeologic Workplan. The borehole is located at the Laboratory's eastern boundary in Los Alamos Canyon. When completed, it will be the first main aquifer characterization well drilled at the Laboratory since 1961.

(3) Environmental surveillance program and ER Project investigations at TA-54 and TA-49 indicate that the portion of the mesa at an elevation above the neighboring canyon bottom is subjected to a naturally occurring evaporation and drying mechanism. This evaporation apparently occurs by air movement along fractures and higher permeability zones. The consistency in results at the two sites, one on the eastern edge of the Laboratory and the other on the south central edge, indicates that this phenomenon may occur at most mesa settings. This drying process results in very low infiltration rates within the mesa.

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 whether proposed major actions will significantly affect the environment 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 responsibility 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 Order 451.A, DOE reviews proposed LANL activities and determines whether the activity qualifies for a categorical exclusion from the need to prepare further NEPA documentation based on previous agency experience and analysis or whether to prepare the following:

- an Environmental Assessment (EA), which should briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI) for the proposed action,
- an EIS, which is a detailed written statement of impacts with a subsequent Record of Decision (ROD).

If an EA or an EIS is required, the DOE is responsible for its preparation. In some situations, a LANL project may require an EA or EIS but, because the project is connected to another larger action requiring an EIS (e.g., the LANL Site-Wide EIS or a programmatic EIS done at the nationwide level), it may be included in the EIS analyzing the larger action or may later tier off the final programmatic EIS after a ROD is issued.

LANL project personnel initiate NEPA reviews by completing environment, safety, and health identification documents, which form the basis of a DOE NEPA environmental review form formerly known as a DOE Environmental Checklist. These forms are written by the LANL Ecology Group (ESH-20) using the streamlined format known as a NEPA Environmental Review form, specified by the DOE/Los Alamos Area Office (LAAO).

b. Compliance Activities. In 1997, LANL sent 137 NEPA environmental review forms to DOE for review. DOE categorically excluded 129 actions and made a determination for 6 other actions. Two actions were unresolved in 1997. Pursuant to authority delegated by DOE, LANL applied "umbrella" categorical exclusion determinations for 117 actions. DOE completed three EAs and issued three FONSIs in 1997.

c. Site-Wide Environmental Impact Statement. Under DOE's compliance strategy for NEPA, a Site-Wide Environmental Impact Statement (SWEIS) is prepared to examine the environmental impacts of operations at a multiprogram site. A SWEIS was prepared for the operation of LANL in 1979. That document and subsequent NEPA reviews for specific project or program activities have served as the NEPA basis for operations at LANL since 1979. DOE is now preparing an updated SWEIS to replace the 1979 SWEIS, and future NEPA documents at LANL will be tiered from or reference this SWEIS. This SWEIS addresses operation of LANL (from 1997 through 2006) across the approximately 43 square miles of government land under the administrative control of DOE. DOE is the lead agency and Los Alamos County is a cooperating agency (due to the interdependence of county and DOE planning) in the preparation of this SWEIS.

The process for the preparation of this SWEIS was designed to enhance the participation of members of the public. The SWEIS Advance Notice of Intent, published in the *Federal Register* (FR) on August 10, 1994 (59 FR 40889), identified possible issues and alternatives to be analyzed. It was followed by a series of public meetings intended to both provide information on LANL and the plans for the SWEIS and to obtain public input regarding the scope of the SWEIS. Based on the input received during this "prescoping" period, DOE prepared and published the Notice of Intent to prepare the SWEIS on May 12, 1995 (60 FR 25697). This publication was also followed by a series of public meetings to provide opportunities for stakeholders to identify the issues, environmental concerns, and alternatives that should be analyzed in the SWEIS. Nearly 1,300 comments from 215 commentors were recorded. DOE began preparing the draft SWEIS document in late 1996 and continued this effort during 1997.

Two of the Laboratory's projects were previously considered EA-level and during 1997, these projects were instead included in the SWEIS. The project descriptions follow.

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 analysis for this project considers five alternatives for the management of LLWs: (1) using the active disposal area at Area G until it is full, (2) developing Zone 4 at TA-54, west of the active disposal area, (3) developing Zone 6 at TA-54, west of Area L and extending to Area J, (4) developing the North Site at TA-54, north of Zone 6, and (5) developing another location within the Laboratory, with TA-67 used as a representative undeveloped mesa site. Potential environmental, safety, and health issues include land use, air quality, ecological resources, soil, surface water, threatened and endangered species, cultural resources, and environmental restoration.

Enhancement of Pit Manufacturing Operations. The proposed action is to relocate or upgrade certain existing operations and to construct an access road to support plutonium pit (the central core of a nuclear weapon typically composed of plutonium-239 and/or highly enriched uranium) manufacturing operations at LANL. Essential operations at TA-55 and the Chemistry and Metallurgy Research (CMR) Building would be expanded and relocated between TA-55 and the CMR Building or upgraded in place. A new controlled access road would be constructed between TA-55 and the CMR Building. As a result of these upgrades and construction activities, LANL would be able to manufacture each type of pit required to support the existing nuclear weapons stockpile. In addition, the Laboratory would be able to produce a maximum of up to 80 pits per year if required. Alternatives to the proposed action include configuration for expanding existing facilities as well as the construction of a new facility. Potential environmental, safety, and health issues include worker exposure to construction hazards as well as interruption to existing traffic patterns and minor increases in traffic volumes.

d. Environmental Assessments. The status of the Laboratory's EA-level NEPA documentation and project descriptions follow.

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. The DOE needs to maintain the capability to continue to perform uninterrupted interim and ongoing radioactive chemical and metallurgical research activities in a safe, secure and environmentally sound manner at LANL. DOE proposes to extend the life of the building 20 years by performing 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, safety, and health issues include worker safety while the work is performed and LLW disposal. The EA for this proposed action was completed, and a FONSI was issued in February 1997.

Transfer of the DP Road Tract to the County of Los Alamos. Under the proposed action, DOE intends to transfer ownership of a 28-acre tract of land located along DP Road, currently part of TA-21, to the County of Los Alamos. The transfer of this tract of land would result in a permanent change to the existing DOE property boundaries for TA-21. The county proposes to construct a new office building to house county employees, a new warehouse, garages, and a support building in order to transfer its equipment maintenance, school bus yard, and school supplies warehousing activities to the site. The alternative action is not to transfer the land and to continue to maintain government ownership of the tract. Potential environmental, safety, and health issues include worker and public exposure to construction hazards and nonradioactive air emissions from operations and from increased vehicular traffic. The proposed action could create approximately 450 new direct jobs and 585 indirect jobs. The EA for this action was completed, and a FONSI was issued in January 1997.

Lease of Land for the Development of a Research Park at LANL. DOE proposes to lease to the County of Los Alamos approximately 60 acres of land located in TA-3. This tract of land is bordered on the east by Diamond Drive, West Jemez Road on the south, West Road on the west, and Los Alamos Canyon on the north. The existing DOE property site boundary would not change under the proposed action. The county would be responsible for construction, development, and operation of the research park. The county or future tenants would be prohibited from developing the tract for residential uses, heavy industrial uses, or any other uses that would not be consistent with LANL mission operations. Approximately 10 variably sized office buildings and supporting infrastructure are to be built on this tract. Approximately 300,000 ft^2 of floor space is planned for the site with parking for up to 1,400 cars. Up to 1,500 employees are anticipated to occupy the research park after its completion. Roadway improvements would be necessary for West Road, West Jemez Road, and Diamond Drive. Traffic signals would need to be modified on West Jemez Road at Casa Grande and Pajarito Roads. Alternatives that were considered but dismissed include the following: (1) lease of the tract to a nongovenment entity, (2) lease of the tract to another federal agency or Indian tribe, (3) transfer ownership of the proposed research park land to the county, (4) transfer of the land to entities other than the county, and (5) lease of a tract at another LANL location. Potential environmental, safety, and health issues include worker exposure to construction hazards as well as interruption of existing traffic patterns and minor increases in traffic volumes. The EA for this proposed action was completed, and a FONSI was issued in October 1997.

e. Mitigation Action Plans. Mitigation Action Plans (MAPs) are designed to (1) document potentially adverse environmental impacts of a proposed action, (2) identify commitments made in the final NEPA documents, and (3) establish action plans to carry out each commitment. The status of the Laboratory's MAPs follows.

Dual Axis Radiographic Hydrodynamic Test Facility Mitigation Action Plan. In August 1995, DOE published a final EIS on the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility at LANL. DOE published a ROD on this final EIS in the Federal Register (60 FR 53588) on October 16, 1995. The DARHT ROD states that DOE has decided to complete and operate the DARHT facility while implementing a 10-yr phased-containment program to conduct most tests inside steel containment vessels.

The ROD further states that DOE must develop several mitigation measures to protect workers, soils, water, and biotic and cultural resources in and around the DARHT facility. The DOE has published the first official DARHT MAP Annual Report, which identified potential impacts associated with the course of action selected in the ROD and commitments and action plans that DOE considers necessary to mitigate these potential impacts.

Low-Energy Demonstration Accelerator Mitigation Action Plan. In conjunction with the Low-Energy Demonstration Accelerator (LEDA) EA and FONSI, approved in April 1996, DOE issued a MAP that defined a scope of activities that would be implemented to mitigate some of the potential environmental impacts associated with the LEDA project. The LEDA MAP is being implemented by LEDA project management and overseen by DOE/LAAO and ESH-20.

The MAP requires a written annual report to provide the status of the LEDA schedule and the action taken on the identified mitigation measures. 1997 was the second year of LEDA project development. The LEDA project was scaled back and will now only proceed to Stage III as described in the EA and allowed by the current safety analysis document. Because Stages IV and V development have been removed from the LEDA project schedule, the large quantities of water and power use estimated in the final LEDA EA will no longer be required and generated. This affects the LEDA MAP because the land disturbance issue for utility line installation is removed and the quantity of water released into Sandia Canyon will be much less. For example, no erosion is expected at the drainage channel of NPDES Outfall 03A113, and it is unlikely that a wetland will be created in Sandia Canyon. Thus, potential environmental impacts mentioned in the final EA and MAP will be eliminated or much reduced due to the changes in the project.

During early FY97, planning was completed for the remediation of a potential release site containing lead shot (pellets) near Outfall 03A113 and the LEDA site. All of the necessary documentation and approvals for the cleanup by the LANL ER Project were conducted and completed as required before a remediation. The lead-shot site was successfully cleaned up in FY97. Laboratory samples showed no traces of lead in the soil afterwards.

Lease of Land for the Development of a Research Park at LANL Mitigation Action Plan. DOE issued this MAP in October 1997. The EA indicates that potential adverse effects of the proposed action under normal conditions would be minimal. However, the EA includes provisions concerning the analysis of the environmental effects of the proposed site development and subsequent occupation to mitigate any potential adverse effects that could result from future construction activities on the site. DOE's commitment to mitigate possible adverse effects related to potential habitat or cultural resources will be included in appropriate final lease documents. Temporary site exclusion zones will be established to protect ongoing Mexican spotted owl and cultural resource surveys, evaluations, and data recovery activities located on and near the site. Additionally, the mitigations include the establishment of a site buffer zone next to Los Alamos Canyon where construction will be excluded.

The DOE has overall responsibility for insuring the adequate and timely completion of all actions associated with this MAP. ESH-20 is responsible for conducting the mitigation measures, data collection, and monitoring activities.

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, supporting DOE's compliance requirements 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 106 of the National Historic Preservation Act Public Law 89-665 (implemented by 36 CFR 800) requires federal agencies to evaluate the impact of all proposed actions 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.

During 1997, Laboratory archaeologists evaluated 751 Laboratory proposed actions; 28 new field surveys were conducted to identify cultural resources. The results of 12 surveys were sent by DOE 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 were also sent to the governors of the Pueblos of San Ildefonso, Santa Clara, Cochiti, Jemez, and to the President of the Mescalero Apache tribe for comment and identification of any traditional cultural properties which may be affected by a proposed action. No adverse effects to prehistoric cultural resources were identified in 1997.

The American Indian Religious Freedom Act of 1978 (Public Law 95-341) stipulates that it is federal policy to protect and preserve the right of American Indians to practice their 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 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. No inadvertent discoveries of burials or cultural objects were made during 1997.

The Archeological Resources Protection Act 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. One illicit pot-hunting incident was discovered on DOE land in 1997.

13. Biological Resources including Floodplain and Wetland Protection

a. Introduction. The DOE and the Laboratory must comply with the Endangered Species Act, the Migratory Bird Treaty Act; the Bald Eagle Protection Act; EO 11988, Floodplain Management; EO 11990, Protection of Wetlands (EPA 1989); and Section 404 of the CWA. The Laboratory also considers plant and animal species listed under the New Mexico Conservation Act and the Endangered Species Act.

b. Compliance Activities. During 1997, ESH-20 reviewed approximately 750 proposed Laboratory actions for potential impact on threatened and endangered species. The Biology Team of ESH-20 reviewed 210 proposed Laboratory projects for their impact on biological resources. 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 project area. The Biology Team also identified approximately 60 projects that required habitat evaluation surveys to assess if the appropriate habitat types and habitat parameters were present to support any threatened or endangered species. In addition, the Biology Team identified 15 projects that required a species-specific survey designed to determine the presence or absence of a threatened or endangered species at the project site. As a result of species-specific surveys, five biological assessments were prepared and submitted to the US Fish and Wildlife Service. The Laboratory adhered to protocols set by the US Fish and Wildlife Service and permit requirements of the New Mexico State Game and Fish Department.

c. Biological Assessments. The Biology Team is currently preparing a threatened and endangered species habitat management plan on behalf of the DOE as part of the DARHT MAP commitments by DOE. The site plan should be completed in October 1998 and will be used to further evaluate and manage the threatened and endangered species occupying DOE/Laboratory property.

C. Current Issues and Actions

1. Compliance Agreements

a. Mixed Waste Federal Facility Compliance Order. DOE and the Laboratory are required by the Federal Facility Compliance Act of 1992 (section 3021[b] of RCRA) to prepare a Site Treatment Plan (STP) describing the development of treatment capacities and technologies for treating mixed waste generated at LANL that is being stored beyond the one-year time frame provided for in the land disposal restrictions (Section 3004(j) of RCRA and 40 CFR Section 268.50). On October 4, 1995, the State of New Mexico issued the Federal Facility Compliance Order to both DOE and UC requiring compliance with the STP and thereby terminating the Federal Facility Compliance Agreement that had previously been in effect (ESP 1996). The Laboratory met all 1997 STP deadlines and milestones.

b. Federal Facility Compliance Agreement on Storage of Polychlorinated Biphenyls. On August 8, 1996, DOE, the Naval Nuclear Propulsion Program, and EPA entered into a PCB Federal Facility Compliance Agreement pertaining specifically to radioactive PCB and PCB waste containing RCRA wastes. The Agreement is intended to be a compliance bridge from now until EPA's December 6, 1994, proposed rule updating the PCB regulations is final. The Agreement also contains provisions to address the discrepancy created in the TSCA PCB regulations when the Department of Transportation changed its container specifications. The PCB

Agreement incorporates the proposed rule and provides regulatory relief for facilities now. When EPA makes the final decision, it will supersede the PCB Federal Facility Compliance Agreement.

The PCB Federal Facility Compliance Agreement requires an annual report to be prepared by DOE and submitted to EPA. LANL met that requirement in 1997.

c. National Pollutant Discharge Elimination System Federal Facility Compliance Agreement and Administrative Order. AO Docket No. VI-96-1236, issued to the Laboratory on September 16, 1996, incorporated the revised High-Explosive Wastewater Treatment Plant (HEWTP) schedule and the new schedule for completion of the remaining corrective actions for the WSC project. The Laboratory met the March 31, 1997, deadline to complete 100% of the WSC corrective actions, as specified in the AO and corresponding Federal Facilities Compliance Agreement (Docket No. VI-96-1237).

The new TA-16 HEWTP (NPDES Outfall 05A055) is also covered under AO Docket No. VI-96-1236. The AO required construction of the new HEWTP to be completed by September 1997 and in compliance with effluent limits by October 1997. Construction, initial testing, and startup of the new facility has been completed. New WAC have been developed based on RCRA universal treatment standards, New Mexico Stream Standards, and NPDES permit requirements. All HE wastewater is characterized through the Laboratory's Waste Profile Form process. Wastewater that does not meet the WAC is evaluated against the NPDES limits and may be sent to the existing HEWTP, which will remain on-line and serve as a backup treatment facility until all HE waste streams are characterized and are confirmed to meet the WAC for the new HEWTP. Both the new and the backup HEWTP are currently meeting NPDES permit requirements.

2. Environmental Oversight and Monitoring Agreement

The Environmental Oversight and Monitoring Agreement—known as the Agreement in Principle (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 period for the current AIP is effective through September 30, 2000.

During 1997, the NMED/DOE Oversight Bureau staff focused most of their resources on environmental surveillance activities. This independent monitoring program allows the Laboratory's data to be verified. NMED regularly holds public meetings and publishes reports on its independent assessments of quality at the Laboratory. Highlights of these activities are presented below (NMED 1998).

Air particulate and water vapor monitoring: The DOE Oversight Bureau maintains five air particulate samplers co-located with the Laboratory's Air Monitoring Network (AIRNET) samplers. Overall, the Bureau's data for 1997 were similar to data reported by the Laboratory.

Environmental radiation dosimetry: The DOE Oversight Bureau maintains a network of 12 thermoluminescent dosimeters (TLDs) for measuring the levels of gamma radiation and any Laboratory-related gamma radiation anomalies. Levels of gamma radiation measured by the Bureau were consistently lower than the levels measured by the Laboratory, and none of the TLD measurements were above natural background radiation levels.

Environmental radiation ambient monitoring system: The Bureau maintains an air monitoring station in Santa Fe that is part of a national EPA-sponsored network designed to collect air and water samples for analysis of radioactivity. Data from this station is available at *http://www.epa.gov/narel/erdonline.html* on the World Wide Web.

Surface water and groundwater: In 1997, the DOE Oversight Bureau began evaluating the influence of the Pajarito fault zone on surface water infiltration in Pajarito Canyon, Cañon de Valle, and Water Canyon. The study found contaminants in Cañon de Valle surface water and indications of perennial flows in both Pajarito Canyon and Cañon de Valle. Field data were also collected to better understand perennial surface water in Sandia Canyon.

The Bureau also performed a study of water and sediment quality at two locations on the Rio Grande—one upstream of the Laboratory and one downstream. Preliminary data indicate that the water quality was similar at both locations.

During 1997, Bureau staff conducted eight informal inspections at the Laboratory for liquid release notifications, the NPDES outfall reduction program, and construction activities.

Sediments, soils, vegetation, and foodstuffs: Preliminary comparisons of the analysis of split samples from selected locations indicate Laboratory data are consistent with the Bureau's data and tract historical radiological trends.

Environmental Restoration Project: The NMED formed a working group to integrate the regulatory and technical requirements of the regulations governing the ER Project at the Laboratory. The DOE Oversight Bureau staff actively participated in the prioritization of cleanup projects based on health or environmental risks versus prioritization of interim measures based on the potential for contaminant migration. Bureau staff continued to work with regulatory agencies and the ER Project to develop consensus on technical approaches in order to facilitate the review of requests for no further action.

The Bureau continues to work with the Laboratory to identify ER Project sites with the potential for erosion and to determine what measures are needed to prevent the migration of contaminants into watercourses. Staff reviewed stabilization measures at TA-21 and TA-9, Area M.

NEPA**:** The DOE Oversight Bureau reviewed and commented on three draft DOE NEPA documents for proposed activities at the Laboratory.

D. Significant Events

1. Consent Decree/Settlement Agreement. During 1997, the DOE and the Laboratory Director entered into a Consent Decree and a Settlement Agreement to resolve a lawsuit filed by Concerned Citizens for Nuclear Safety (CCNS) in 1994 that alleged that LANL was not in full compliance with the Clean Air Act Radionuclide NESHAP, 40 CFR 61 Subpart H. Many of the provisions of the decree and the agreement were initiated in 1997 and are as follows:

- $150,000 payment to the US Treasury. Per the Consent Decree, the DOE submitted the paperwork for payment to the US Treasury Department in April 1997.
- Independent technical audits of the Laboratory's Radionuclide NESHAP program. Per the provisions of the decree and agreement, an independent team was selected and began the technical audit in June 1997. The audit is expected to be completed in fall 1998. The audit report will be submitted to DOE, which will provide copies to EPA Region 6, CCNS, and to the Laboratory's public reading room. Additional audits will be performed in future years as required.
- AIRNET stations. Per the Consent Decree, four AIRNET stations in the proximity of TA-54, Area G are operating and will continue to be operated for the next five years. In addition, AIRNET stations were installed and are operating at TA-33 and in the Santa Fe area. The quarterly raw data and analyses have been provided to the Laboratory's Reading Room and to CCNS.
- Additional thermoluminescent dosimeters (TLDs). Per the Consent Decree, in May 1997 approximately 50 new TLDs were added to the existing TLD monitoring network. The new TLDs were placed at the 17 AIRNET compliance stations, as well as at TA-53, TA-50, TA-54, TA-16, and TA-15. Seven TLDs specific to neutron detection were installed at TA-18. Duplicate TLDs were installed for quality assurance measurements. An independent laboratory is currently under contract to analyze the duplicate quality assurance TLDs. The quarterly raw data and analyses have been provided to the Laboratory's reading room and to CCNS.
- Operation of northern New Mexico NEWNET stations. Per the Consent Decree, the DOE calibrated the NEWNET stations located in northern New Mexico, and the stations are fully operational. The NEWNET data is available at *http://newnet.jdola.lanl.gov/* on the World Wide Web.
- Meetings on environmental, safety, and health issues. Per the Consent Decree, the UC's ESH Panel (a group whose purpose is to provide advice and consultation to the UC President's Council on National Laboratories) met on July 17, 1997, to hear the public's concerns on environmental issues specific to LANL. The Laboratory Director met with CCNS representatives in July 1997 to discuss protection of employees from retaliation or harassment for voicing environmental concerns, as well as to discuss CCNS's environmental concerns. Four public meetings were held in 1997 dealing with environmental issues specific to LANL's processes and programs.
- Payment to the University of New Mexico (UNM) School of Medicine. Per the Settlement Agreement, in April 1997, DOE allocated $150,000 to the UNM School of Medicine to fund development of curriculum in the Masters of Public Health degree program on environmental health issues.
- Five-day course in radiation education. Per the Settlement Agreement, in September 1997, a five-day training course on radiation exposure

and radiation protection was presented to representatives of CCNS, the Four Accord Pueblos, and regional city/county government officials in Española, NM.

- Radiation detection equipment loan program. Per the Settlement Agreement, radiation monitoring equipment was purchased in 1997 for use by individuals who attended the five-day training course. The equipment will be available through December 31, 2002. Additional equipment is continuing to be evaluated and tested for use in this program.

2. Lummis Fire.

On June 27, 1997, a wildland fire was ignited by a lightning strike in the Lummis Canyon area of Bandelier National Monument. This fire, the Lummis Wildland Fire, was managed as a prescribed natural fire. It was allowed to burn on the mesas, but handlines were constructed and backlines were secured to prevent the fire from entering nearby canyons. On July 9, it was determined that the Lummis Wildland Fire did not pose a threat to life and property, and the prescribed fire teams were demobilized. The fire burned 1,660 acres all within Bandelier National Monument.

3. Interagency Wildfire Management Team.

In the wake of the Dome Fire (Balice 1996), LANL formed the Interim Fire Management Team at the request of DOE in May 1996. After the Lummis Wildland Fire, it became evident that a more permanent organization was needed. In July 1997, the Laboratory formed the Interagency Wildfire Management Team (IWMT), which includes representatives of the following Laboratory groups: ESH-20, Emergency Management Response, Fire Protection, the ER Project, ESH-18, ESH-17, and Utilities and Infrastructure. ESH-20 chairs the IWMT. External participants include representatives from the DOE/LAAO, the Los Alamos County Fire Department, US Forest Service, Bandelier National Monument, Pueblo of San Ildefonso, NM State Forester's Office, and NM DOE Oversight Bureau. The IWMT operates under an agreement in principle.

The IWMT has worked to reestablish fire roads and fire breaks, as well as thinning trees to reduce fire fuel. In addition, a permanent logistical support center that includes a helibase for fire suppression operations was established at TA-49, allowing for rapid response by both Bandelier National Monument and LANL during the Lummis wildfire. The lines of communication and coordination between all agencies have also been strengthened.

4. National Resources Trustee Council

During 1997, DOE began to establish a Natural Resources Trustee Council in order to provide for the restoration of natural resources injured and services lost as a result of unpermitted releases of hazardous substances or discharge of oil from LANL in accordance with applicable federal laws and regulations (including sections 101, 104, 107, and 120 of CERCLA; and the Natural Resource Damage Assessment Regulations, 43 CFR Part 11 and 15 CFR Part 990). The Council provides a framework for coordination and cooperation between the trustees in order to meet this goal. Participating trustee organizations include the United States Departments of Energy, Interior, and Agriculture; the State of New Mexico; and the Pueblos of Cochiti, Jemez, San Ildefonso, and Santa Clara.

5. Lawsuit Filed

In May 1997, a national coalition of 39 citizen interest groups filed a motion with the U.S. District Court in Washington D.C. asking for a preliminary injunction to force DOE to stop work on 13 facilities at LANL, Lawrence Livermore National Laboratory and Pacific National Laboratory. The suit also charged that the 1996 Stockpile Stewardship and Management (SSM) Programmatic Environmental Impact Statement (PEIS) was inadequate and asked the Court to enforce a 1990 order for the DOE to prepare a PEIS on its Environmental Restoration Program. The DOE's SSM Program oversees the safety, security and reliability of the nation's nuclear weapons stockpile, and is a key mission at LANL. In August, the Court denied the motion for preliminary injunction. Subsequently, in January 1998, the coalition filed an amended complaint; in August 1998, the Court dismissed the portion of the plaintiff's case on the adequacy of the SSM PEIS.

E. Awards

1. Water Quality

Members of the SDWA/Engineering and NPDES Outfall Teams, at ESH-18 received awards during 1997: the 1997 Pollution Prevention Award (EM Division) for NPDES Outfall Reduction, the 1997 Distinguished Performance Award (ESH-Division) for

NPDES Outfall Reduction, and the 1997 Albuquerque Field Office Team Quality, Silver Award, was issued by DOE Albuquerque Operations Office for dedication and excellence by the High Explosives Wastewater Treatment Facility Team.

2. Air Quality

In late 1997, ESH-17 applied for and won the annual Donald Summers Quality Excellence Award for 1997. This award recognizes the organization with an outstanding quality program and adherence to quality management practices. The award was established in recognition of the late group leader of the Quality Management Group who was a strong advocate for quality within the Laboratory.

3. Air Emissions and Pollutants

a. Fuelwood Removal. LANL, through the efforts of the IWMT, won the 1997 Innovative Pollution Prevention Award" for their alternative fire control efforts at the State Road 501 fuel break." This award was presented by the New Mexico Facility Managers Network and the City of Albuquerque. Instead of conducting a prescribed burn of 110 acres at LANL, the IWMT determined that cutting and removing trees was the best approach. Trees were marked by Laboratory workers, cut by the United States Forest Service (USFS) Hot Shot Crew, then the USFS/DOE issued permits to local citizens who gathered the cut wood. By using the tree-cutting method in place of a controlled burn, the amount of air emissions were minimized, avoiding emitting 76 tons of carbon dioxide, 6 tons of VOCs, 12 tons of particulate matter, 1 ton of nitrogen oxides, and 0.1 ton of sulfur dioxides. The project also avoided sanitary waste generation in that the chipped product was used by the Laboratory for landscaping mulch and erosion control.

b. Protective Coating. During 1997, Laboratory researchers developed a method that produces highly adherent coatings of metal oxides, nitrides, carbides, and diamond-like carbon for use as coatings on metals, ceramics, and plastics that need to be protected from corrosion, erosion, friction, and stress. The new technique uses a plasma to create a graded coating that has "roots" in the substrate of the material. The gradation eliminates the problems of a sharp interface between substrate and coating and so provides excellent resistance against delimitation. In addition to improved adhesion and reduced thickness of the coating, the new technique is less expensive and more environmentally friendly than previously used methods.

c. Dry Cleaning Process. The Laboratory received a Research & Development 100 Award for a drywash system that replaces harsh dry cleaning chemicals with a liquid carbon dioxide cleaning process.

d. Nitrogen Oxide Emissions. A LANL research team won an award from the Partnership for the Next Generation of Vehicles, commonly called the Green Car Project. The LANL team won the award for its work in reducing nitrogen oxide emissions from diesel and gasoline engines.

4. Environment Reports

a. Report for Our Communities. ESH Division published and distributed 20,000 copies of a new annual report, "Environment, Safety, and Health at Los Alamos National Laboratory: A Report to Our Communities." This report gives the Laboratory, its neighbors, and other stakeholders a snapshot of some of the ESH programs. This first-time publication received several awards including an international award for technical excellence from the Society for Technical Communication and a Los Alamos Achievement Award.

b. Environmental Surveillance Reports. In August 1997, the Laboratory team that produces the annual report, "Environmental Surveillance at Los Alamos" received a Los Alamos Achievement Award. This team developed new processes and a proactive network of subject matter experts who now publish this report on schedule gaining credibility for the Laboratory in its ability to assure timely and effective reporting.

c. Habitat Management. The Laboratory's Threatened and Endangered Species Habitat Management Plan Annual Review document received a regional award from the Society for Technical Communication.

E. References

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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).

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3. Environmental Radiological Dose Assessment

primary author:

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Highlights from 1997

The calculated maximum off-site radiation exposure to a member of the public from Los Alamos National Laboratory sources is near East Gate, north of the Los Alamos Neutron Science Center; this dose of 2.2 mrem per year is below the applicable dose limits. This dose is calculated using all exposure pathways to satisfy Department of Energy requirements and is different than the air-pathway dose presented in Chapter 2, which is calculated for compliance with National Emission Standards for Hazardous Air Pollutants. The calculated maximum on-site individual exposure to a member of the public is 6.1 mrem. This member of the public is considered to be an individual who passes along Pajarito Road, near the Technical Area 18 criticality facility during multiple experiments. Most of this dose would be from direct radiation for which the applicable dose limit is 100 mrem, the allowed dose from all pathways (DOE 1990).

To Read About . . . **Turn to Page . . .**

A. Overview of Radiological Dose Equivalents

Radiological dose equivalents are calculated doses received by individuals exposed to radioactivity. Radiation can damage living cells because of its ability to deposit energy as it passes through living matter. Energy deposited in the cell can result in cell damage, cell death, and, rarely, cell mutations that survive and can cause cancer. Because energy deposition is the mechanism for cell damage, radiation doses are measured in the quantity of radiation energy deposited per unit mass in the body. Different types of radiation carry different amounts of energy and are multiplied by adjustment factors for the type of radiation absorbed. Radiation affects different parts of the body with varying degrees of effectiveness. The term "effective dose equivalent" (EDE), referred to here as dose, is the "effective" dose calculated to have been received by the whole body, generally from an external radiation source. Long-lived radionuclides that are taken into the body by inhalation or ingestion continue to deposit energy in the body and give doses for a long time after their intake. To account for this extended dose period, a "committed effective dose equivalent" (CEDE), also referred to in this report as "dose" is calculated. The CEDE gives the total dose, integrated over 50 years that would result from the intake of radionuclides taken into the body from short-term exposures. In this report, CEDEs are calculated for radionuclides taken into the body during 1997. The doses reported below include the contributions from internally deposited radionuclides (CEDE) and from radiation exposures received from sources outside the body (EDE).

Federal government standards limit the dose that the public may receive from Laboratory operations. The Department of Energy (DOE 1990) public dose limit (PDL) is 100 mrem per year received from all pathways (i.e., all ways in which people can be exposed to radiation, such as inhalation, ingestion, and direct exposure). The dose received from airborne emissions of radionuclides is further restricted by the Environmental Protection Agency's (EPA's) dose standard of 10 mrem per year which is codified in the Code of Federal Regulations (40 CFR 61), (see Appendix A). These limitations are in addition to exposures from normal background, consumer products, and medical sources. Dose calculations performed to show compliance with 40 CFR 61 are presented in Chapter 2 and are based on different pathways and use different modeling programs than those for DOE requirements, which are presented in Chapter 3.

B. Public Dose Calculations

1. Scope

Annual radiation doses to the public are evaluated for three principal exposure pathways: inhalation, ingestion, and external (also referred to as direct) exposure. Evaluations focus on calculating doses that the population as a whole within 80 km may have received and also on calculating doses to specific hypothetical individuals within that population. We calculate doses for the following hypothetical people:

(1) The entire population within 80 km of the Laboratory. This is a modeled dose that is based on all sources of radioactive air emissions at LANL. The modeling includes direct exposure to the radioactive material as it passes, direct inhalation of radioactive material, and ingestion of material that is deposited on or incorporated into vegetation, and food from animal products such as poultry, eggs, and beef.

(2) The maximally exposed individual (MEI) who is not on LANL property (referred to as the off-site MEI). For this calculation, the definition of location is taken from 40 CFR 61, which defines the receptor as someone that lives or works at the off-site location. Any school, residence, place of worship, or non-LANL workplace would be considered a potential location for the off-site MEI. Please note that although the definition for the location of this hypothetical individual is taken from 40 CFR 61, the dose calculation performed here is very different than the one required for compliance with 40 CFR 61 (presented in Chapter 2). The calculated dose to the off-site MEI includes contributions from air emissions from all stack and diffuse sources at LANL, ingestion of food gathered locally, drinking water from local wells, and exposure to soils in the vicinity.

(3) The MEI who is in transit through LANL property but not necessarily employed by LANL. DOE-owned roads pass through LANL property but are generally open to public travel. Doses are calculated for a hypothetical member of the public traveling these roads.

(4) An “average” resident of Los Alamos and White Rock. These are calculated based on average air concentrations (from LANL’s Air Monitoring Network [AIRNET]) in Los Alamos and White Rock. To these calculated doses, we add the contributions from the Los Alamos Neutron Science Center (LANSCE) and Technical Area (TA) 18 (LANSCE and TA-18 emissions are not captured by AIRNET), from ingestion of local food products and water, and from exposure to radionuclides in local soils.

(5) Ingestion doses for various population locations in northern New Mexico from ingestion of food grown (fruits and vegetables) or gathered (deer, elk, beef, and fish) locally. Because not all food products are available everywhere within the 80-km radius, we do not have a uniform set of ingestion data on which to calculate doses. We report doses for all locations from which food was gathered.

(6) *Special Scenarios*
Each year, we look at a number of special situations that could result in the exposure of a member of the public. This year, we report doses calculated for

Ingestion of Radioactive Effluent from the TA-50 Outfall (Mortandad Canyon)

Ingestion of Wild Fruits and Vegetables from Mortandad Canyon

Exposure to Sediments in Mortandad Canyon

Exposure to Soils in the Vicinity of Los Alamos and White Rock

Hiking up Los Alamos Canyon from State Road 4 to DP Canyon

Jogging near TA-21.

2. General Methodology

Our dose calculations follow methodologies recommended by federal agencies to determine radiation doses (DOE 1991, NRC 1977) where possible. However, where our calculations do not lend themselves easily to standard methodologies, we have developed and described the methods we used. The general process for calculating dose from ingestion is to multiply the concentration of radionuclides in the food product or in air by the amount of food ingested or air breathed to calculate the total amount of radioactivity taken in to the body of each radionuclide. Then, this amount is multiplied by factors specific for each radionuclide (DOE 1988) to give the dose from each radionuclide. These are summed to give the total dose from ingestion of a food type or from inhalation throughout the year. Where local concentrations are not known but source amounts (amounts released from stacks or from diffuse emission sources) are known, the doses at receptor locations can be calculated by using a model. The model combines source term information with meteorological data to estimate where the radioactivity went. By determining air concentrations in all directions around the source, the model can then calculate doses at any location. The models are also capable of calculating how much of the airborne radioactivity finds its way into nearby vegetation and animal material. We use the Generation II (GENII) model (Napier et al., 1988) because this is the accepted DOE model for dose calculation. Some of the specifics of the modeling are provided in following sections.

C. Dose Calculations and Results

Explanation of Reported Doses Including Negative Values. Because the concentrations of radionuclides are extremely low in most environmental samples, it is common that some of these concentrations will be reported as negative values by the analytical laboratory that performs the analysis. This should be expected when very small concentrations are being analyzed. In fact, if all of our samples truly contained zero radioactivity, about half of our analyses would show positive numbers, about half would show negative results, and a few would actually show zero.

In past annual site surveillance reports, we have carried these negative concentrations through all calculations but then, if the calculated dose was less than zero, it was reported as zero. This year, doses are reported exactly as calculated based on analytical results. Therefore, you will see that some of the reported doses are less than zero. Obviously, a person could not receive a negative dose, and it may seem incorrect to report these numbers. However, many of the positive numbers we report are also not meaningfully positive. By reporting all of the calculated doses here whether negative or positive and using all these data over a period of years, it is possible to more closely calculate actual doses to individuals.

The average or maximum dose reported also includes a number in parentheses. This number is two standard deviations of the dose. It means that approximately 96% of the dose values lie within the dose plus and minus the two standard deviations. A large standard deviation means there is much uncertainty in the reported dose, most likely because it is very near zero. As doses get larger and more meaningful, the standard deviation generally decreases dramatically and we can have more confidence that a dose really occurred.

1. Dose to the Population Within 80 km

The population distribution is used to calculate the collective dose resulting from 1997 Laboratory operations. In 1997, the estimated population of Los Alamos County (Figure 1-1) was approximately 18,300 people (BBER 1998). It is estimated that approximately 234,000 persons lived within an 80-km radius of the Laboratory in mid-1997 (Table 3-1).

The collective EDE (or dose) from Laboratory operations is the sum of the estimated dose received by each member of the population within an 80-km radius of LANL. Because 99% of this dose results from airborne radioactive emissions, the collective dose was estimated by modeling the transport of radioactive air emissions. The population distribution given in Table 3-1 was used in the dose calculation.

The collective dose was calculated using the GENII collection of computer programs (Napier et al., 1988). Airborne radioactive emissions from all types of releases were included in the analysis. Stack emissions were modeled from all monitored stack sources. Diffuse emissions from LANSCE and Area G were also included in the modeling. Air concentration data from the 9 AIRNET stations at Area G were used to calculate the diffuse emission source term from Area G. All of these source terms were put into GENII to evaluate public doses. The exposure pathways included 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 1997 collective population dose attributable to Laboratory operations to persons living within 80 km of the Laboratory was calculated to be 0.9 person-rem. This is comparable to the population dose of 1.2 person rem reported for 1996 (ESP 1997). Figure 3-1 shows the different contributors to the population dose. Short-lived air activation products such as carbon-11, nitrogen-13, and oxygen-15 that are created by the accelerator at LANSCE contribute about 75% to the calculated population dose. Diffuse emissions of uranium, plutonium, and tritium from Area G and tritium from stack sources are about 25% of the dose. Plutonium, uranium, and americium from stack sources cause less than 1% of the dose.

2. Dose to Maximally Exposed Individual not on Los Alamos National Laboratory Property (Off-Site MEI)

The location of the off-site MEI is at East Gate, along State Road 502 entering the east side of Los Alamos County. This has traditionally been the site of

Table 3-1. Estimated 1997 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	3	3	0	0	21	0	15	127	381	2,962
NNE	3	3	0	0	31	1	711	1,244	6,463	49,597
NE	3	11	0	0	4	1	0	0	2,037	164
ENE	1	16	29	0	7	0	26	355	2,340	4
E	0	3	83	216	0	6	61	267	57	68
ESE	2	15	969	6,155	0	0	24	28	58	2,427
SE	5	31	887	1,407	0	2	23	47	418	553
SSE	7	63	639	288	0	5	19	253	154	284
S	7	68	240	129	0	13	87	917	786	566
SSW	7	61	83	16	2	10	2,311	386	646	296
SW	4	7	0	0	1	1,185	14,165	2,436	2,363	3,483
WSW	0	0	0	0	540	1,456	4,282	3,426	1,369	1,493
W	0	0	0	1	313	1,291	3,852	362	21	401
WNW	0	0	0	0	7	11	652	7,408	679	2,108
NW	0	1	0	4,552	496	0	947	69,214	7,129	640
NNW	2	3	0	604	354	0	289	5,397	2,444	101
Totals	44	285	2,930	13,368	1,776	3,981	27,464	91,867	27,345	65,147

[a]Total population within 80 km of Los Alamos National Laboratory is 234,207.

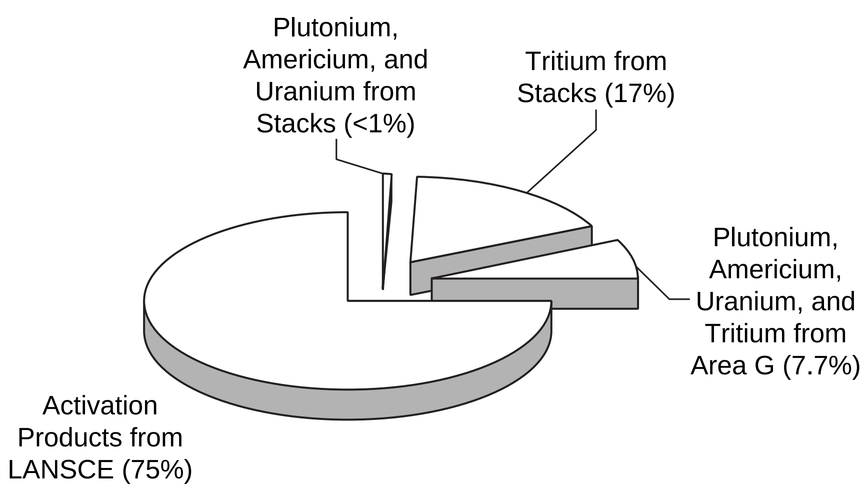

Figure 3-1. Contributions to population air pathway dose from Los Alamos National Laboratory sources.

Note: Total population air pathway dose = 0.9 person-rem.

the highest exposure to a member of the public because of its proximity to LANSCE. 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 kilometers from LANSCE 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 by modeling.

For 1997, the off-site MEI is located at the businesses across from the old guard tower on SR 502. The dose for the off-site MEI is calculated by modeling the releases from LANSCE using the GENII computer code. The GENII computer code has been developed by DOE for use in modeling doses from its facilities. To this modeled dose, we add the dose calculated using air concentration data from the AIRNET station (#10), located very nearby. We also add the contribution from ingesting food grown or gathered locally, from drinking water from local supply wells, and from living on contaminated soils in the vicinity even though nobody actually lives at the location of these soils. The 1997 MEI air pathway dose calculated using GENII for all LANSCE sources is 1.16 mrem (Figure 3-2 and Table 3-2).

Annual average air concentrations of tritium; plutonium-238; plutonium-239, -240; uranium-234; uranium-235; uranium-238; and americium-241, are calculated from annual air concentration data from AIRNET station #10, at East Gate. The total net dose calculated from the AIRNET data is 0.031 mrem. Airborne tritium, which gave a dose of 0.022 mrem is the major dose contributor.

The dose contribution from food grown or gathered in the area was calculated for all food products that were gathered around Los Alamos. These studies indicate contributions from produce (fruits and vegetables), piñon, milk, honey, Navajo tea, eggs, deer, and elk (Table 3-3). The total calculated dose is 0.31 mrem.

For 1997, strontium-90 was the only radionuclide detected in Los Alamos water supply wells, and it was detected only in well G-1, which serves primarily North and Barranca Mesas. Assuming that the MEI only consumed water from that well, at a rate of 2 liters per day, the dose would be 0.49 (0.27) mrem.

Soils were collected from a number of sites near or within Los Alamos (1996 Table 6-1). Using the data from sites in or near Los Alamos as input to the RESRAD computer code (Version 5.70), the dose from living on these soils was calculated to be 0.16 (0.63) mrem for 1997. The dose calculation includes subtraction of the dose from living on "background" soils, away from the Los Alamos area and considers

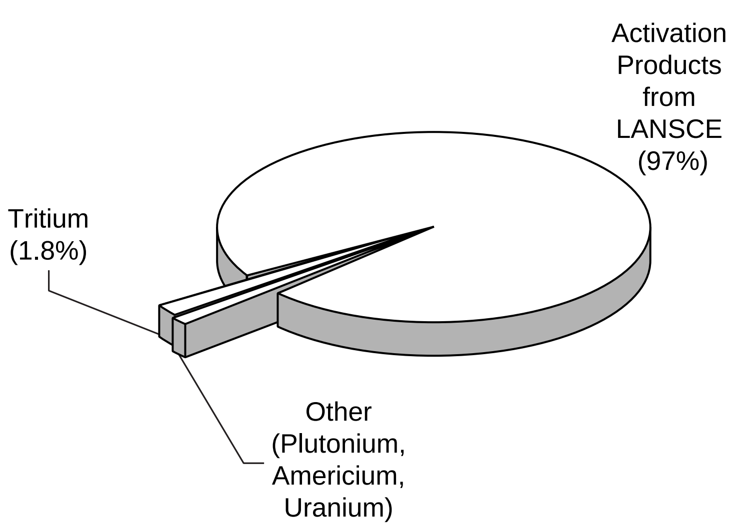

Figure 3-2. Contributions to air pathway dose at East Gate.

Note: Total air pathway dose = 1.2 mrem.

Table 3-2. Compiled Doses during 1997[a]

	Receptors			
Sources	**Off-Site MEI Eastgate (mrem)**	**On-Site MEI Pajarito Road (mrem)**	**LA Average Resident (mrem)**	**WR Average Resident (mrem)**
LANSCE[b]	1.2	0.14	0.011	0.025
TA-18	0.0000076	5	0.0000076	0.000046
AIRNET[c]	0.031	0.021	0.023	0.015
Food Stuffs Ingestion[d]	0.31	0.31	0.31	0.28
Well Water Ingestion[e]	0.49	0.49	0.49	0
Soils Exposure[f]	0.16	0.16	0.16	0.16
Total	2.2	6.1	1.0	0.5

[a] The DOE permissible annual dose for all pathways is 100 mrem for a member of the public.
[b] These doses are modeled using GENII.
[c] These doses are calculated based on data from AIRNET stations in these areas. The calculations include background subtraction. The dose at Pajarito Road assumes the receptor is an average Los Alamos resident.
[d] Calculated from ingestion of foods grown or gathered locally.
[e] Calculated based on detected levels of strontium-90 in Well G-1. We include this dose for Los Alamos but not in White Rock because Well G-1 does not serve White Rock.
[f] These doses are modeled with the RESDRAD Code 5.70 using radionuclide data from local soil concentrations.

direct exposure to soil, and inhalation and ingestion of the soil.

Figure 3-3 shows the combination of the AIRNET calculated dose of 0.031 mrem (which includes the contributions from all stacks and diffuse sources at LANL), the GENII modeled dose of 1.16 mrem (which includes the contributions from LANSCE sources only), the food ingestion dose of 0.31 mrem, the water ingestion dose of 0.49 mrem, and the soils dose of 0.16 mrem gives a total off-site MEI dose of 2.2 mrem (Table 3-2). This is far below applicable standards and no adverse effects are expected.

This dose is not comparable directly to the 3.51 mrem dose reported in Chapter 2, which is calculated for compliance with 40 CFR 61. That dose assumes dose through the air pathway only and is modeled using CAP88, as required by 40 CFR 61. The dose presented here is for all pathways and uses the GENII computer code, which is the DOE code for dose assessment. We believe that the main difference in the Chapter 2 and 3 calculated air pathway doses are caused by differences in the two codes used to model the doses. In this case, CAP88 gives a more conservative but probably less realistic calculation.

3. Maximally Exposed On-Site Member of the Public (On-Site MEI)

The Laboratory's largest contributor to the on-site MEI 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, neutrons and photons from the experiments reach Pajarito Road, a local, DOE-owned road that is open to the public most of the time. 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. Although exposure to a member of the public would be negligible during road closures, we calculated the potential dose to a member

Table 3-3. Ingestion Doses from Foods Gathered or Grown in the Area during 1997

	Dose per Unit Consumed in 1997 (mrem)	Average Consumption[a] Dose[b] (mrem)		Maximum Consumption[a] Dose[b] (mrem)	
Produce					
Regional Background (see text)	0.00060/lb	0.078	(0.20)	0.21	(0.55)
LANL On-Site Stations	0.00022/lb	0.028	(0.23)	0.077	(0.61)
Los Alamos Townsite	–0.00019/lb[c]	–0.025	(0.23)	–0.068	(0.63)
White Rock & Pajarito Acres	–0.00032/lb	–0.041	(0.21)	–0.11	(0.56)
San Ildefonso Pueblo	–0.00067/lb	–0.088	(0.21)	–0.24	(0.58)
Cochiti Pueblo	–0.00027/lb	–0.035	(0.22)	–0.094	(0.59)
Piñon					
Regional Background (see text)	–0.0023/lb	–0.0068	(0.37)	–0.023	(1.2)
Los Alamos	–0.00021/lb	–0.00062	(0.54)	–0.0021	(1.8)
White Rock	–0.00021/lb	–0.00063	(0.57)	–0.0021	(1.9)
San Ildefonso Pueblo	0.011/lb	0.033	(0.52)	0.11	(1.7)
Milk					
Regional Background (Albuquerque)	0.0021/gal.	**0.065**	**(0.064)**	**0.16**	**(0.16)**
Los Alamos	0.0069/gal.	0.22	(0.26)	0.54	(0.64)
Pojoaque	0.0048/gal.	0.15	(0.31)	0.38	(0.77)
Honey					
Regional Background (Jemez Pueblo)	0.00042/lb	0.0014	(0.0028)	0.0047	(0.0093)
Los Alamos	–0.0000012/lb	–0.000018	(0.0034)	–0.000058	(0.011)
White Rock	–0.00036/lb	–0.0012	(0.0029)	–0.0040	(0.0097)
Navajo Tea (Cota)					
Regional Background (Española)	0.0012/L (~quart)	0.46	(1.1)	0.63	(1.5)
Los Alamos	–0.00015/L (~quart)	–0.059	(1.2)	–0.081	(1.7)
White Rock	–0.00017/L (~quart)	–0.069	(1.7)	–0.094	(2.3)
San Ildefonso Pueblo	0.00044/L (~quart)	0.18	(1.5)	0.24	(2.0)
Egg					
Regional Background (Española)	0.000018/2 eggs	0.0041	(0.0069)	0.0066	(0.011)
Los Alamos	–0.000021/2 eggs	–0.0048	(0.023)	–0.0077	(0.037)
San Ildefonso Pueblo	–0.0000050/2 eggs	–0.0011	(0.011)	–0.0018	(0.017)
Steer					
Regional Background (see text)	–0.017/lb muscle 0.054/lb bone	**2.9**	**(1.6)[d]**	**3.3**	**(1.9)[d]**
San Ildefonso	0.015/lb muscle 0.013/lb bone	0.80	(1.9)[d]	0.92	(2.2)[d]
Deer					
Regional Background (Dulce, NM)	0.0052/lb muscle 0.035/lb bone	0.17	(0.024)[e]	0.42	(0.056)[e]
Los Alamos Area Roads	–0.00066/lb muscle 0.00073/lb bone	–0.011	(0.14)[e]	–0.025	(0.33)[e]

Table 3-3. Ingestion Doses from Foods Gathered or Grown in the Area during 1997 (Cont.)

	Dose per Unit Consumed in 1997 (mrem)	Average Consumption[a] Dose[b] (mrem)		Maximum Consumption[a] Dose[b] (mrem)	
Elk					
Regional Background (Coyote, NM)	0.00021/lb muscle 0.019/lb bone	**0.11**	**(0.039)[d]**	**0.25**	**(0.088)[d]**
Los Alamos Area Roads	0.00041/lb muscle 0.031/lb bone	**0.18**	**(0.15)[d]**	**0.41**	**(0.34)[d]**
Game Fish					
Regional Background (upstream)	0.00022/lb	0.0028	(0.018)	0.010	(0.066)
Cochiti (downstream)	0.00025/lb	0.0031	(0.019)	0.012	(0.070)
Nongame Fish					
Regional Background (upstream)	0.00086/lb	0.011	(0.019)	0.040	(0.071)
Cochiti (downstream)	0.00068/lb	0.0085	(0.039)	0.031	(0.14)

[a] Average and maximum consumption values used in calculations are reported in text for specific food product.
[b] The mean dose is reported with two standard deviations (2s) given in parentheses. Because most of the means are very close to zero, the 2s range usually includes zero, small positive, and small negative values. If the mean is greater than 2s, it is more likely that the mean is significant. Numbers where the mean is greater than or equal to the 2s value are bolded in the table.
[c] See Section 3.C for an explanation of negative numbers.
[d] Consumption of 0.25 lb of bone included for every pound of muscle. Those that appear to be statistically meaningful, i.e., the 2s range around the mean is greater than or equal to zero.
[e] Consumption of 0.21 lb of bone included for every pound of muscle. Those that appear to be statistically meaningful, i.e., the 2s range around the mean is greater than or equal to zero.
Note—doses presented in this table are based on foodstuffs and biota data included in Chapter 6.

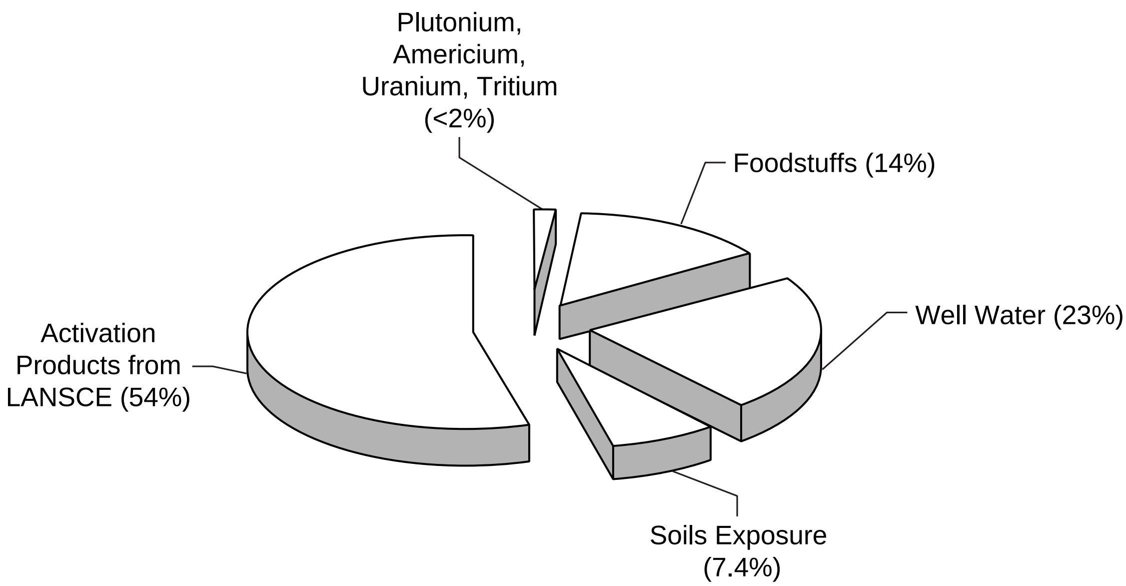

Figure 3-3. Contributions to total dose of 2.2 mrem at East Gate.

of the public who passes by TA-18 repeatedly throughout the year and thus could be subjected to multiple small exposures.

Two scenarios were evaluated: a driver in a car that passes the facility 10 times per day, 250 days per year, traveling 40 miles per hour; and a slow jogger who passes the facility twice each day (one trip out and back), 250 round trips per year, at a speed of 3 miles per hour. Probabilistic statistics were used to calculate the chance of an exposure occurring while the driver or jogger was within the 0.5-mile stretch of roadway passing by TA-18.

The calculations predicted that the driver of the car would receive a dose of 4 mrem and the jogger would receive 5 mrem. These are conservative calculations that assume if an exposure occurred, it would be at the maximum possible level. Furthermore, fractional probabilities of exposure are rounded up so that if the calculated probability of exposure were 1.3, it is assumed that 2 exposures would occur.

Assuming that the jogger was a resident of Los Alamos during 1997, dose from food and water ingestion, from LANSCE operation, and from exposure to contaminated soils and air would add to the dose from TA-18. These additional doses are shown in Table 3-2 and in Figure 3-4. The total calculated dose to this hypothetical resident of Los Alamos would be 6.1 mrem. This dose is 6% of the DOE PDL of 100 mrem [DOE Order 5400.5 (DOE 1990)].

4. Doses to Average Residents of Los Alamos and White Rock

Doses to the average residents of Los Alamos and White Rock are calculated based on average air concentrations (from AIRNET) in these areas. To these calculated doses, we add the contributions from LANSCE and TA-18 (emissions from LANSCE and TA-18 are not captured by AIRNET), from ingestion of local food products and water, and from exposure to radionuclides in soil. In previous years, the Laboratory's annual environmental surveillance report has not included doses other than those from LANSCE and those calculated from AIRNET data in estimating average doses to Los Alamos and White Rock residents. Therefore, the doses reported below are higher than, and not directly comparable to, earlier estimates of average doses in Los Alamos and White Rock.

a. Los Alamos Dose. The total LANL contribution to dose to an average member of Los Alamos during 1997 was 1.0 mrem from all pathways (Table 3-2). Figure 3-5 shows the various Laboratory contributions to this dose. The remainder of this section explains what contributes to this 1.0 mrem dose calculation.

Air concentration data for uranium, plutonium, americium, and tritium were compiled from stations #4 (Barranca School), #5 (Urban Park), #6 (48th Street), #7 (Shell Station), #8 (McDonalds), #9 (Los

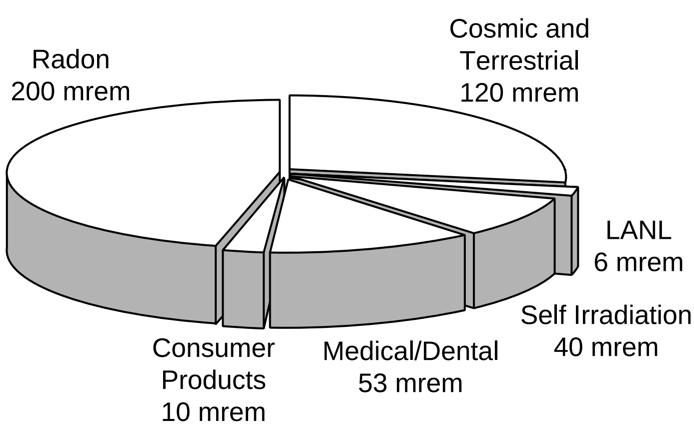

Figure 3-4. All contributions to the 1997 radiation dose for the Laboratory's maximum exposed individual.

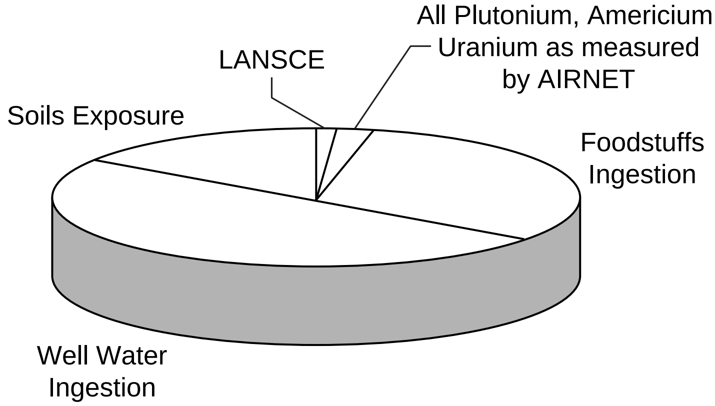

Figure 3-5. Laboratory contributions to dose (1.0 mrem) to an average Los Alamos resident.

Alamos Airport), #10 (East Gate), #12 (Royal Crest Trailer Court), #60 (Los Alamos Canyon), #61 (Los Alamos Hospital), and #62 (Trinity Bible Church). The modeling to calculate doses from the AIRNET data includes the dose a person would receive from inhalation and contaminated food and soil from the immediate area. The total dose calculated from the Los Alamos AIRNET data is 0.023 (0.0093) mrem.

Because most of the radioactive emissions from LANSCE and TA-18 are not captured by AIRNET, we modeled the dose from these emissions to a central point in Los Alamos using the GENII computer code. Exposure to the radioactive plume as it passes is the only significant pathway. The dose to a typical Los Alamos resident was calculated by GENII to be 0.011 mrem from LANSCE and 0.0000076 mrem from TA-18 (Table 3-2).

As discussed earlier, the dose calculated (with two standard deviations in parentheses) from exposure to contaminated soil in Los Alamos is 0.16 (0.63) mrem. The net dose is statistically indistinguishable from zero.

Ingestion of locally grown or gathered food could provide additional dose. Ingestion of food gathered or grown in the Los Alamos area could give a dose of 0.31 (1.4) mrem, including consumption of fish caught in Cochiti Reservoir (Table 3-2).

Ingestion of water from local wells is another exposure source for residents of Los Alamos. For 1997, only one of the Los Alamos water supply wells (G-1) showed any radionuclides above the detection limit. Strontium-90 in this well showed a concentration of 5.19 (1.39) pCi per liter (see Table 5-18 and Section 5.D.3.c). Assuming consumption of 2 L of water per day (considered to be the maximum reasonable consumption), the dose from this well water, uncorrected for background strontium-90, would be 0.49 mrem. This is quite conservative because most of the water consumed in Los Alamos would be from a combination of the wells and the average concentration of strontium would be near zero.

b. White Rock Dose. The total dose from all pathways to an average member of White Rock from Laboratory operations was 0.5 mrem in 1997. The methodology for calculating the White Rock dose was identical to that used for Los Alamos. The AIRNET stations used to calculate average White Rock air concentrations were #13 (Rocket Park Tennis Courts), #14 (Pajarito Acres), #15 (White Rock Fire Station), #16 (White Rock Church of the Nazarene), and #63 (Monte Rey South). The dose calculated from these data is 0.015 (0.012) mrem. The dose contribution from LANSCE operations in 1997 was 0.025 mrem, and the contribution from TA-18 was negligible (Table 3-2).

Because none of the water from well G-1 reached White Rock residents in 1997, there is no calculated water ingestion dose for White Rock. Living on local soils provides the same dose potential as to a member of Los Alamos; the dose would be 0.16 (0.63) mrem from exposure to soils. Ingestion of locally grown or gathered food products would provide a dose of 0.28 mrem (Table 3-3).

5. Ingestion Doses for Various Locations in Northern New Mexico

Many different types of potential food products are collected and analyzed for their radionuclide content. The following section presents the details of calculating food ingestion doses for various potential receptors in northern New Mexico. The food ingestion doses described here are included in the total doses reported above for average and maximally exposed residents of Los Alamos and White Rock. These doses are tabulated in Table 3-3.

The following sections describe the doses calculated for each type of food. Doses are calculated (Table 3-3) for regional background concentrations, i.e., potential foods that were grown or gathered distant from LANL and which are presumed to reflect concentrations not affected by LANL operations, and for net concentrations at all other locations. Net concentrations are calculated by subtracting background concentrations from those at the location of interest.

Three calculations are performed: one assuming average consumption rates, one assuming maximum hypothetical consumption rates, and one for dose-per-unit of food consumed. The consumption rates used in these calculations are reported in the subsections below. We report the dose-per-unit of food consumed so that individuals may calculate their own hypothetical doses based on their knowledge of their actual consumption rates.

a. Ingestion of Produce (Fruits and Vegetables). Fruits and vegetables were collected at a number of locations throughout northern New Mexico. Because the plant types collected differed according to site, it is not possible to compare produce ingestion doses from location to location. Although the specific food types differed at various locations, the values for fruits and vegetables are shown in Table 6-3. For 1997, the average American consumed an average of 130 lb per year and a maximum of 352 lb per year of fruits and vegetables (NRC 1977). The highest doses were calculated to have occurred from ingestion of food products in regional background locations. The average consumption net dose at Los Alamos on-site location of 0.028 mrem has an associated two standard deviation value of 0.23, indicating the large uncertainty in this low value.

b. Ingestion of Piñon. Doses for ingestion of piñon are calculated and presented separately from other produce because of the traditional importance of piñon in the native diet. Because piñon nuts were not available for collection, piñon shoot tips were collected and analyzed and are reported in (Table 3-3). The dose calculated from hypothetical ingestion of shoot tips is greater than that from nuts because radionuclides tend to collect in higher concentrations in the tips than in the nuts (Salazar 1979). The highest (and only positive) unit dose of 0.011 mrem per pound of piñon was seen at the Pueblo of San Ildefonso. We assumed that the average annual consumption was about 3 lb and that the maximum annual consumption was 10 lb. The average consumption dose at the Pueblo of San Ildefonso for 1997 was calculated to be 0.033 (0.52) mrem.

Piñon tree nuts are produced irregularly in nonannual cycles about every seven to 10 years and there was no crop produced in 1997. Although it is not known whether the use of piñon tree foliage to estimate the dose for the ingestion of pine nuts is an acceptable surrogate for nuts, most literature suggests that the nonedible portions of plants tend to have higher concentrations of radionuclides than the edible portions of plants. Therefore, the use of piñon tree foliage to estimate doses for the ingestion of pine nuts is probably an over (conservative) estimation of risk.

c. Ingestion of Milk. Milk from Los Alamos, Pojoaque, and Albuquerque (as background) was collected and analyzed (Table 6-7). The largest net doses from milk ingestion were seen in the Los Alamos area where consumption of each gallon of milk would yield a dose of 0.0069 mrem (Table 3-3). Average annual consumption of 31.3 gal. of milk would have resulted in a dose of 0.22 (0.26) mrem and consumption of 78.4 gal. of milk, considered a maximum amount, would have yielded a dose of about 0.54 (0.64) mrem. Cesium-137 and iodine-131 are the largest contributors to dose.

d. Ingestion of Honey. Honey was collected and analyzed from two locations in Los Alamos and two locations in White Rock, and from Jemez Pueblo, which was used as the background location. Average annual consumption of honey was assumed to be 3.3 lb and maximum annual consumption was assumed to be 11 lb. The highest (and only positive) consumption dose was calculated for the background location (Jemez Pueblo) (Table 3-3) and was 0.0014 (0.0028) mrem for average consumption in 1997.

e. Ingestion of Navajo Tea (Cota). Navajo tea (Cota) leaves were collected from Los Alamos, White Rock/Pajarito Acres, the Pueblo of San Ildefonso and Española (as the background location). The largest doses were calculated from the background location (Española) and were 0.0012 mrem per liter of tea consumed (Table 3-3). The largest (and only positive) net dose was determined for the Pueblo of San Ildefonso, where an average annual consumption of 402 L per year would have resulted in a net dose of 0.18 (1.5) mrem, and a maximum annual consumption of 548 L would have given a dose of 0.24 (2.0) mrem.

f. Ingestion of Chicken Eggs. Chicken eggs were collected and analyzed from Los Alamos, the Pueblo of San Ildefonso, and from Española (as a background location). All of the doses calculated from egg consumption were extremely small; none were statistically different than zero. The only positive doses were calculated for the background location in Española, where the unit dose from eating two eggs was 0.000018 mrem (Table 3-3). An annual dose from an average consumption of about 1.25 eggs per day would be 0.0041 (0.0069) mrem, and a maximum consumption of about 2 eggs per day would be 0.0066 (0.011) mrem.

g. Ingestion of Steer Meat and Bone. A free-range steer was collected from Pueblo of San Ildefonso lands and a regional background steer was collected from El Rito (Table 6-12). Doses for consumption of meat and bone from the background steer and for consumption of the steer from the Pueblo of San Ildefonso, after subtracting the background dose are presented in Table 3-3. The background dose (with two standard deviations shown in parentheses) from consuming 209 lb of muscle and about 53 lb of bone is 2.9 (1.6) mrem. At maximum consumption rates of 242 lb of muscle and 61 lb of bone, the dose would be 3.3 (1.9) mrem. The net dose from average consumption at the Pueblo of San Ildefonso is 0.80 (1.9) mrem, and the dose from maximum consumption is 0.92 (2.2) mrem. Consuming muscle or bone would give doses 0.015 and 0.013 per pound, respectively.

h. Ingestion of Deer Meat and Bone. Deer killed along roadways around Los Alamos were collected, and their meat and bone tissue were analyzed, and compared to regional background samples. The dose from the background deer was calculated to be 0.0052 mrem per pound of muscle consumed and 0.035 mrem per pound of bone consumed. At an average consumption rate of 20.9 lb of muscle and 4.4 lb of bone, the 1997 background dose was 0.17 (0.024) mrem. Maximum consumption of 50 lb of muscle and 11 lb of bone would have given a dose of 0.42 (0.056) mrem. Calculated net dose for the deer roadkills near Los Alamos was negative; the average consumption dose calculated as –0.011 (0.14) mrem.

We can probably never say that on a definitive basis that the elk or deer collected on LANL lands as road kill lived or fed on LANL property for any given length of time. However, we now have strong evidence, based on a two year radio collaring study, that elk that have spent an average of 50% of their time on LANL lands contain similar radionuclide concentrations in muscle and bone as those that have been collected as road kill as part of the environmental surveillance program. These data are scheduled for publication at the end of 1998.

i. Ingestion of Elk Meat and Bone. Elk were collected around Los Alamos and their meat and bone tissue was analyzed and compared to a regional background elk samples. The dose from the background elk was calculated to be 0.00021 mrem per pound of muscle consumed and 0.019 mrem per pound of bone consumed. At an annual average consumption rate of 20.9 lb of muscle and 5.3 lb of bone in 1997, the background dose was 0.11 (0.039) mrem. The maximum consumption rate of 50 lb of muscle and 13 lb of bone would have given a dose of 0.25 (0.088) mrem. Calculated net dose for consumption of the Los Alamos elk was 0.00041 mrem per pound of muscle and 0.031 mrem per pound of bone consumed. At an average consumption rate the calculated dose is 0.18 (0.15) mrem, and at maximum consumption rate, the dose would be 0.41 (0.34) mrem (Table 3-3).

j. Ingestion of Fish. Surface feeding fish (referred to as game fish), including trout, walleye, and bass, were collected from reservoirs upstream of LANL (Abiquiu, Heron, and El Vado) and compared to game fish collected from Cochiti Reservoir, downstream of LANL. The calculated net dose from downstream game fish was slightly higher than the 0.0028 (0.018) mrem dose for upstream fish although the uncertainties indicate the doses are statistically not different from each other (Table 3-3). At an average annual consumption of 12 lb of fish, the net downstream dose would be 0.0031 (0.019) mrem, and it would be 0.012 (0.070) at maximum consumption of 46 lb.

Bottom-feeding fish (referred to as nongame fish), including carp, catfish, and sucker, were collected from the same reservoirs as game fish. For nongame fish, the background dose was slightly higher than the net, downstream dose although, as for the game fish, the differences were not statistically meaningful (Table 3-3). The assumed average and maximum consumption rates were the same for nongame fish as were those used for game fish.

k. Ingestion Doses for the Pueblo of San Ildefonso. Residents of the Pueblo of San Ildefonso may receive doses from ingestion of food products grown or gathered locally and from drinking water from local supply wells.

Food products were analyzed for radionuclide content (see Chapter 6), and these analyses were used to calculate doses from ingestion. The doses from ingestion of all foods grown or gathered locally are tabulated in Table 3-3. The foods that were grown or gathered on or near Pueblo of San Ildefonso lands are summarized in Table 3-4. The total dose from consumption at average rates (as defined in the text of Section 3.C.5) was calculated to be 1.1 (2.5) mrem. The large uncertainty indicates that the actual dose may be zero. The largest contributor to this reported dose was from consumption of steer meat from a steer that was collected on Pueblo of San Ildefonso lands.

Table 3-4. Dose from Foodstuff Grown or Gathered Near Pueblo of San Ildefonso Lands

Food Product	Dose[a] (mrem)	
Produce	–0.088[b]	(0.21)
Piñon	0.0333	(0.52)
Navajo Tea	0.18	(1.5)
Eggs	–0.0011	(0.011)
Steer	0.80	(1.9)
Deer	–0.011	(0.14)
Elk	0.18	(0.15)
Total Annual	1.1	(2.5)

[a] Dose assumes average consumption rates as defined in the text. Two standard deviation values are shown in parentheses.
[b] See Section 3.C for an explanation of negative numbers.

Sampling from wells in and around the Pueblo of San Ildefonso revealed four cases where uranium in the groundwater exceeded about 25% of the EPA-proposed drinking water MCL of 20 µg of uranium per liter of water. The dose from ingesting this groundwater was calculated assuming 2 liters per day were consumed of this water. The ratio of the uranium isotopes was assumed to be the same as natural isotopic ratios. The dose from drinking the uranium in these well waters is shown in Table 3-5. The highest calculated dose was from the New Community Well with a dose of 2.8 (0.56) mrem. The valley area, including the Pueblo of San Ildefonso, is known to contain high concentrations of natural uranium in subsurface deposits and groundwater. The uranium in the groundwater below the Pueblo of San Ildefonso is natural in origin.

l. Conclusions. Potentially significant doses were seen for consumption of milk, steer, deer, and elk from background areas in the Los Alamos area. By significant, we mean that the uncertainty in the measurements (which are shown in parentheses) are smaller than the measured number. When the uncertainty range includes zero (i.e., when the reported number minus the uncertainty is less than zero) then the number itself is not statistically different that zero.

The largest statistically significant dose is from ingestion of steer collected in El Rito, NM. This totaled 2.9 (1.6) mrem for average consumption rates. Consumption of an average quantity of elk from the Los Alamos area would give a dose of 0.18 (0.15) mrem.

Table 3-5. Dose from Ingestion of Two Liters of Water per Day from Wells Near San Ildefonso

Well Name	Committed Dose[a] (mrem)	
Pajarito Well	1.37	(.27)
Don Juan Playhouse Well	0.87	(0.17)
New Community Well	2.81	(0.56)
Sanchez House Well	1.64	(0.33)

[a] Two standard deviation values are reported in parentheses.

6. Special Scenarios

a. Ingestion of Radioactive Effluent from the Technical Area 50 Outfall. TA-50 discharges residual radioactive effluent to Mortandad Canyon. During 1997, the effluent included tritium; sodium-22; strontium-89; strontium-90; cesium-137; uranium-234; uranium-235; plutonium-238; plutonium-239, -240; and americium-241. No water is derived from Mortandad Canyon for drinking, industrial, or agricultural purposes and comparisons with drinking water standards are not appropriate. However, because the area below the outfall is not closed to the public, it is possible that an ingestion of the effluent could occur. The most likely scenario involves a very thirsty jogger or hiker who hears the water trickling and, in desperation, drinks from the end of the pipe. Rather than attempt to estimate a “reasonable” amount that someone might consume, the dose per liter consumed is presented here so that others may draw conclusions about the radiological dose and relative hazard that this effluent represents. The dose of effluent consumed is calculated to be 1.2 mrem per liter. Last year, the dose was also reported as 1.2 mrem per liter (ESP 1997). The plutonium isotopes (238, 239, and 240) and americium-241 contribute the majority of this calculated dose.

b. Ingestion of Wild Fruits and Vegetables from Mortandad Canyon. Fruits and vegetables were collected from LANL/DOE property in areas where members of the public, including Native Americans, would be unlikely to gather fruits or vegetable to ingest. However, because access to the areas is not closed, we cannot discount the possibility that an individual might consume small quantities of the edible materials. Dose calculations are shown in Table 3-6 and are based on the concentrations shown in Table 6-3. Strawberries provide the largest dose, at 0.12 mrem per pound consumed.

Table 3-6. Mortandad Ingestion during 1997

	Gross Dose Total[a] (mrem/lb)
LANL (Mortandad Canyon):	
Raspberries	0.00243
Currants	0.00287
Acorns	0.0280
Wild Rhubarb	0.0947
Rose Hips	0.00389
Piñon (shoot tips)	0.00300
Strawberries	0.120

[a]These doses do not include a subtraction for background concentrations.

c. Exposure to Sediments in Mortandad Canyon. In previous annual environmental surveillance reports (ESP 1996, 1997), we modeled potential doses from contaminated sediments in Mortandad Canyon. We performed a similar residual radioactive material computer code (RESRAD) analysis this year for comparison with earlier reports but have also included a more realistic assessment of potential doses without using RESRAD. Both analyses are presented below.

Radioanalytical results for sediments collected from Mortandad Canyon in 1996 were modeled using the RESRAD model, version 5.70. The pathways evaluated included external gamma exposure from radioactive material deposited in the sediments, inhalation of materials resuspended by winds, and soil ingestion. Because water in the canyon is not generally used for drinking water or irrigation and there are no cattle grazing in the canyon or gardens in the canyon, the drinking water, meat ingestion, and fruit/vegetable ingestion pathways were not considered.

The RESRAD model was run for each of 11 sampled locations for any radionuclides detected. Locations include the Chemistry and Metallurgy Research (CMR) Building, west of GS-1, GS-1, MCO-5, MCO-7, MCO-9, MCO-13 [A-5], A-6, A-7, SR-4 [A-9], and A-11 and are shown in Figure 5-5**.** A background was determined for each radionuclide by averaging values for river and lake (reservoir) sediments distant from LANL. These background values were subtracted from the concentrations reported for Mortandad Canyon and were used to calculate potential net doses from exposure to these sediments. The input parameters for the RESRAD model are summarized in Table 3-7.

The total dose at each sampling location is presented in Table 3-8. For comparison, the 1996 dose for each monitoring location is also shown. In 1997, the maximum dose was 23 mrem at the GS-1 sampling location. Figure 3-6 shows the dose contributions from each radionuclide at each location. Direct exposure to cesium-137 is the largest contributor to dose. For monitoring locations away from GS-1 (i.e., near the CMR building, MCO-13 (A-5, A-6, A-7, A-9, and A-11), the naturally occurring radionuclides of uranium, strontium-90, and cesium-137 from nuclear atmospheric testing contributed more than 5% of the dose.

The dose calculated by RESRAD is quite unrealistic and overly conservative because the sediment channel is generally rocky and choked with brush, and it is extremely unlikely that a person would spend much time in the actual stream bottom. Rather than walk through the stream bed, visitors generally walk or jog or ride bikes along the road/trail nearby. This road/trail crosses the stream channel above GS-1, but generally lies 40 to 120 m from the channel for the 1.8 km below GS-1. We recalculated a more likely dose rate from walking along this road in the vicinity of the most contaminated sediments at GS-1. The following assumptions were made:

- The entire stream channel for approximately one mile is contaminated at the highest measured concentration of 15.5 pCi per gram.
- The contaminated volume is 1 m deep, 1 m wide, and 1,760 m long.
- All the dose is from direct exposure to cesium-137 (no inhalation or ingestion).
- The visitor is an average distance of 50 m from the stream channel.
- No shielding is assumed between the sediments and the visitor.

Table 3-7. RESRAD[a] Input Parameters for Mortandad Canyon Sediments Collected in 1997

Parameter	Value	Comments
Area of contaminated zone	100 m^2 [b]	RESRAD default value; a larger area maximizes exposure via external gamma, inhalation and ingestion pathways
Thickness of contaminated zone	3 m	Based on mesa top conditions (Fresquez et al., 1996)
Time since placement of material	0 yr	Assumes current year (i.e., no radioactive decay) and minimal weathering
Cover depth	0 m	Assumption of no cover maximizes dose
Density of contaminated zone	1.6 g/cm^3	Based on previous models [Buhl 1989] and mesa top conditions (Fresquez 1996)
Contaminated zone erosion rate	0.001 m/yr	RESRAD default value
Contaminated zone total porosity	0.5	Average from several samples in Mortandad Canyon [Stoker et al., 1991]
Contaminated zone effective porosity	0.3	Table 3.2 in data handbook [Yu et al., 1993]
Contaminated zone hydraulic conductivity	440 m/yr	An average value for soil (not tuff) [Nyhan et al., 1978)
Contaminated zone b parameter	4.05	Mortandad Canyon consists of two units, the top most unit being sand (Purtyman 1983) and Table 13.1 in the data handbook [Yu 1993]
Humidity in air	4.8 g/cm^3	Average value from Los Alamos Climatology (Bowen 1990)
Evapotranspirations coefficient	0.85	Based on tritium oxide tracers in Mortandad Canyon (Penrose et al., 1990)
Precipitation	0.48 m/yr	Average value from Los Alamos Climatology (Bowen 1990)
Irrigation rate	0 m/yr	Water in Mortandad Canyon is not used.
Runoff coefficient	0.52	Based on mesa top conditions (Fresquez et al., 1996)
Inhalation rate	8400 m^3/yr	RESRAD default value
Mass loading for inhalation	9×10^{-5}	Phermex (OU 1086) Risk Assessment for respirable particles
Exposure duration	1 year	Assumes current year exposure only
Dilution length for airborne dust	3 m	RESRAD default value
Shielding factor, inhalation	0.4	RESRAD default value
Shielding factor, external gamma	0.7	RESRAD default value
Fraction of time spent indoors each year	0.7	Based on 18 h/d (Fresquez et al., 1996)
Fraction of time spent outdoors	0.01	Assumes an industrial scenario where access to site is somewhat limited. (Robinson and Thomas 1991)
Shape factor	1	Corresponds to a contaminated area larger than a circular area of 1200 m^2.
Depth of soil mixing layer	0.15 m	RESRAD default value.
Soil ingestion rate	44 g/yr	Calculated based on 100 mg/d for 24 yr (adult) and 200 mg/d for 6 yr (child) [Fresquez et al., 1996]

[a]RESRAD is a computer modeling code designed to model radionuclide transport to the environment.
[b]For each sampling location, the area of the contaminated zone was assumed to be 100 m^2.

Table 3-8. Total Effective Dose Equivalent[a] (mrem) for Mortandad Canyon

Location	1997		1996	
Near CMR Building	0.16	(± 0.058)[b]	0.16	(± 0.032)[b]
West of GS-1	0.022	(± 0.082)[b]	3.3	(± 0.60)[b]
GS-1	23	(± 2.8)[b]	24	(± 3.4)[b]
MCO-5	19	(± 3.4)[b]	21	(± 3.2)[b]
MCO-7	5.9	(± 0.91)[b]	8.8	(± 1.4)[b]
MCO-9	0.041	(± 0.076)[b]	0.78	(± 0.21)[b]
MCO-13 (A-5)	0.0041	(± 0.016)[b]	0.65	(± 0.19)[b]
A-6	3.3	(± 0.69)[b]	0.41	(± 0.097)[b]
A-7	0.038	(± 0.053)[b]	0.36	(± 0.072)[b]
SR 4 (A-9)	0.011	(± 0.061)[b]	0.19	(± 0.057)[b]
Rio Grande (A-11)	0.0051	(± 0.17)[b]	0.16	(± 0.12)[b]

[a]Based on results from RESRAD version 5.70.
[b]±2 sigma in parenthesis; to convert to μSv multiply by 10.

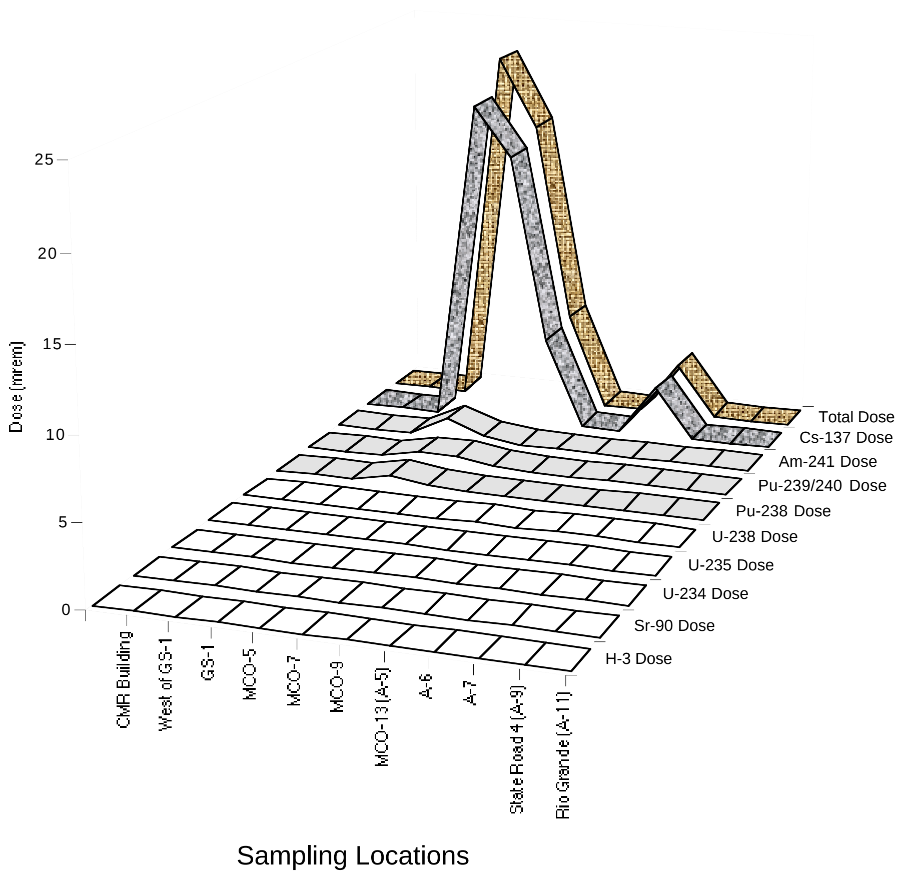

Figure 3-6. RESRAD calculated dose in 1997 from exposure to contaminated sediments in Mortandad Canyon.

- The visitor is in the area about an hour each day, 200 days per year.

The dose calculated for this scenario is 0.22 mrem. This number is about 1/100th or 1% of that calculated using RESRAD and represents a much more realistic estimate of potential dose received by visitors to this area. This is our best (but still conservative) estimate of the dose someone would receive walking along this road 200 times per year. Inhalation of cesium-137 and americium-241 would add an extremely small increment to this dose.

d. Exposure to Soils in the Vicinity of Los Alamos and White Rock. A simplified version of the residential scenario originally developed by Fresquez and others (1996a) was used in a computer model, RESRAD (version 5.70), to estimate the EDE from external radiation and the CEDE from internally deposited radiation (Yu et al., 1995). The primary simplification was that the modeling performed here did not consider horizons other than the contaminated zone. The rationale behind this simplification is that we are not including the plant or drinking water ingestion pathways here because they are evaluated through direct measurement of these media. With these pathways we have included direct exposure to, inhalation of, and ingestion of, contaminated soil. Inclusion of zones other than the contaminated soil horizon is not important. The radon pathway is not included because these soil measurements of uranium (the parent material for radium-226, which generates radon-222), are of recent, shallow soils. Because of the 4.5 billion year half life of uranium-238 and the 1,600 year half life of radium-226, no appreciable radon would be generated in the short time since deposition of these shallow soils. The dose is compared to that from exposure to background soils from Embudo, Cochiti Pueblo, and Jemez Pueblo.

The net dose and two standard deviations for Los Alamos/White Rock area were found to be 0.16 (0.63) mrem. The background dose was 0.50 (0.25) mrem. The Los Alamos/White Rock doses are included in the dose summary table (Table 3-2). They are added to the dose to an average member of Los Alamos or White Rock.

e. Hiking up Los Alamos Canyon from State Road 4 to DP Canyon. Over a period of about 50 years, a number of LANL operations, primarily at TA-21, released contaminants into DP Canyon, which drains into Los Alamos Canyon about 2.5 mi west of State Road 4. The main source for the contaminants is believed to be an outfall (#21-011[k]) that discharged radionuclides including americium-241, cesium-137, plutonium-238, plutonium-239, and strontium-90 (Reneau and McDonald 1996).

Data were collected to assess radionuclide concentrations in Los Alamos Canyon Sediments**.** These stream channel and overbank deposits were analyzed down to depths of more than a meter to determine concentrations of radionuclides. Most of the contamination appears to have deposited within about 80 m of DP Canyon although slightly elevated levels of contaminants continue down Los Alamos Canyon. We used these data to evaluate potential exposures a visitor to this area might receive.

The scenario for exposure is as follows:

A casual hiker walks up the Los Alamos Canyon stream channel every day of the year and takes 4 hours for the approximately 8 km walk from State Road 4 to DP Canyon confluence and back. This assumption is quite conservative in that most hikers would likely follow the road, which parallels the stream bed and is quite a bit farther from the contamination. The hiker is assumed to be about 5 m, on average, from the overbank deposits and is assumed to be directly in contact with the channel deposits. No background subtraction was made for the sediment concentrations. Therefore, the reported doses are “gross” doses. Calculations based on net concentrations would reduce these doses.

Based on the scenario described above, the hiker would receive a dose of about 2.7 mrem for the entire year. It is probably unreasonable to assume that any one person would do this particular hike every day. The dose received per hike is estimated to be 0.0074 mrem. Individuals who mainly stay on the road as they walk through the canyon would receive a much smaller dose.

f. Walking Near the Northeast Corner of Technical Area 21. The thermoluminescent dosimeter (TLD) at TA-21, Area T indicated an annual dose at that site of 307 (17) mrem for 1997. This is approximately double the annual dose seen on TLDs, and the extra dose, is attributed to residual cesium-137 ground contamination. Because this is an area that workers walk or jog by frequently, we calculated a potential dose to a hypothetical walker. Assuming that about half of the 307 mrem is attributable to the cesium-137 ground contamination, then the annual dose above background is about 160 mrem. This dose would occur if an individual spent 24 hours per day, 365 days per year at the TLD site. Assuming that a person walked by the site once per day, 200 days per year, spending about 10 minutes per trip near this location, their total time at this location would be about 33 hours per year. This is about 0.4% of the total time in a year and would result in a dose from the ground contamination of about 0.61 mrem. An individual who spent more or less time in this area would receive a correspondingly larger or smaller dose.

D. Estimation of Radiation Dose Equivalents for Naturally Occurring Radiation

Operations at LANL contribute radiation and radioactive materials to the environment. To understand the Laboratory's impact, it is important to understand its contribution relative to existing natural and man-made radiation and radioactive materials in the environment.

External radiation, which affects the body by exposure to sources external to the body (not from inhalation or ingestion), comes from two sources that are approximately equal: cosmic radiation from space and terrestrial gamma radiation from radionuclides in the environment. Estimates of dose rates from natural radiation are based on a comprehensive report by the National Council on Radiation Protection and Measurements (NCRP 1987b) and assume the dose from cosmic radiation dose is reduced 20% because of time spent indoors and the dose from terrestrial radiation sources is reduced by 30% because our bodies provide some shielding for our internal organs from terrestrial photons. In general, doses from direct radiation from cosmic and terrestrial sources are higher in Los Alamos than White Rock because White Rock is at a lower elevation and less cosmic radiation reaches the earth's surface. Actual annual external background radiation exposures vary depending on factors such as snow cover and fluctuations of solar radiation (NCRP 1975a).

The largest component of our annual dose is from the decay of natural uranium. Uranium products occur naturally in soil and are commonly incorporated into building construction materials. Radon-222 is produced by decay of radium-226, which is a member of the uranium decay series. Inhalation of radon-222 results in a dose to the lung, which is the largest component of natural background radiation dose. The dose from radon-222 decay products to local residents is assumed to be equal to the national average of 200 mrem per year. This estimate may be revised if a nationwide study of background levels of radon-222 in homes is undertaken or if we obtain reliable data on average radon concentrations in homes in northern New Mexico. A national survey has been recommended by the NCRP (NCRP 1984, 1987a).

Another naturally occurring source of dose to the body is from natural radioactive materials incorporated into the body. Most importantly, a small percentage of all potassium is radioactive potassium-40. Because our bodies require potassium, we have a certain amount of radioactive potassium within us and the decay of this potassium-40 gives us a dose of about 18 mrem per year. Natural uranium and carbon-11 contribute another 21 mrem or so to give a total dose from internal radionuclides of about 40 mrem each year.

Global fallout doses resulting from atmospheric testing of nuclear weapons are only a small fraction of total environmental doses (<0.3% [NCRP 1987a]). Naturally occurring radiation dose is due primarily to exposure to the lungs from radon decay products and exposures from non-radon sources that affect the whole body.

Finally, members of the US population receive an average dose of 53 mrem per year from medical and dental uses of radiation (NCRP 1987a). The various contributors to radiation dose to the maximally exposed individual in the Los Alamos area are shown graphically in Figure 3-4. In the Los Alamos area, we receive roughly 120 mrem from terrestrial and cosmic external sources, 200 mrem from radon, 40 mrem from internal sources, 53 mrem from medical and dental procedures, and perhaps 1 mrem from global fallout to give a total "background" dose of about 413 mrem.

E. Risk to an Individual from Laboratory Operations

1. Estimating Risk

In the 1995 Environmental Surveillance Report, we discontinued our practice of calculating and reporting cancer risks associated with doses received as a result of LANL operations. We did this because health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem delivered at high dose rates (HPS 1996). Doses resulting from LANL operations are typically in the low mrem or fractional mrem range and our conclusion is that there would be no adverse health effects, including cancer, from these doses.

If a reader believes that there is a direct relationship between low radiation dose and cancer, she/he could calculate that risk by multiplying the doses reported in this report by the cancer risk factor (which should be given in terms of excess cancer death risk per mrem of exposure). If one chooses to use the BEIR or EPA risk estimates (factors) to calculate the potential excess cancer rates from a radiation dose, a sizable body of research indicates that the calculation will over estimate the actual risk.

2. 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 1997 Laboratory activities were 1.0 and 0.5 mrem, respectively. 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 1975a).

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.

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4. Air Surveillance

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Highlights from 1997

Three instances of elevated air concentrations were investigated in 1997: plutonium and americium at one location within Technical Area (TA) 54, Area G; plutonium and americium at TA-21; and gross alpha and beta at the Los Alamos county landfill. At TA-54, Area G, elevated levels of plutonium and americium were measured by two air sampling network (AIRNET) samplers (see Section 4.A). A nearby area of contamination, which had been brought to the surface by trenching activities and was being resuspended by construction and use of a rerouted dirt road, was covered with a mixture of sand and gravel to isolate the contamination and greatly reduced ambient concentrations. However, the concentrations have not dropped to pre-1995 levels. Additional mitigation is possible. The elevated gross alpha and beta measurements at the Los Alamos County landfill appear to be caused by radon decay products, but the evidence is not conclusive. Elevated concentrations of plutonium and americium were measured at TA-21 and may have been related to soil disturbances or to past decontamination and decommissioning activities.

In early 1998, we found that the silica gel collection media used to collect tritiated water was not capable of removing all of the moisture from air samples. Collection efficiencies were as low as 10% to 20% in the middle of the summer when the ambient concentrations of water vapor were the highest. Because 100% of the water was not collected on the silica gel, and this water was used to measure water vapor concentrations, the atmospheric water vapor, and therefore tritiated water, has been underestimated. However, data from the meteorological monitoring network provide accurate measurements of atmospheric water vapor concentrations and have been combined with the analytical results to calculate all ambient tritium concentrations in this report.

The Air Quality Group began routine publication of AIRNET data on the World Wide Web during 1997, and data are now available on the World Wide Web within two to three months following the sampling period. The web site at http://www.air-quality.lanl.gov/ also includes followup information on investigations of higher than normal values.

In January 1997, the DOE and the Laboratory reached an agreement with the Concerned Citizen's for Nuclear Safety, which settled a lawsuit concerning violations of the Clean Air Act. As part of the agreement, additional air monitoring and penetrating radiation stations were added to the existing AIRNET and the thermoluminescent network (TLDNET) programs, respectively. Two AIRNET stations were added at TA-33 and in Santa Fe, and over 50 TLDNET stations, primarily located on Laboratory property, were established. In addition, seven neutron monitoring stations were established in the vicinity of TA-18, the Los Alamos Critical Assemblies Facility.

To Read About . . . **Turn to Page . . .**

4. Air Surveillance

A. Ambient Air Sampling

1. Introduction

The radiological air sampling network at Los Alamos National Laboratory (LANL or the Laboratory) is designed to measure environmental levels of airborne radionuclides that may be released from Laboratory operations. Laboratory emissions include plutonium, americium, uranium, tritium, and activation products. Each station collects two types of samples for analysis: a total particulate matter sample and a water vapor sample.

Natural atmospheric and fallout radioactivity levels fluctuate and affect measurements made by the Laboratory's air sampling program. Regional 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, terrestrial radon diffusing out of the earth, and materials resulting from interactions with cosmic radiation (for example, natural tritiated water vapor produced by interactions of cosmic radiation and stable water). Regional levels of radioactivity in the atmosphere, which are useful in interpreting air sampling data, are summarized in Table 4-1.

Particulate matter in the atmosphere is primarily caused by the resuspension of soil, which is dependent on meteorological conditions. Windy, dry days can increase the soil resuspension, but precipitation (rain or snow) can wash particulate matter out of the air. Consequently, changing meteorological conditions often cause large daily and seasonal fluctuations in airborne radioactivity concentrations.

The summed dose, as calculated from the measured airborne concentrations is less than the Environmental Protection Agency (EPA) annual dose limit of 10 mrem (see Section 2.B.6.b).

2. Air Monitoring Network

During 1997, the Laboratory operated more than 50 environmental air samplers to sample radionuclides by collecting water vapor and particulate matter. This air sampling network is referred to as AIRNET (Figures 4-1 through 4-3). Sampling locations are categorized as regional, pueblo, perimeter, quality assurance (QA), Technical Area (TA) 21, TA-15, TA-54 (Area G) or other on-site locations. There are four regional sampling stations for determining regional background and fallout levels of atmospheric radioactivity. These regional stations are located in Española, El Rancho (this station replaced the Pojoaque station in early 1997), and at two locations in Santa Fe. The pueblo monitoring stations are located at the Pueblos of San Ildefonso, Taos, and Jemez. In 1997, there were more than 20 perimeter stations located within 4 km of the Laboratory boundary.

Because maximum concentrations of airborne releases of radionuclides would most likely occur on-site, more than 30 stations are within the Laboratory boundary. For QA purposes, two samplers are co-located as duplicate samplers, one at TA-54 and one at TA-49. In addition, there is a backup station located at East Gate. Stations can also be classified as being inside or outside a controlled area. A controlled area is defined as having possibly radioactive materials or elevated radiation fields and are clearly posted as such (DOE 1988). The active waste disposal site at TA-54, Area G, is an example of a controlled area.

3. Sampling Procedures, Data Management, and Quality Assurance

a. Sampling Procedures. 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 water vapor for tritium determination. The filter and the gel cartridge are typically collected and analyzed biweekly. After collection, the particulate matter filters are cut in half, and one-half is promptly sent to an analytical laboratory for gross alpha and beta analysis. The other half is retained and composited quarterly for isotopic analysis to increase our ability to detect specific radionuclides. Details about the sample collection, sample management, chemical analysis, and data management activities are provided in the AIRNET project plan (ESH-17 1997) and in the numerous procedures through which the plan is implemented.

b. Data Management. The 1997 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 electronically in the field on a palm-top microcomputer. These data were later transferred to a table format within the ESH-17 AIRNET Microsoft Access database.

c. Analytical Chemistry. One-half of each 1997 particulate matter filter was analyzed biweekly by a commercial laboratory for gross alpha and gross beta. A composite for isotopic analyses was prepared quarterly for each station by combining the remaining half filters from the six or seven sampling periods during the quarter. Every two weeks, Air Quality Group (ESH-17) staff distilled the water from the silica gel cartridges and submitted the distillate to a commercial laboratory for tritium determination using liquid scintillation spectrometry. All analytical procedures meet the requirements of 40 Code of Federal Regulations (CFR) 61, Appendix B, Method 114. A summary of the target minimum detectable amounts (MDA) for the biweekly and quarterly samples is provided in the AIRNET project plan.

d. Laboratory Quality Control Samples. For 1997, ESH-17 maintained a program of blank, spike, duplicate, and replicate analyses. This program was designed to provide information on the quality of the data received from analytical chemistry suppliers. The chemistry met QA requirements for the AIRNET program.

4. Radiochemical Analytical Results

a. Explanation of Reported Doses including Negative Values. All data in this AIRNET section, whether in the tables or the text, that are expressed as a value plus or minus (±) another value, represent a 95% confidence interval. Because these confidence intervals are generally calculated with data from multiple sites and throughout the year, they include not only random measurement and analytical errors, but also seasonal and spatial variations as well. As such, the calculated 95% confidence intervals are overestimated (wider) for the average concentrations and probably represent confidence intervals that are essentially 100%. In addition, the standard deviation values in the tables represent one standard deviation calculated from the sample data. In past surveillance reports, two standard deviations were generally reported. Finally, all AIRNET concentrations and doses are total measurements without any type of regional background subtractions or corrections unless otherwise stated.

Some values in the tables indicate that we measured negative concentrations of radionuclides in the ambient air, which, of course, is impossible. However, it is possible for the measured concentration to be negative because the measured concentration is a sum of the true value and all random errors. As the true value approaches zero, the measured value approaches the total random errors. When the true value does reach zero, the measured value is equal to the total random errors. Because the random errors are normally distributed with a mean of zero, half of the measured values are expected to be negative and half are expected to be positive. Arbitrarily discarding negative values when the true value is equal to zero, will result in expected mean values being overestimated by approximately 0.67 standard deviations.

b. Gross Alpha and Beta Radioactivity. Gross alpha and gross beta analyses are used primarily to evaluate general radiological air quality and to identify potential trends. 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 investigate whether there has been a problem, such as an unplanned release. Gross alpha and beta activity in air exhibit considerable environmental variability, and for alpha measurements analytical variability. The sources of variability generally overwhelm any Laboratory contributions.

The National Council on Radiation Protection and Measurements (NCRP) estimated the average concentration of long-lived gross alpha activity in air to be 2 fCi per cubic meter. The primary alpha activity is due to polonium-210 (a decay product of radon) and other naturally occurring radionuclides (NCRP 1975, NCRP 1987). The NCRP also estimated average concentration levels of long-lived gross beta activity in air to be 20 fCi per cubic meter. This activity is primarily because of the presence of lead-210 and bismuth-210 (also decay products of radon) and other naturally occurring radionuclides.

More than 1,000 air samples were collected in 1997 and analyzed for gross alpha and gross beta activity. As shown in Table 4-2, the annual mean for all of the stations are less than the NCRP's estimated average (2 fCi per cubic meter) for gross alpha concentrations. 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 (NCRP 1975, NCRP 1987).

Table 4-3 shows gross beta concentrations within and around the Laboratory. These data show variability similar to the gross alpha. All of the annual averages are below 20 fCi per cubic meter, the NCRP estimated national average for gross beta concentrations.

c. Tritium. Tritium is present in the environment primarily as the result of nuclear weapons tests and natural production by cosmogenic processes (Eisenbud and Gesell 1997). Tritium is released by the Laboratory in curie amounts; in 1997, Laboratory operations released 420 Ci of tritium.

Two factors are needed to estimate ambient levels of tritium as an oxide (water): water vapor concentrations in the air and tritium concentrations in the water vapor. Both of these need to be representative of the true concentrations to obtain an accurate estimate of the ambient tritium concentrations. In early 1998, it was found that the silica gel collection medium was not capable of removing all of the moisture from the atmosphere (Eberhart 1998). Collection efficiencies were as low as 10% to 20% in the middle of the summer when the ambient concentrations of water vapor were the highest. Because 100% of the water was not collected on the silica gel, and this water was used to measure water vapor concentrations, the atmospheric water vapor, and therefore tritiated water, has been underestimated. However, data from the meteorological monitoring network provide accurate measurements of atmospheric water vapor concentrations and have been combined with the analytical results to calculate all ambient tritium concentrations in this report.

These sampling results for tritiated water concentrations are presented in Table 4-4. Average annual concentrations for 1997 at all of the on-site stations are higher than all of the regional and pueblo stations. Most of the perimeter stations were also higher than the regional and pueblo stations. These data clearly indicate that the Laboratory is a measurable source of tritium based on ambient measurements.

The highest off-site annual concentration of 3.8 pCi per cubic meter was at station #8 in Los Alamos. This represents only about 0.25% of the EPA public dose limit. Elevated concentrations were observed at a number of on-site stations, with the highest maximum and annual mean concentrations at station #35 within TA-54, Area G. Station #35 is located in a radiological control area, near shafts where tritium-contaminated waste has been disposed. However, the annual mean concentration, 605 pCi per cubic meter, is only about 0.003% of the Department of Energy (DOE) derived air concentration (DAC) for worker exposure (20×10^6 pCi per cubic meter).

Elevated mean air concentrations were also seen at other Area G stations and a station located at TA-16 (#25). Station #25 is located near a tritium facility, but the source of the higher tritium levels appears to be off-gassing of tritium from some used glove boxes that are stored nearby. Annual mean concentrations at all sampling sites were well below the applicable EPA and DOE guidelines.

If the tritium concentrations for this report had been calculated using the amount of water vapor collected by the silica gel as the atmospheric water vapor measurements, the concentrations would generally be from 30% to 70% of the reported values. The high on-site concentration (#35) would drop by 68% to 195 pCi per cubic meter and the highest off-site concentration (#8) would drop by half to 1.9 pCi per cubic meter.

d. Plutonium. While plutonium occurs naturally at extremely low concentrations, it is not naturally present in measurable quantities in the ambient air. All measurable sources are from nuclear explosions, the nuclear fuel cycle, and other related activities. With few exceptions, worldwide fallout from atmospheric testing of nuclear explosives is the primary source of plutonium concentrations in ambient air (Eisenbud and Gesell 1997). Four isotopes of concern can be present in the atmosphere: plutonium-238, plutonium-239, plutonium-240, and plutonium-241. However, plutonium-241 is not measured because it is an insignificant alpha emitter that decays by beta emission to americium-241. This beta decay in not only hard to measure, but the dose is insignificant when compared to americium-241. Plutonium-239 and plutonium-240 are indistinguishable by alpha spectroscopy and are grouped together for analytical purposes.

Sampling results for plutonium-238 are presented in Table 4-5. Most of the analytical results, including the on-site stations, were below the MDA. The highest group summary mean was for the TA-54, Area G stations, with an annual mean of 3.0 aCi per cubic meter. This corresponds to approximately 0.15% of the EPA public dose limit. The highest annual mean for an individual station, which was in a controlled access area, was at station #27 on the north perimeter of TA-54, Area G, with an annual mean activity of 19 aCi per cubic meter. This corresponds to approximately 0.9% of the EPA's public dose limit, or about 0.09 mrem. The data from this station indicate continued elevated concentrations of plutonium, americium, and uranium as originally described in the 1996 environmental surveillance report (ESP 1997) and in a recent paper (Kraig et al., 1998). Additional details concerning these higher concentrations are provided in Section 4.A.5 of this chapter.

Sampling results for plutonium-239 are presented in Table 4-6. As with the plutonium-238 analyses, most of the analytical results were below the MDA. Only TA-54 concentrations were above the MDA for more than 50% of the samples. The regional, pueblo, and perimeter station group summaries all indicate annual means near zero. The highest annual mean at any off-site station occurred at three locations and was

1.4 aCi per cubic meter of plutonium-239, -240. This annual mean concentration corresponds to approximately 0.1% of the EPA's public dose limit, or about 0.01 mrem. The stations at TA-21 have an annual group mean that is higher than the other groups, with the exception of the TA-54, Area G stations discussed below. The somewhat elevated concentrations at TA-21 may have resulted from increased ground-level emissions associated with resuspension of soil containing elevated plutonium concentrations.

The maximum on-site station mean for plutonium-239 (679 aCi per cubic meter) was recorded at station #27, TA-54, Area G. This concentration is equivalent to a dose of 4.5 mrem, or .03% of the DOE DAC limit for worker exposure. There has been a significant increase in the air concentration of plutonium-239 at station #27 beginning during the second quarter of 1995 and continuing at least through the final quarter of 1997 with reductions due to mitigation (see Section 4.A.5).

e. Americium. The americium-241 concentrations are the primary source of dose caused by the release of plutonium-241. As a decay product of plutonium-241, measurable sources are from nuclear explosions, the nuclear fuel cycle, and other related activities.

Americium results are presented in Table 4-7. As described for plutonium-238 and -239, americium is present in very low concentrations in the environment, and this is indicated by the low annual mean concentrations seen at the regional, pueblo, and perimeter station summaries. Most of the off-site measurements are below the MDA. The slightly elevated americium concentrations at the TA-21 stations may be due to increased ground-level emissions caused by resuspension of dust. The highest concentrations of americium-241 were measured at the TA-54, Area G stations, especially at site #27 where the annual concentration was nearly 100 times higher than the next highest annual concentration. This concentration, 469 aCi per cubic meter, is equivalent to a dose of 2.5 mrem, only 0.02% of the applicable DOE DAC.

f. Uranium. Three isotopes of uranium are naturally present in the ambient air: uranium-234, uranium-235, and uranium-238. The natural sources of uranium are crustal rocks and soils. Therefore, the ambient concentrations are dependent upon the mass of suspended particulate matter, the uranium concentrations in the parent material, and any local sources. Typical uranium crustal concentrations range from 0.5 ppm to 5 ppm, but local concentrations can be well outside this range (Eisenbud and Gesell 1997). Uranium results are given in Tables 4-8 through 4-10.

All annual mean concentrations of the three uranium isotopes were well below the applicable EPA and DOE guidelines. The highest on- or off-site annual mean concentrations for all three uranium isotopes were at station #27, where, as noted previously, there are elevated concentrations of other radionuclides. However, the proportional increases in uranium isotopic measurements at this site are not nearly as dramatic as the increases for plutonium and americium. The relative abundance of the three isotopes indicate that the concentrations are attributable to natural uranium. Therefore, the higher concentrations of uranium at this site are apparently caused by the higher levels of suspended particulate matter from unpaved roads and surface soil disturbances.

Most of the uranium-235 measurements, both on - and off-site, were below the MDA (97%) whereas only about 20% of the uranium-234 and uranium-238 concentrations were below the MDA. Both the regional and pueblo groupings had higher average concentrations of uranium-234 and uranium-235 than all of the other groupings except for the TA-54, Area G stations. The regional and pueblo groups were also higher than the perimeter group for uranium-238, but on-site concentrations were generally higher probably because of various Laboratory sources of uranium-238 as discussed in the following paragraph. These higher off-site concentrations indicate that the high background levels of particulate matter and natural uranium in the soils usually predominate when compared to Laboratory contributions.

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 99 kg of depleted uranium containing approximately 40 millicuries of radioactivity was used in such experiments in 1997. 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 and Johnson 1977). Elevated concentrations of uranium-238 were generally not detected near the firing sites with the possible exception of station #77 at TA-15 where isotopic ratios indicate a higher-than-natural abundance of uranium-238 (three to five times higher than the natural ratio of uranium-238 to uranium-234). The annual concentration at this site was 46 aCi of uranium-238 per cubic meter with a high quarterly concentration of 109 aCi of uranium-238 per cubic meter. This annual high concentration is equivalent to a dose of .05 mrem or 0.5% of the EPA public dose limit.

5. Investigation of Elevated Air Concentrations

In 1997, 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 AIRNET project plan (ESH-17 1997). When a measured air concentration exceeds an investigation level, ESH-17 verifies that the calculations were done correctly and that the sampled air concentrations are likely to be representative, i.e., that no cross contamination has taken place. Next, we work with personnel from the appropriate operations to assess potential sources and possible mitigation for the elevated concentrations. The following sections identify three incidents of elevated air concentrations that warrant further discussion.

a. Technical Area 54, Area G. An increasing trend in plutonium and americium levels has been occurring at two stations (#27 and #38) (Kraig et al., 1998). The stations are co-located for QA purposes and both stations show about the same results. No other stations at Area G or stations in White Rock show elevated results. The upward trend began in 1995, with the majority of the increase occurring in 1996 and early 1997. Personnel from Area G, ESH-17, and the Hazardous and Solid Waste Group (ESH-19) worked together to investigate the cause of this trend.

During the week of May 19, 1997, a survey of the area was performed using a direct reading radiological survey instrument that indicated an area of americium surface contamination near stations #27 and #38. Discussion with Area G personnel revealed that in 1995, when the elevated readings first appeared, some trenching work had been performed within several meters of the two stations. Additionally, the dirt access road in the vicinity of the stations was relocated in the spring of 1996, coincident with a very significant increase in air concentration. A second trenching operation was also completed at about this time. It appears that contaminated material was brought to the surface during the trenching and that local traffic transported some of the material toward the air monitoring stations.

Although the elevated results did not indicate either a compliance issue or a health and safety concern, a mitigation plan was developed. The mitigation plan included covering the surface contamination with a mix of gravel and sand in order to isolate the contamination. Relevant air sampling data were analyzed at an increased frequency (biweekly instead of quarterly) to evaluate the effectiveness of the remediation. Results are now available and show a large decrease in air concentrations since the remediation.

During the approximately nine months following the remediation, air concentrations of plutonium-239 have decreased from about 1,600 to 47 aCi of plutonium-239 per cubic meter and levels have dropped from approximately 1,000 to 44 aCi of americium per cubic meter. Although these are major reductions, the concentrations do not appear to have dropped to pre-1995 levels. TA-54, Area G personnel have been informed of this situation and are considering what additional mitigation efforts may be necessary. ESH-17 personnel will continue their follow-up evaluations, and updates will be posted on the ESH-17 home page (*http://www.air-quality.lanl.gov/*), as they become available.

b. First Quarter 1997 Investigation at Technical Area 21. The first quarter of 1997 showed three stations within TA-21 boundaries with values exceeding the investigation level. In order to determine the cause of the elevated levels, personnel involved in the ER Project and decontamination and decommissioning (D&D) program were contacted. Basically, two operations were underway during the first quarter of 1997 that could have had potential air quality impacts. The first was a drilling operation at Area T. We don't believe the drilling operation is the likely cause because Area T is located significantly toward the west, away from stations #73 and #74. In addition, a high-efficiency particulate air filtration device was attached to the drill rig and would have captured essentially all of the particulate matter before it was released to the atmosphere.

Minimal activities were occurring in association with the TA-21 D&D program shutdown. Soil moving operations were conducted on the south side of Buildings 4 and 5 on February 8, 1997. On February 19, 1997, bulk waste shipments were being made out of the Buildings 4 and 5 south areas. However, the bulk waste shipments contained minimal levels of radioactive materials. The investigation to determine the cause of the elevated readings is inconclusive. Second quarter data did not exceed action levels.

c. Los Alamos County Landfill. Air concentration values for gross alpha exceeded action levels for sample periods November and December in 1997 at the county landfill AIRNET station (#32). Because of these exceedances, the samples were reanalyzed for gross alpha and gross beta. Isotopic analyses were also performed to provide information as to which radionuclides were causing the gross alpha and beta increases.

From these data, we concluded that polonium-210, a radionuclide within the natural radon-222 decay chain was responsible for the increased gross alpha values at the time of the reanalysis, but not necessarily at the time of the original analysis. Plutonium, uranium, and americium from LANL operations were not elevated and did not cause the elevated gross alpha for either the original analysis or the reanalysis.

Large, short-term fluctuations in atmospheric levels of radon and radon decay products are very common, but we cannot conclude that these natural fluctuations caused the gross alpha and gross beta increases in late 1997. We do not have a method (either by analytical chemistry or by calculations) that will allow us to make a definitive judgment as to whether or not the polonium-210 was the cause of the high alpha and beta concentrations measured by the original analysis in late 1997. Since naturally occurring radon decay products are constantly being deposited on the surface of materials exposed to the atmosphere, it is likely that handling any material will resuspend these decay products, such as lead-210 and polonium-210, to some extent. Such resuspensions will occur with regularity at a landfill. Therefore, nearby samplers such as this AIRNET sampler will occasionally collect elevated concentrations of these naturally occurring radioactive materials.

For complying with the Clean Air Act, this elevated value will be considered a release of polonium-210 when calculating the annual dose to a member of the public for compliance with 40 CFR 61 Subpart H.

6. Long-Term Trends

As noted in the tritium section above, we discovered that the silica gel collection medium was not collecting all of the water vapor present in the air samples. This underestimate appears to have been going on for many years, but to date, we have recalculated tritium concentrations for the past five years. These recalculated concentrations are generally two to three times higher than previously published values, but since the sampling stations collection efficiencies varied together, historical comparisons *between* sites will, in most cases, still be valid. Figure 4-4 shows time-series data from three stations: Santa Fe, a background site (#3); East Gate (#10), the maximum exposed individual (MEI) site, located in the eastern part of Los Alamos near the LANL perimeter; and a site within TA-54, Area G (#35), an active radioactive waste disposal site. This figure shows the same data on different scales. Figure 4-4a clearly shows that tritium concentrations are several orders of magnitude greater at the TA-54, Area G waste disposal site than at the other two sites. The cause of these high tritium concentrations is the tritium from buried radioactive waste diffusing from the ground into the ambient air. This graph also shows that the diffusion rate dramatically increases during the summer months because of higher temperatures and increased evaporation and transpiration. There is clearly an on-site impact in the controlled area, but the average concentrations at the TA-54, Area G site are less than 0.01% of the DAC for worker exposure.

Figure 4-4b is a plot of the same data, but the scale has been reduced by a factor of 50. A few low winter tritium values at TA-54, Area G show on this scale and are comparable to the highest values recorded for Santa Fe and East Gate. Even though both the Santa Fe and East Gate stations have very low concentrations of tritium (normally less than 10 pCi of tritium per cubic meter), the East Gate station is still significantly higher than the Santa Fe station, which indicates a LANL impact at the East Gate location. In addition, most of the measurements of tritium at the East Gate site are above the MDA whereas most of the measurements at the Santa Fe site are below the MDA. This qualitatively indicates that there are measurable concentrations at East Gate, but not at Santa Fe.

B. Stack Air Sampling for Radionuclides

1. Introduction

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 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 1997, 28 stacks met this criterion. An additional three sampling systems were in place to meet DOE requirements for nuclear facilities prescribed in their respective technical or operational safety requirements. Where sampling is not required, emissions are estimated using engineering calculations and radionuclide inventory information.

2. Sampling Methodology

As of the end of 1997, LANL was continuously sampling 31 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.

Emissions of radioactive particulate matter, generated by operations at facilities such as the Chemistry and Metallurgy Research Building (CMR) and TA-55, 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 weekly using gross alpha/beta counting and gamma spectroscopy to identify any increase in emissions and to identify short-lived radioactive materials. Every six months, ESH-17 composites these samples to be shipped to an off-site commercial laboratory. These composited samples are analyzed to determine the total activity of materials such as uranium-234; uranium-235; uranium-238; plutonium-238; plutonium-239, -240; and americium-241. These data are then used to calculate emissions.

VAP emissions, generated by Los Alamos Neutron Science Center (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 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 calculated 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. Gaseous air activation products are also generated as nonpoint or diffuse sources at TA-53 and at TA-18. The diffuse source contributions from TA-53 are determined by measurements using an ionization chamber while the diffuse source contributions at TA-18 are determined through Monte Carlo modeling.

3. Sampling Procedure and Data Management

a. Sampling and Analysis. Analytical methods were chosen for compliance with EPA requirements (40 CFR 61, Appendix B, [EPA 19] Method 114). These methods were derived during 1995, as part of the development of QA project plans for tritium, particulate, and vapor sampling. General discussions on the sampling and analysis methods for each of LANL's emissions follow.

Particulate Matter Emissions. Glass-fiber filters, used to sample facilities with significant radioactive particulate emissions, were generally removed and replaced weekly and transported to the Health Physics Analysis Laboratory (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. In addition to 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 1997, a change to the sample analyses for these composites was implemented. Rather than using isotopic data only to identify radionuclides as was done in the past, the data were also used to quantify these emissions. This method is considered an improvement in sample analysis and in emissions determination. To further ensure that the analyses requested identify any significant activity in the composites, ESH-17 compares the results of the isotopics to gross activity measurements.

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 elemental and oxide 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 oxide 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 offline. 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 using 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. Diffuse sources of activated air at LANSCE are calculated by performing several individual measurements and calculations. First, the concentration of radioactive air in the room is measured using flow through air ionization chambers. Next, the outflow of the building is determined through measurements and engineering calculations. The measured concentration is then multiplied by the building outflow to determine the amount of radioactive air released into the environment.

Diffuse sources of activated air at TA-18 are calculated based on data from Monte Carol modeling. The modeling results identify the number of argon-41 atoms that are produced from a single neutron released from a criticality experiment. Using this information along with the number of neutrons released during the year, the total amount of activated air (argon-41) is determined.

b. Laboratory Quality Control Performance. Groups of discrete samples were submitted to commercial laboratories 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 tritium analyses for the stack program, the Health Physics Analytical Laboratory (HPAL) maintained a program of blanks and duplicates analyses that was more frequent than EPA guidelines.

4. Analytical Results

Measurements of Laboratory stack emissions during 1997 totaled 20,000 Ci. Of this total, tritium emissions comprised 420 Ci, and air activation products from LANSCE contributed 19,600 Ci. Combined airborne emissions of materials such as plutonium, uranium, americium, and particulate/vapor activation products were less than 1 Ci. Detailed emissions data for Laboratory buildings with sampled stacks are provided in Table 4-11. Table 4-12 provides a detailed listing of the constituent radionuclides in the groupings of G/MAP and particulate/vapor activation products (P/VAP). The half-lives of the radionuclides emitted by the Laboratory are presented in Table 4-13. Diffuse sources of activated air from TA-53 totaled 830 Ci of carbon-11 and 35 Ci of argon-41 while the TA-18 contribution was 1.4 Ci of argon-41.

As in 1995 and 1996, radioactive particulate source terms were developed using radionuclide-specific analyses rather than 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. For this reason, emissions of americium-241 are now presented separately from emissions of plutonium.

5. Long-Term Trends

Radioactive emissions from sampled Laboratory stacks are presented in Figures 4-5 through 4-8. These figures illustrate trends in measured emissions for plutonium, uranium, tritium, and G/MAP emissions, respectively. As the figures demonstrate, only emissions from TA-53, LANSCE increased from 1996 to 1997. This increase was a result of an increase in run-time for the accelerator.

Figure 4-9 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.

Because G/MAP emissions account for most of the airborne radioactivity, and because 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). Because of the short half-lives of the G/MAP isotopes, carbon-10 (19.3 s), carbon-11 (20.5 min), nitrogen-13 (10 min), nitrogen-16 (7.13 s), oxygen-14 (70.6 s), oxygen-15 (122.2 s), and argon-41 (1.83 h), this delay is sufficient to significantly reduce the total activity before 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.

C. Cosmic and Gamma Radiation Monitoring Program

1. Introduction

Naturally occurring external penetrating radiation originates from terrestrial and cosmic sources in the form of gamma rays, neutral particles, charged particles, and heavy nuclei. Man-made radiation consists of the same types of radioactive materials with the exception of the heavy nuclei. To evaluate natural and man-made radiation, the Laboratory's environmental monitoring program uses thermoluminescent dosimeters (TLDs) and a high-pressure ion chamber (HPIC) which is part of the Neighborhood Environmental Watch Network (NEWNET) community monitoring network operated by the Laboratory's Instrumentation and Control group. Because the natural background from terrestrial and cosmic sources is much larger than those from man-made sources, it is extremely difficult to distinguish man-made sources from the natural background. There are several environmental mechanisms that contribute to this difficulty.

The terrestrial component results primarily from naturally occurring potassium-40, the thorium and uranium decay chains, and radionuclides deposited as a result of fallout from nuclear atmospheric testing (e.g., strontium-90, cesium-137, and small amounts of plutonium). 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 that reduce or block the radiation from terrestrial sources (NCRP 1975). There is also spatial variation that is a result of the soil type and the placement of the dosimeters. For example, those dosimeters that are placed in a narrow canyon will receive radiation from the sidewalls and the floor of the canyon as well as from the cosmic sources (ESP 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 per year. Los Alamos, with a mean elevation of about 2.2 km receives about 75 mrem per year from cosmic sources. However, different locations in the region range in elevation from about 1.7 km at Española to 2.7 km at Fenton Hill, resulting in a corresponding range of 45 to 90 mrem per year 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.

2. Monitoring Network

a. Laboratory and Regional Areas. In an attempt to be able to distinguish any impact from Laboratory operations, 93 TLD stations are placed around the Laboratory and in the surrounding communities. This network of dosimeters is divided into three groups: off-site regional, off-site perimeter, and on-site locations.

The off-site regional group has four locations ranging from approximately 7 to 117 km from the Laboratory boundary. These regional stations are located in the neighboring communities of Española, El Rancho, Santa Fe, and the Pueblo of San Ildefonso. Jemez Pueblo and Fenton Hill were part of this network in 1996 but were discontinued in 1997 because of repeated loss of measurements. The Pojoaque station was moved to El Rancho in 1997.

The off-site perimeter group has 28 locations within 4 km of the Laboratory boundary (see Figure 4-10). These stations are placed in residential areas surrounding the Laboratory and in locations where people work. Five perimeter stations were added, and two stations were removed in 1997.

In 1997 the number of on-site monitoring stations was significantly expanded from 27 to 62. The on-site locations are within Laboratory boundaries, generally around operations that may produce ionizing radiation. Most of the additional stations are located near the TA-53, LANSCE lagoons, TA-50 locations, Mortandad Canyon, and TA-15 Phermex. Other locations include TA-16, TA-36 Kappa Site, TA-33, and the Fitness Trail near TA-8, Building 24.

b. Technical Area 53, Los Alamos Neutron Science Center Network. To monitor external penetrating radiation from airborne gases, particles, and vapors resulting from LANSCE operations at TA-53, a network of 24 TLD stations is used. Twelve of these monitoring locations are approximately 800 m north of and downwind from the LANSCE stack. The other 12 TLD stations are located about 9 km from LANSCE, near the southern boundary of the Laboratory and are used as a background measurement. Both sets of 12 monitoring locations are placed at approximately the same elevations to help eliminate elevation effects from the cosmic component of the natural radiation.

c. Low-Level Radioactive Waste Management Areas. The Laboratory has 10 inactive and 1 active (TA-54, Area G) low-level radioactive waste management areas. To monitor any external penetrating radiation from these areas, 97 dosimeters are placed around the perimeter of these waste management areas. This total represents an increase over the number of 1996 locations, with the number of strategic monitoring locations at TA-54, Area G increasing from 25 to 32. All waste management areas are controlled-access areas and are not accessible to the general public. The average annual dose at each waste area is calculated from a set of TLDs located around each site.

d. Technical Area 18 Albedo Dosimeters. To monitor potential neutron doses from activities at TA-18, seven albedo TLD stations were maintained on the north, south, and east sides of TA-18. Albedo dosimeters are used to measure neutrons around TA-18. Albedo dosimeters are sensitive to neutrons and uses a polyethylene phantom. The phantom is used to capture neutron backscatter and simulates the human body. Since the human body has many hydrogen atoms, a significant fraction of intermediate energy and fast neutrons can be slowed down to epithermal energies and backscattered, and thus can interact with neutron sensitive thermoluminescent material.

The albedo dosimeters were sited early in the second quarter of 1997 at locations where public access is possible. The dosimeters were placed to simulate backscatter from the human body. Two albedo TLDs were placed at each monitoring station. In the event of a road closure during special operations, the second of the dosimeters was removed and stored at a control location until the road was reopened. The measurement results from albedo dosimeters should not be compared to results of measurements using other geometries. Two background stations were located at Santa Fe and TA-49, respectively. Neutron background is essentially zero. Because of dosimeter loss, only one quarter of data was available from the Santa Fe monitoring station.

3. Sampling Procedures, Data Management, and Quality Assurance.

Environmental TLDs used at the Laboratory are composed of natural lithium fluoride crystals containing 7.4% lithium-6 in the form of 3.2-mm^2 by 0.9-mm-thick chips, referred to as TLD-100. After exposure to x- and gamma radiation, the TLD chips are collected and heated in a laboratory setting to measure the energy stored in the crystal. This stored energy is released in the form of light that is proportional to the amount of radiation absorbed by the TLD. The TLD-100 overresponds to and is extremely sensitive to thermal neutrons, but is insensitive to fast- or high-energy neutrons. These neutrons must be moderated before they can be measured by TLD-100 chips.

A newly designed dosimeter was introduced for field monitoring in 1996 and was used for all monitoring locations in 1997. This new dosimeter uses the same type of "acorn" holder as the old dosimeter, but utilizes five, 1/8 in. TLD-100 chips, instead of the four, 1/4 in. TLD-100 chips used in the old dosimeter. (For a complete description of this dosimeter, see Archuleta 1997.) American National Standards Institute (ANSI) N545 performance testing of this newly designed dosimeter was completed in 1996, and the dosimeter passed all performance tests (ANSI 1966).

Procedures that outline the QA/quality control (QC) protocols; placement and retrieval of the dosimeters; reading of the dosimeters; and data handling, validation and tabulation can be found in operating procedures maintained by ESH-17. A QA project plan was updated in 1997 (ESH-17 1997b).

4. Analytical Results

The dose equivalent ranges observed in 1997 are consistent with natural background radiation or the 1996 measurements.

a. Laboratory and Regional Areas. Results from these locations are presented in Table 4-14. Some of the TLD stations are lacking one or more quarters of data. Reasons for these omissions include dosimeter loss, animal damage to stations, processing error, removal requests by the public, and new station installation after the beginning of the monitoring year.

Only one off-site regional station, El Rancho (station #53), had a complete set of data in 1997 (i.e., data for each quarterly monitoring period). Station #53 shows an annual dose equivalent of 109 mrem without any background subtraction. The average quarterly dose equivalents at the other off-site regional stations ranged from 30 to 36 mrem, corresponding to an approximate annual dose equivalent of 120 to 144 mrem. The annual measurements at off-site perimeter stations having complete data sets ranged from 107 to 164 mrem. Annual measurements at on-site stations reporting 100% data ranged from 135 to 178 mrem. Five new monitoring locations near the LANSCE lagoons and stacks indicated doses ranging from 222 to 934 mrem for nine months of monitoring. These results are not representative of potential doses to a member of the public because they include operational exposures at areas where public access is restricted.

b. Technical Area 53. 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. There is no significant difference ($p>.05$) between the site and background TLD measurements observed in the vicinity of the LANSCE. The average dose at the 12 site stations was 164 ± 10 mrem, while the background was 165 ± 10 mrem.

c. Low-Level Radioactive Waste Management Areas (WASTENET). Results from monitoring the waste disposal management areas are presented in Table 4-15. Among the sites with a complete data set, the annual average doses at all inactive waste management areas during 1997 ranged from 132 to 307 mrem. The 1997 annual doses for two stations at TA-50, Area C, are incomplete because of lost dosimeters. Six monitoring stations at TA-54, Area G, did not have complete data for 1997. Five of these were initialized in the second quarter of 1997 while the last station lost one quarter due to equipment malfunction.

The highest waste management area annual average dose for 1997 was measured at TA-54, Area G, LANL's only active low-level radioactive waste area. During the second half of 1997, several TLD stations at TA-54 Area G in the vicinity of the TWISP (Transuranic Waste Inspectable Storage Project) were higher than the 10-year historical means (1985–1995). The TWISP project entails removing transuranic waste from storage for further characterization and ultimate shipment to the Waste Isolation Pilot Plant. The radiological constituents of these drums varies greatly, and the drum inventory near the TLDs is changing constantly. As the TWISP project progresses, changes in external penetrating radiation doses near the project are expected to vary. These TLD locations are on-site and not in an area that can be routinely accessed by members of the public. The 32 environmental surveillance TLDs at TA-54, Area G, are located within the waste site and along the perimeter fence. The doses measured at this site are representative of storage and disposal operations that occur at the facility. Evaluation of this data is useful in minimizing occupational doses. However, this is a controlled-access area and these measurements are not representative of a potential public dose.

One of the monitoring sites at TA-21, Area T had an elevated reading of 307 ± 17 mrem in 1997. This value is consistent with values observed at this location in the past and is attributed to cesium-137 on the ground at that location. Discussions on potential dose equivalent to a member of the public from this location are discussed in Chapter 3.

d. Technical Area 18 Albedo Dosimeters. Table 4-16 presents the monitoring results from the TA-18 albedo dosimeter monitoring network. In all cases except the Santa Fe background result, the doses are presented for the second through fourth quarters of 1997; only the second quarter of data is available for the Santa Fe station because of dosimeter loss. Neutron doses are presented for TLDs undergoing continuous exposure and for those removed during road closure. Members of the general public could only be exposed at times when the road in front of TA-18 was open. The average neutron dose at the seven stations is 6.2 mrem over three quarters of 1997 during road open conditions, while the maximum dose of 18 mrem occurred at the TA-18 personnel gate near the parking lot. This high result is expected because of multiple operations at TA-18 capable of generating neutron exposure. The neutron dose results from the background monitoring stations are, as expected, essentially zero accounting for analytical uncertainty.

D. Nonradioactive Emissions Monitoring

1. Introduction

Emissions from industrial-type sources are calculated annually because these sources are responsible for 90% 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.

2. Particulate Matter Sampling

Particulate matter (PM-10) samples (particles less than 10 µm in aerodynamic diameter) were not collected during 1997.

3. 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 that include the type of explosives used as well as other material expended at each mound. Table 4-17 summarizes estimated toxic releases from the explosives detonations conducted at the Laboratory during 1997. The Laboratory also burns scrap and waste explosives because of treatment requirements and safety concerns. In 1997, the Laboratory burned 3.7 tons of high explosives.

4. Emissions Calculations

The 1997 calculated actual emissions for the criteria pollutants from industrial-type sources are shown in Table 4-18. Following is an explanation of the different industrial-type sources at LANL. The power plants produce steam for heating and electricity when sufficient power from outside sources is not available. The water pump is used to pump water from underground wells. Small amounts of asphalt are produced for road repairs at LANL. Boilers provide comfort and process heat. These industrial-type sources are primarily operated on natural gas. The TA-3 power plant can use fuel oil as a backup. These sources and emissions estimates will be reported to NMED under 20 NMAC 2.73-Notice of Intent and Emissions Inventory Requirements.

Various methods and resources were used to estimate source emissions. Emissions from the asphalt plant are based on the 1,306 tons of asphalt produced in 1997. The PM emissions from the asphalt plant were calculated using an emission factor obtained from a stack test. Emissions from fuel combustion equipment are based on the actual or estimated fuel consumption. The nitrogen oxide (NO_X) emissions from the TA-3 Power Plant were calculated using an emission factor obtained from a stack test. The NO_X and carbon monoxide (CO) emission factors for the TA-16 boilers were calculated using data provided by the manufacturer. Emission factors for NO_X, CO, and volatile organic compound (VOC) emissions from the water pump were obtained from the manufacturer. All other criteria emissions were estimated using EPA guidance documents.

In addition to the industrial type sources, VOC emissions from research and development activities will be reported to NMED under 20 NMAC 2.73.

VOCs are any compound of carbon, with the exception of specific chemicals, which participate in atmospheric photochemical reactions. VOCs include commonly used chemicals such as ethanol, methanol, and isopropyl alcohol. In 1997, ten tons of VOC emissions were estimated based on chemical procurement records. For this estimate, it was conservatively assumed that air releases were equivalent to the quantity purchased.

E. Meteorological Monitoring

1. Introduction

Meteorological data obtained from the meteorological monitoring network support many Laboratory activities, including emergency management and response, regulatory compliance, 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 World Wide Web at *http://weather.lanl.gov/* and are discussed in the Meteorological Monitoring Plan (Baars et al., 1998).

2. 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 because of the 1,000-ft change in elevation across the site.

Four distinct seasons occur in Los Alamos. Winters are generally mild, but occasionally winter storms dump large snows and cause frigid temperatures. Spring is the windiest season of the year. Summer is the rainy season, when afternoon convective-type 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 cooler summers than those in nearby locations, which are at lower elevations. The sloping nature of the Pajarito Plateau causes cooled air to drain off the plateau at night; thus, nighttime temperatures on the plateau are often warmer than those at lower elevations. Also, the Sangre de Cristo Mountains to the east act as a barrier to arctic air masses affecting the central United States, although the temperature does occasionally drop well below freezing. Another factor affecting the temperature 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 (the average diurnal temperature range is 13˚C).

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 is –28˚C (–18˚F). Winter is usually not particularly windy, so extreme wind chills are uncommon.

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 is 35˚C (95˚F).

The average annual precipitation (including both rain and water equivalent of frozen precipitation) 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.

Winter precipitation in Los Alamos is often caused by storms entering the US from the Pacific Ocean, or by cyclones forming or intensifying in the lee of the Rockies. When these storms cause upslope flow over Los Alamos, large snowfalls can occur. The record snowfall for one day is 22 in., and the record snowfall in one season is 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 37% of the annual precipitation. During the July to August period, afternoon thunderstorms form as a result of the flow of moist air from the Gulf of Mexico and from 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 can be seen. During the daytime, upslope flow sometimes exists on the Pajarito Plateau, causing an southeasterly component to the winds on the plateau (Figure 4-12). During the nighttime, as the mountain slopes and plateau cool, the flow becomes downslope, causing light westerly and northwesterly flow (Figure 4-13). Cyclones moving through the area disturb and override the cycle. Flow within the canyons of the Pajarito Plateau is quite complex and very different from flow over the plateau.

3. Monitoring Network

A meteorological network of five towers was used to gather data at the Laboratory during 1997 (see Fig. 13.1 in the Meteorological Monitoring Plan [Baars et al., 1998] or access through the World Wide Web at *http://weather.lanl.gov/*). A sodar (sonic detection and ranging) and three precipitation measurement sites also supplemented the data collected. The towers are located at TA-6 (the official 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 at TA-16.

4. 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 wake effects from 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 that measure longwave radiation and 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, because winds from the east are uncommon. The multiple levels give duplicate measurements for QA. Temperature sensors are shielded and aspirated with small fans to minimize radiative heating effects.

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 data loggers 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 also 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 undergo calibration inspections twice a year. An external audit is performed every two to three years and takes the place of one of the internal calibration inspections. All instrument calibrations are traceable to the National Institute of Standards and Technology standards. In 1997, a calibration inspection and external audit were performed, and no significant problems were found (Sandstrom 1997).

5. Analytical Results

A graphical summary of the weather at Los Alamos (TA-6) for 1997 is presented in Figure 4-11. This figure shows the average temperature range and precipitation by month, compared with the normals, which are averages based on a 30-yr record (1961 to 1990). Significant departures from normal include below average temperatures in January, February, April, November, and December, and above average temperatures in May. For the year, temperatures were below normal.

Precipitation exceeded normal monthly totals for eight months of the year. January, February, April, and August were particularly wet, and precipitation in those months was near or above twice the normal precipitation amounts. May and October were unusually dry with precipitation less than half the normal amounts. The total precipitation for the year was 136% of normal. The annual snowfall for 1997 was 162% of normal. The months of February, April, November, and December saw over double the normal snowfall amounts. Precipitation data for 1997 for all recording sites are listed in Table 4-19.

Wind statistics based on 15-min average wind observations at the four towers on the Pajarito Plateau are shown in the form of wind roses in Figures 4-12 through 4-14. 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-53 (Figure 4-12), the most frequent wind direction is southerly, which occurs 14% of the time. The wind speed for that direction is most often in the 2.5 to 5.0 m/s category, followed by the 0.5 to 2.5 m/s category, the 5.0 to 7.5 m/s category, and the 7.5+ m/s category. Winds were calm 1.0% of the time at TA-53 during the daytime in 1997.

During the daytime (Figure 4-12), winds were predominately southerly at all four towers. Looking at the nighttime wind roses (Figure 4-13), it can be seen that the winds were more westerly and northwesterly, and that the winds are generally weaker. Wind roses for all times are given in Figure 4-14.

F. Quality Assurance Program in the Air Quality Group

1. Quality Assurance Program Development

During 1997, the Air Quality Group continued to maintain and to improve upon the QA program developed in recent years. This program includes a group quality management plan, project plans, and implementing procedures. QA plans for sampling systems follow the EPA QA-R/5 data quality objective process. Required elements of DOE QA programs are incorporated. Together, these plans and procedures describe or prescribe all the planned and systematic activities believed necessary to provide adequate confidence that ESH-17 processes perform satisfactorily.

2. Analytical Laboratory Assessments

During 1997, biweekly gross alpha, gross beta, and isotopic gamma analytical services were provided by Wastren-Grand Junction analytical laboratory associated with the DOE's Grand Junction Project Office. Biweekly tritium analytical services were provided by Paragon Analytics, Inc., Fort Collins, CO. Analytical chemistry services for alpha-emitting isotopes (americium, plutonium, and uranium) on quarterly composite samples were also provided by Wastren-Grand Junction. Application of the data quality objectives (DQO) process led to definition of analytical chemistry DQOs. These DQOs were summarized as purchase requirements in statements of work used for procurement of chemical analyses from the commercial laboratories. Before awarding the purchases, ESH-17 evaluated the lab procedures, quality plans, and national performance evaluation program results of these suppliers and found that they met purchase requirements. ESH-17 also performed formal on-site assessments at the Grand Junction and Paragon laboratories during 1997.

Both Paragon and the Grand Junction analytical laboratories participated in national performance evaluation studies during 1997. 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 that is of interest to the ESH-17 QA program.

G. Unplanned Releases

There were no unplanned radioactive or nonradioactive air releases during 1997.

H. Special Studies

1. Neighborhood Environmental Watch Network Community Monitoring Stations

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 onto 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 LANL. 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-h 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 pressure, and gross gamma radiation using a pressurized ion chamber. The radiation sensors are sampled at 5-s intervals and averaged every 15 min. These values are transmitted every 4 h.

More information about NEWNET and the data is available at *http://newnet.jdola.lanl.gov/* on the World Wide Web.

I. Tables

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

	Units	Northern New Mexico (LANL)[a] 1997	EPA Concentration Limit[b]
Gross Alpha	fCi/m^3	0.7	NA[c]
Gross Beta	fCi/m^3	14.1	NA
^{234}U	aCi/m^3	16.3	7,700
^{235}U	aCi/m^3	1.2	7,100
^{238}U	aCi/m^3	14.2	8,300
^{238}Pu	aCi/m^3	0.1	2,100
$^{239,240}Pu$	aCi/m^3	0.3	2,000
Tritium	pCi/m^3	0.3	1,500
^{241}Am	aCi/m^3	2.3	1,900

[a] Data from regional air sampling stations operated by LANL at Santa Fe, Pojoaque, El Rancho, and Española.
[b] Each EPA limit equals 10 mrem/yr.
[c] Not available.

Table 4-2. Airborne Long-Lived Gross Alpha Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	1 *s*
Regional Stations						
01 Española	27	1	1.16	0.14	0.61	0.24
02 Pojoaque	2	0	0.70	0.41	0.55	0.21
03 Santa Fe	27	0	2.19	0.33	0.79	0.40
55 Santa Fe West (Buckman Booster #4)	11	0	1.03	0.36	0.64	0.20
56 El Rancho	18	1	1.05	0.22	0.64	0.24
Pueblo Stations						
41 San Ildefonso Pueblo	27	1	1.28	0.16	0.71	0.22
42 Taos Pueblo	15	0	1.23	0.35	0.74	0.28
53 Jemez Pueblo-tribal office	25	2	1.28	0.18	0.80	0.31
Perimeter Stations						
04 Barranca School	27	2	1.08	0.06	0.50	0.23
05 Urban Park	27	6	0.85	0.10	0.43	0.20
06 48th Street	26	7	0.90	0.04	0.40	0.24
07 Gulf/Exxon/Shell Station	27	1	1.15	0.12	0.65	0.25
08 McDonalds Restaurant	27	1	1.38	–0.05[a]	0.52	0.28
09 Los Alamos Airport	27	2	1.33	0.20	0.61	0.28
10 East Gate	23	1	1.13	0.18	0.51	0.23
11 Well PM-1 (E. Jemez Road)	27	4	0.98	0.04	0.51	0.24
12 Royal Crest Trailer Court	27	0	1.25	0.25	0.54	0.26
13 Piñon School	27	2	0.88	0.21	0.55	0.20
14 Pajarito Acres	27	4	1.14	0.10	0.49	0.23
15 White Rock Fire Station	27	2	1.18	0.14	0.51	0.24
16 White Rock Nazarene Church	27	1	0.92	0.25	0.51	0.18
17 Bandelier Entrance	27	2	1.46	0.12	0.50	0.25
60 LA Canyon	27	3	1.06	–0.02	0.43	0.21
61 LA Hospital	27	2	0.96	0.18	0.58	0.23
62 Trinity Bible Church	27	2	1.04	0.13	0.50	0.20
63 Monte Rey South	27	2	0.89	0.04	0.44	0.18
90 East Gate-Backup	4	0	0.57	0.33	0.43	0.11
TA-15 Stations						
76 TA-15-61	27	1	1.88	0.16	0.59	0.37
77 TA-15-IJ Site	27	2	14.47	0.10	1.21	2.68
78 TA-15-N	27	5	1.27	0.12	0.48	0.24
TA-21 Stations						
20 TA-21 Area B	27	0	2.99	0.25	0.61	0.56
71 TA-21.01 (NW Bldg 344)	27	1	0.97	0.21	0.54	0.21
72 TA-21.02 (N Bldg 344)	27	2	0.89	0.16	0.55	0.22
73 TA-21.03 (NE Bldg 344)	26	2	1.03	0.23	0.65	0.23
74 TA-21.04 (SE Bldg 344)	27	1	2.59	0.12	0.56	0.44
75 TA-21.05 (S Bldg 344)	27	3	1.01	0.11	0.53	0.24

Table 4-2. Airborne Long-Lived Gross Alpha Concentrations for 1997 (Cont.)

Station Location		Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	1 *s*
TA-54 Area G Stations							
27	TA-54 Area G (by QA)	27	0	7.44	0.64	1.88	1.62
34	TA-54 Area G-1 (behind trailer)	27	2	0.95	0.20	0.56	0.22
35	TA-54 Area G-2 (back fence)	27	3	0.99	0.13	0.52	0.21
36	TA-54 Area G-3 (by office)	27	3	1.60	0.12	0.68	0.37
45	TA-54 Area G (SE Perimeter)	26	0	2.39	0.23	0.91	0.63
47	TA-54 Area G (N Perimeter)	27	2	0.95	0.14	0.55	0.21
50	TA-54 Area G-expansion	26	0	1.92	0.24	0.85	0.39
51	TA-54 Area G-expansion pit	27	0	1.41	0.32	0.66	0.27
Other On-Site Stations							
23	TA-52 Beta Site	27	3	1.45	0.16	0.49	0.27
25	TA-16-450	26	4	1.30	0.12	0.51	0.28
26	TA-49	26	3	0.99	0.22	0.45	0.20
30	Pajarito Booster 2 (P-2)	27	2	0.94	0.12	0.51	0.23
31	TA-3	27	1	0.92	0.17	0.54	0.18
32	County Landfill (alias TA-48)	29	0	7.84	0.25	1.48	1.58
49	Pajarito Road (TA-36)	27	4	0.97	0.16	0.51	0.22
54	TA-33 East	18	1	1.09	0.16	0.59	0.24
QA Stations							
38	TA-54 Area G (adjacent to station 27)	27	0	7.90	0.40	1.78	1.68
39	TA-49 (adjacent to station 26)	26	3	1.04	0.15	0.51	0.24

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[b]	1 *s*
Regional	85	2	2.19	0.14	0.68	±0.07	0.30
Pueblo	67	3	1.28	0.16	0.75	±0.07	0.27
Perimeter	485	44	1.46	–0.05[a]	0.51	±0.02	0.23
TA-15	81	8	14.47	0.10	0.76	±0.35	1.58
TA-21	161	9	2.99	0.11	0.57	±0.05	0.34
TA-54 Area G	214	10	7.44	0.12	0.83	±0.10	0.78
Other On-Site	207	18	7.84	0.12	0.65	±0.10	0.71

Concentration guidelines are not available for gross alpha concentrations.

[a] See Appendix B for an explanation of negative numbers.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-3. Airborne Long-Lived Gross Beta Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	1 *s*
Regional Stations						
01 Española	27	0	20.9	10.3	14.4	3.2
02 Pojoaque	2	0	15.4	8.5	12.0	4.9
03 Santa Fe	27	0	20.0	9.0	13.1	2.8
55 Santa Fe West (Buckman Booster #4)	11	0	27.0	11.8	16.2	4.5
56 El Rancho	18	0	21.6	8.3	14.3	3.7
Pueblo Stations						
41 San Ildefonso Pueblo	27	0	20.8	7.9	13.6	3.5
42 Taos Pueblo	15	0	19.8	8.6	12.6	2.4
53 Jemez Pueblo-tribal office	25	0	19.4	8.3	13.5	2.8
Perimeter Stations						
04 Barranca School	27	0	19.4	7.1	13.0	3.1
05 Urban Park	27	0	18.3	4.8	12.0	3.2
06 48th Street	26	0	18.3	6.7	12.3	2.7
07 Gulf/Exxon/Shell Station	27	0	20.4	7.0	12.8	2.8
08 McDonalds Restaurant	27	0	20.5	7.5	13.2	2.6
09 Los Alamos Airport	27	0	20.5	8.2	14.1	3.0
10 East Gate	23	0	25.0	7.8	13.4	3.6
11 Well PM-1 (E. Jemez Road)	27	0	20.8	7.4	12.9	3.0
12 Royal Crest Trailer Court	27	0	22.3	7.2	13.6	3.2
13 Piñon School	27	0	20.1	8.3	14.1	3.1
14 Pajarito Acres	27	0	20.2	7.2	13.8	2.8
15 White Rock Fire Station	27	0	20.1	9.6	13.1	2.8
16 White Rock Nazarene Church	27	0	19.0	8.7	13.3	2.7
17 Bandelier Entrance	27	0	19.2	7.8	14.1	3.0
60 LA Canyon	27	0	26.2	8.1	13.0	3.3
61 LA Hospital	27	0	19.4	8.4	13.2	2.5
62 Trinity Bible Church	27	0	18.2	6.7	13.2	2.9
63 Monte Rey South	27	0	20.3	6.4	12.7	3.5
90 East Gate-Backup	4	0	18.2	10.2	14.3	3.3
TA-15 Stations						
76 TA-15-61	27	0	29.0	7.6	15.1	4.4
77 TA-15-IJ Site	27	0	21.7	8.5	13.8	3.4
78 TA-15-N	27	0	22.5	7.9	13.6	3.3
TA-21 Stations						
20 TA-21 Area B	27	0	20.3	8.7	13.3	2.8
71 TA-21.01 (NW Bldg 344)	27	0	20.3	7.7	13.1	3.0
72 TA-21.02 (N Bldg 344)	27	0	26.2	7.3	14.5	4.0
73 TA-21.03 (NE Bldg 344)	26	0	21.8	7.9	14.2	3.2
74 TA-21.04 (SE Bldg 344)	27	0	25.6	7.8	13.8	3.8
75 TA-21.05 (S Bldg 344)	27	0	22.8	7.7	13.6	3.5

Table 4-3. Airborne Long-Lived Gross Beta Concentrations for 1997 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	1 *s*
TA-54 Area G Stations						
27 TA-54 Area G (by QA)	27	0	26.2	7.8	15.3	4.5
34 TA-54 Area G-1 (behind trailer)	27	0	24.2	8.2	14.4	4.2
35 TA-54 Area G-2 (back fence)	27	0	19.8	8.2	12.7	2.8
36 TA-54 Area G-3 (by office)	27	0	20.9	8.0	12.4	3.0
45 TA-54 Area G (SE Perimeter)	26	0	20.8	7.6	14.0	2.9
47 TA-54 Area G (N Perimeter)	27	0	20.4	8.3	13.4	3.1
50 TA-54 Area G-expansion	26	0	23.2	6.4	14.6	3.6
51 TA-54 Area G-expansion pit	27	0	20.0	7.8	13.6	3.1
Other On-Site Stations						
23 TA-52 Beta Site	27	0	21.7	9.2	14.8	3.1
25 TA-16-450	26	0	21.3	7.7	13.2	3.1
26 TA-49	26	0	17.5	7.3	11.6	2.3
30 Pajarito Booster 2 (P-2)	27	0	22.2	8.2	12.9	3.1
31 TA-3	27	0	18.0	8.1	12.6	2.3
32 County Landfill (for TA-48)	29	0	21.9	5.8	12.1	3.4
49 Pajarito Road (TA-36)	27	0	22.0	9.7	14.0	3.0
54 TA-33 East	18	0	23.4	10.4	15.6	3.2
QA Stations						
38 TA-54 Area G (adjacent to station 27)	27	0	19.6	5.0	12.4	3.3
39 TA-49 (adjacent to station 26)	26	0	18.7	7.3	12.6	2.6

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[a]	1 *s*
Regional	85	0	27.0	8.3	14.1	±0.8	3.5
Pueblo	67	0	20.8	7.9	13.3	±0.7	3.0
Perimeter	485	0	26.2	4.8	13.2	±0.3	3.0
TA-15	81	0	29.0	7.6	14.2	±0.8	3.7
TA-21	161	0	26.2	7.3	13.7	±0.5	3.4
TA-54 Area G	214	0	26.2	6.4	13.8	±0.5	3.5
Other On-Site	207	0	23.4	5.8	13.3	±0.4	3.1

Concentration guidelines are not available for gross beta concentrations.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-4. Airborne Tritium as Tritiated Water Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	1 *s*
Regional Stations						
01 Española	27	26	2.8	–1.4[a]	0.3	0.9
02 Pojoaque	2	1	2.5	–0.4	1.0	2.0
03 Santa Fe	27	27	2.4	–1.1	0.1	0.7
55 Santa Fe West (Buckman Booster #4)	11	10	2.8	–1.2	0.4	1.0
56 El Rancho	18	17	3.5	–1.6	0.4	1.2
Pueblo Stations						
41 San Ildefonso Pueblo	27	25	4.7	–1.2	0.3	1.1
42 Taos Pueblo	15	13	2.0	–1.0	0.3	0.8
53 Jemez Pueblo-tribal office	26	25	3.6	–1.4	0.2	1.0
Perimeter Stations						
04 Barranca School	27	21	2.4	–1.0	0.8	0.7
05 Urban Park	27	20	3.1	–1.0	0.9	0.9
06 48th Street	27	18	7.0	–0.3	1.3	1.6
07 Gulf/Exxon/Shell Station	27	11	5.2	–0.4	1.6	1.4
08 McDonalds Restaurant	27	2	10.7	0.5	3.8	2.2
09 Los Alamos Airport	27	5	5.8	0.3	2.6	1.3
10 East Gate	21	3	11.7	0.6	3.7	3.3
11 Well PM-1 (E. Jemez Road)	27	10	10.0	–0.3	2.5	2.7
12 Royal Crest Trailer Court	27	8	4.8	0.1	1.8	1.2
13 Piñon School	27	8	7.0	–0.1	2.5	1.8
14 Pajarito Acres	27	16	6.1	0.0	1.4	1.4
15 White Rock Fire Station	26	12	13.9	–0.2	1.9	2.7
16 White Rock Nazarene Church	27	5	11.6	0.2	3.2	2.5
17 Bandelier Entrance	27	14	12.4	–1.2	1.7	2.5
60 LA Canyon	27	4	4.7	1.0	2.4	1.1
61 LA Hospital	27	16	4.9	–0.9	1.1	1.1
62 Trinity Bible Church	27	6	5.6	–0.2	2.0	1.3
63 Monte Rey South	27	18	3.5	–0.3	1.1	1.0
90 East Gate-Backup	6	3	9.0	0.6	3.7	3.7
TA-15 Stations						
76 TA-15-61	27	17	9.6	–0.5	1.6	1.8
77 TA-15-IJ Site	27	15	5.1	–0.5	1.4	1.0
78 TA-15-N	27	8	10.1	0.4	2.2	2.0
TA-21 Stations						
20 TA-21 Area B	27	0	14.9	0.9	4.6	3.6
71 TA-21.01 (NW Bldg 344)	27	1	10.3	0.3	3.2	2.2
72 TA-21.02 (N Bldg 344)	26	0	12.7	1.5	3.6	2.4
73 TA-21.03 (NE Bldg 344)	27	0	19.4	1.7	6.3	4.9
74 TA-21.04 (SE Bldg 344)	27	0	14.6	2.0	5.2	3.0
75 TA-21.05 (S Bldg 344)	27	0	14.1	2.1	5.7	3.2

Table 4-4. Airborne Tritium as Tritiated Water Concentrations for 1997 (Cont.)

Station Location		Number of Results	Number of Results <MDA	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	1 *s*
TA-54 Area G Stations							
27	TA-54 Area G (by QA)	27	0	60.7	2.3	24.6	20.2
34	TA-54 Area G-1 (behind trailer)	27	0	68.2	2.6	22.8	18.6
35	TA-54 Area G-2 (back fence)	27	0	2,673.4	10.2	604.6	717.9
36	TA-54 Area G-3 (by office)	27	2	190.6	–0.1	32.4	51.8
45	TA-54 Area G (SE Perimeter)	26	0	32.7	1.7	13.5	9.4
47	TA-54 Area G (N Perimeter)	26	0	44.6	1.9	17.1	13.5
50	TA-54 Area G-expansion	27	1	21.6	0.7	7.2	5.5
51	TA-54 Area G-expansion pit	26	2	20.4	0.3	5.7	4.9
Other On-Site Stations							
23	TA-52 Beta Site	26	3	15.7	0.6	5.5	5.0
25	TA-16-450	27	0	132.0	2.0	62.4	28.7
26	TA-49	27	2	9.2	–0.1	3.6	2.3
30	Pajarito Booster 2 (P-2)	27	7	6.9	0.4	2.4	1.8
31	TA-3	27	6	17.2	0.4	3.6	4.4
32	County Landfill (alias TA-48)	27	11	4.3	–0.5	1.5	1.1
49	Pajarito Road (TA-36)	27	17	4.5	0.0	1.3	1.1
54	TA-33 East	18	17	2.4	0.2	0.9	0.5
QA Stations							
38	TA-54 Area G (adjacent to station 27)	26	0	65.5	2.9	23.7	19.2
39	TA-49 (adjacent to station 26)	27	8	7.6	0.1	3.4	2.4

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	95% Confidence Interval[b]	1 *s*
Regional	85	81	3.5	–1.6	0.3	±0.2	0.9
Pueblo	68	63	4.7	–1.4	0.3	±0.2	1.0
Perimeter	485	200	13.9	–1.2	2.0	±0.2	2.0
TA-15	81	40	10.1	–0.5	1.7	±0.4	1.7
TA-21	161	1	19.4	0.3	4.8	±0.5	3.5
TA-54 Area G	213	5	2,673.4	–0.1	92.1	±43.8	319.4
Other On-Site	206	63	132.0	–0.5	10.6	±3.2	22.8

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for work place exposure is 20,000,000 pCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 1,500 pCi/m^3.

[a] See Appendix B for an explanation of negative numbers.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-5. Airborne Plutonium-238 Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
Regional Stations						
01 Española	4	3	1.0	–0.3[a]	0.2	0.6
02 Pojoaque	1	1	0.3	0.3	0.3	
03 Santa Fe	4	4	0.1	0.0	0.1	0.1
55 Santa Fe West (Buckman Booster #4)	2	2	0.8	–0.4	0.2	0.9
56 El Rancho	3	3	0.1	–0.1	0.0	0.1
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	0.1	0.0	0.1	0.1
42 Taos Pueblo	3	3	0.0	0.0	0.0	0.0
53 Jemez Pueblo-tribal office	4	3	0.6	–0.7	0.1	0.6
Perimeter Stations						
04 Barranca School	4	4	1.1	0.1	0.4	0.5
05 Urban Park	4	3	0.4	–0.4	–0.1	0.3
06 48th Street	4	4	0.6	–0.1	0.1	0.4
07 Gulf/Exxon/Shell Station	4	4	0.3	–0.2	0.1	0.2
08 McDonalds Restaurant	4	3	0.0	–0.3	–0.1	0.1
09 Los Alamos Airport	4	3	0.5	–0.4	0.1	0.4
10 East Gate	4	4	0.5	–0.1	0.1	0.3
11 Well PM-1 (E. Jemez Road)	4	3	0.7	–0.5	0.1	0.5
12 Royal Crest Trailer Court	4	3	0.6	–0.4	0.1	0.4
13 Piñon School	4	4	2.6	–0.2	0.6	1.4
14 Pajarito Acres	4	3	0.1	–0.3	–0.1	0.2
15 White Rock Fire Station	4	4	0.4	–0.1	0.1	0.2
16 White Rock Nazarene Church	4	4	0.6	–0.1	0.1	0.3
17 Bandelier Entrance	4	4	0.3	0.0	0.1	0.1
60 LA Canyon	4	4	0.6	–0.1	0.2	0.3
61 LA Hospital	4	3	0.1	–1.2	–0.3	0.6
62 Trinity Bible Church	4	4	0.6	0.0	0.3	0.3
63 Monte Rey South	4	3	0.1	–0.2	0.0	0.2
TA-15 Stations						
76 TA-15-61	4	3	0.1	–0.3	0.0	0.2
77 TA-15-IJ Site	4	3	0.6	–0.3	0.2	0.4
78 TA-15-N	4	4	0.2	–0.1	0.1	0.2
TA-21 Stations						
20 TA-21 Area B	4	3	5.1	–0.5	1.4	2.6
71 TA-21.01 (NW Bldg 344)	4	3	0.1	–0.1	0.0	0.1
72 TA-21.02 (N Bldg 344)	4	3	3.6	0.1	1.5	1.5
73 TA-21.03 (NE Bldg 344)	4	2	3.8	0.4	2.2	1.7
74 TA-21.04 (SE Bldg 344)	4	3	2.0	0.3	0.8	0.8
75 TA-21.05 (S Bldg 344)	4	4	0.6	–0.1	0.3	0.3

Table 4-5. Airborne Plutonium-238 Concentrations for 1997 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
TA-54 Area G Stations						
27 TA-54 Area G (by QA)	4	2	42.6	2.1	19.0	19.7
34 TA-54 Area G-1 (behind trailer)	4	4	2.1	0.5	1.5	0.7
35 TA-54 Area G-2 (back fence)	4	4	0.9	0.0	0.3	0.4
36 TA-54 Area G-3 (by office)	4	4	1.1	–0.1	0.5	0.5
45 TA-54 Area G (SE Perimeter)	4	4	3.7	0.2	1.5	1.5
47 TA-54 Area G (N Perimeter)	4	4	0.7	0.3	0.5	0.2
50 TA-54 Area G-expansion	4	4	1.4	0.2	0.6	0.6
51 TA-54 Area G-expansion pit	4	3	0.6	–0.3	0.2	0.4
Other On-Site Stations						
23 TA-52 Beta Site	4	4	0.5	–0.1	0.1	0.3
25 TA-16-450	4	3	0.6	–0.4	0.0	0.4
26 TA-49	4	3	0.1	–0.3	0.0	0.2
30 Pajarito Booster 2 (P-2)	4	4	2.2	–0.1	0.6	1.1
31 TA-3	4	4	0.9	–0.1	0.3	0.4
32 County Landfill (alias TA-48)	4	4	0.6	–0.1	0.3	0.3
49 Pajarito Road (TA-36)	4	4	0.6	–0.1	0.2	0.4
54 TA-33 East	3	2	0.7	–0.3	0.3	0.5
QA Stations						
38 TA-54 Area G (adjacent to station 27)	4	2	35.6	2.2	15.2	15.7
39 TA-49 (adjacent to station 26)	4	4	0.6	–0.1	0.2	0.3

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	1 *s*
Regional	14	13	1.0	–0.4	0.13	±0.22	0.4
Pueblo	11	10	0.6	–0.7	0.05	±0.23	0.3
Perimeter	72	64	2.6	–1.2	0.09	±0.11	0.4
TA-15	12	10	0.6	–0.3	0.10	±0.16	0.3
TA-21	24	18	5.1	–0.5	1.01	±0.62	1.5
TA-54 Area G	32	29	42.6	–0.3	3.0	±3.15	8.7
Other On-Site	31	28	2.2	–0.4	0.21	±0.18	0.5

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for work place exposure is 3,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 2,100 aCi/m^3.

[a] See Appendix B for an explanation of negative numbers.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-6. Airborne Plutonium-239 Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
Regional Stations						
01 Española	4	4	0.4	–0.2[a]	0.1	0.3
02 Pojoaque	1	1	1.0	1.0	1.0	
03 Santa Fe	4	4	1.1	–0.1	0.4	0.5
55 Santa Fe West (Buckman Booster #4)	2	2	0.7	0.1	0.4	0.4
56 El Rancho	3	3	0.6	–0.4	0.1	0.5
Pueblo Stations						
41 San Ildefonso Pueblo	4	3	0.8	–0.5	0.4	0.6
42 Taos Pueblo	3	3	0.3	–1.3	–0.3	0.9
53 Jemez Pueblo-tribal office	4	3	1.1	–0.5	0.4	0.7
Perimeter Stations						
04 Barranca School	4	3	1.7	–0.4	0.3	1.0
05 Urban Park	4	3	1.2	–0.2	0.4	0.7
06 48th Street	4	4	0.7	0.2	0.6	0.2
07 Gulf/Exxon/Shell Station	4	4	0.6	0.1	0.4	0.2
08 McDonalds Restaurant	4	4	1.3	–0.2	0.5	0.6
09 Los Alamos Airport	4	4	1.9	0.0	1.1	0.9
10 East Gate	4	4	2.5	0.3	1.4	0.9
11 Well PM-1 (E. Jemez Road)	4	3	2.0	–0.3	0.5	1.0
12 Royal Crest Trailer Court	4	3	1.3	–0.3	0.4	0.7
13 Piñon School	4	4	2.5	0.1	1.1	1.2
14 Pajarito Acres	4	4	0.7	0.0	0.3	0.3
15 White Rock Fire Station	4	4	1.2	–0.1	0.5	0.7
16 White Rock Nazarene Church	4	4	0.5	–0.5	0.2	0.5
17 Bandelier Entrance	4	4	1.1	–0.3	0.4	0.6
60 LA Canyon	4	4	2.2	0.6	1.4	0.7
61 LA Hospital	4	4	1.9	–0.9	0.4	1.1
62 Trinity Bible Church	4	4	4.4	–0.1	1.4	2.0
63 Monte Rey South	4	4	1.0	0.0	0.4	0.5
TA-15 Stations						
76 TA-15-61	4	3	2.2	–0.9	0.6	1.3
77 TA-15-IJ Site	4	3	1.0	–0.6	0.4	0.7
78 TA-15-N	4	4	1.4	–0.1	0.6	0.7
TA-21 Stations						
20 TA-21 Area B	4	4	1.4	1.0	1.2	0.1
71 TA-21.01 (NW Bldg 344)	4	4	2.3	0.5	1.6	0.8
72 TA-21.02 (N Bldg 344)	4	1	33.1	2.0	15.9	12.9
73 TA-21.03 (NE Bldg 344)	4	2	37.0	6.3	18.0	14.5
74 TA-21.04 (SE Bldg 344)	4	1	165.3	7.4	49.1	77.5
75 TA-21.05 (S Bldg 344)	4	2	13.4	1.6	7.5	6.3

Table 4.6. Airborne Plutonium-239 Concentrations for 1997 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
TA-54 Area G Stations						
27 TA-54 Area G (by QA)	4	0	1,584.5	72.1	679.8	723.6
34 TA-54 Area G-1 (behind trailer)	4	1	12.1	1.8	6.8	4.3
35 TA-54 Area G-2 (back fence)	4	3	4.0	0.4	2.2	1.5
36 TA-54 Area G-3 (by office)	4	1	11.6	–0.6	5.6	5.3
45 TA-54 Area G (SE Perimeter)	4	0	34.9	7.7	18.0	13.0
47 TA-54 Area G (N Perimeter)	4	2	18.4	2.8	10.6	8.9
50 TA-54 Area G-expansion	4	2	12.2	2.4	6.2	4.2
51 TA-54 Area G-expansion pit	4	2	4.7	2.2	3.3	1.2
Other On-Site Stations						
23 TA-52 Beta Site	4	4	1.4	–0.1	0.4	0.7
25 TA-16-450	4	4	2.0	0.0	0.8	0.9
26 TA-49	4	4	0.8	–0.1	0.3	0.4
30 Pajarito Booster 2 (P-2)	4	3	4.2	0.3	1.5	1.9
31 TA-3	4	3	6.3	0.2	2.4	2.8
32 County Landfill (alias TA-48)	4	2	4.8	2.2	3.5	1.4
49 Pajarito Road (TA-36)	4	3	1.6	–0.6	0.5	0.9
54 TA-33 East	3	3	2.3	0.1	1.1	1.1
QA Stations						
38 TA-54 Area G (adjacent to station 27)	4	0	1,369.5	41.4	550.8	629.0
39 TA-49 (adjacent to station 26)	4	4	1.3	0.1	0.7	0.5

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	1 *s*
Regional	14	14	1.1	–0.4	0.3	±0.25	0.4
Pueblo	11	9	1.1	–1.3	0.2	±0.47	0.7
Perimeter	72	68	4.4	–0.9	0.6	±0.20	0.9
TA-15	12	10	2.2	–0.9	0.5	±0.55	0.9
TA-21	24	14	165.3	0.5	15.5	±14.11	33.4
TA-54 Area G	32	11	1,584.5	–0.6	91.6	±115.14	319.0
Other On-Site	31	26	6.3	–0.6	1.3	±0.61	1.7

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for work place exposure is 2,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 1,900 aCi/m^3.

[a] See Appendix B for an explanation of negative numbers.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-7. Airborne Americium-241 Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
Regional Stations						
01 Española	4	4	2.7	0.4	1.5	0.9
02 Pojoaque	1	1	4.2	4.2	4.2	
03 Santa Fe	4	2	4.3	1.6	2.5	1.3
55 Santa Fe West	2	2	3.7	0.3	2.0	2.4
(Buckman Booster #4)	2	2	3.7	0.3	2.0	2.4
56 El Rancho	3	3	3.8	1.7	2.8	1.1
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	2.6	1.1	1.6	0.7
42 Taos Pueblo	3	3	5.6	1.4	3.2	2.2
53 Jemez Pueblo-tribal office	4	3	3.3	0.3	2.0	1.3
Perimeter Stations						
04 Barranca School	4	3	3.9	1.3	2.4	1.1
05 Urban Park	4	3	3.9	0.6	2.1	1.4
06 48th Street	4	3	3.6	1.2	2.0	1.1
07 Gulf/Exxon/Shell Station	4	3	3.9	1.1	1.9	1.3
08 McDonalds Restaurant	4	4	2.6	1.3	1.9	0.6
09 Los Alamos Airport	4	4	3.8	0.3	1.5	1.6
10 East Gate	4	3	2.9	1.4	2.1	0.7
11 Well PM-1 (E. Jemez Road)	4	3	3.6	0.3	1.9	1.5
12 Royal Crest Trailer Court	4	4	2.8	0.8	1.8	1.0
13 Piñon School	4	3	2.9	1.4	2.0	0.7
14 Pajarito Acres	4	3	4.2	0.7	2.0	1.5
15 White Rock Fire Station	4	3	4.5	0.7	1.9	1.7
16 White Rock Nazarene Church	4	3	4.1	1.4	2.6	1.2
17 Bandelier Entrance	4	3	3.9	1.5	2.5	1.1
60 LA Canyon	4	4	1.8	0.0	1.1	0.8
61 LA Hospital	4	4	2.3	0.6	1.7	0.8
62 Trinity Bible Church	4	4	1.9	0.8	1.3	0.5
63 Monte Rey South	4	4	3.1	0.1	1.8	1.3
90 East Gate-Backup						
TA-15 Stations						
76 TA-15-61	4	4	2.1	1.4	1.9	0.3
77 TA-15-IJ Site	4	4	3.2	1.0	1.8	1.0
78 TA-15-N	4	4	3.5	0.4	2.0	1.3
TA-21 Stations						
20 TA-21 Area B	4	4	3.1	0.3	2.0	1.2
71 TA-21.01 (NW Bldg 344)	4	3	4.1	1.0	2.4	1.5
72 TA-21.02 (N Bldg 344)	4	2	5.9	2.3	3.9	1.5
73 TA-21.03 (NE Bldg 344)	4	2	20.2	3.8	10.1	7.2
74 TA-21.04 (SE Bldg 344)	4	2	11.8	1.1	4.7	4.8
75 TA-21.05 (S Bldg 344)	4	3	3.8	2.0	2.7	0.8

Table 4-7. Airborne Americium-241 Concentrations for 1997 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
TA-54 Area G Stations						
27 TA-54 Area G (by QA)	4	0	1,033.9	43.6	468.9	487.2
34 TA-54 Area G-1 (behind trailer)	4	2	11.6	0.9	5.9	4.9
35 TA-54 Area G-2 (back fence)	4	2	4.5	0.8	2.8	1.5
36 TA-54 Area G-3 (by office)	4	2	7.9	2.5	4.9	2.2
45 TA-54 Area G (SE Perimeter)	4	1	13.5	3.6	7.8	4.7
47 TA-54 Area G (N Perimeter)	4	2	15.4	2.4	8.4	6.5
50 TA-54 Area G-expansion	4	2	8.2	0.6	5.0	3.2
51 TA-54 Area G-expansion pit	4	1	5.8	1.6	3.5	1.8
Other On-Site Stations						
23 TA-52 Beta Site	4	2	4.2	1.1	2.4	1.3
25 TA-16-450	4	3	3.7	0.9	2.2	1.2
26 TA-49	4	3	4.2	0.4	1.9	1.6
30 Pajarito Booster 2 (P-2)	4	3	6.1	0.6	2.7	2.4
31 TA-3	4	3	5.0	0.6	2.5	1.9
32 County Landfill (alias TA-48)	4	2	3.8	1.4	2.5	1.0
49 Pajarito Road (TA-36)	4	4	2.9	1.0	2.2	0.8
54 TA-33 East	3	3	4.8	0.1	3.1	2.6
QA Stations						
38 TA-54 Area G (adjacent to station 27)	4	0	900.0	30.8	367.8	413.6
39 TA-49 (adjacent to station 26)	4	4	3.1	1.4	2.2	0.7

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	1 *s*
Regional	14	12	4.3	0.3	2.3	±0.8	1.3
Pueblo	11	10	5.6	0.3	2.2	±1.0	1.4
Perimeter	72	61	4.5	0.0	1.9	±0.3	1.1
TA-15	12	12	3.5	0.4	1.9	±0.6	0.9
TA-21	24	16	20.2	0.3	4.3	±1.8	4.3
TA-54 Area G	32	12	1,033.9	0.6	63.4	±78.5	217.3
Other On-Site	31	23	6.1	0.1	2.4	±0.5	1.5

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for work place exposure is 2,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 1,900 aCi/m^3.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-8. Airborne Uranium-234 Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
Regional Stations						
01 Española	4	0	21.0	11.2	15.8	4.3
02 Pojoaque	1	0	21.4	21.4	21.4	
03 Santa Fe	4	0	41.5	13.7	23.0	12.5
55 Santa Fe West (Buckman Booster #4)	2	1	6.7	5.7	6.2	0.7
56 El Rancho	3	0	19.5	8.3	12.8	5.9
Pueblo Stations						
41 San Ildefonso Pueblo	4	0	22.0	14.2	17.2	3.4
42 Taos Pueblo	3	0	26.5	17.6	23.1	4.8
53 Jemez Pueblo-tribal office	4	0	23.3	12.2	16.2	4.9
Perimeter Stations						
04 Barranca School	4	0	12.9	4.5	8.1	3.5
05 Urban Park	4	3	6.8	3.0	4.6	1.7
06 48th Street	4	4	6.1	2.0	3.7	1.9
07 Gulf/Exxon/Shell Station	4	0	18.4	8.6	11.9	4.5
08 McDonalds Restaurant	4	1	11.2	3.6	7.3	3.4
09 Los Alamos Airport	4	0	10.7	5.4	7.3	2.3
10 East Gate	4	1	11.1	3.7	6.6	3.2
11 Well PM-1 (E. Jemez Road)	4	3	8.8	2.8	5.2	2.7
12 Royal Crest Trailer Court	4	3	10.7	3.8	6.5	3.0
13 Piñon School	4	3	8.1	2.2	5.3	2.6
14 Pajarito Acres	4	3	10.1	3.2	5.9	2.9
15 White Rock Fire Station	4	1	15.0	3.8	7.7	5.0
16 White Rock Nazarene Church	4	2	8.2	4.2	6.5	1.9
17 Bandelier Entrance	4	3	7.2	3.7	5.5	1.7
60 LA Canyon	4	0	12.0	5.8	9.0	2.6
61 LA Hospital	4	0	22.3	7.6	13.5	6.9
62 Trinity Bible Church	4	0	10.4	5.2	7.9	2.5
63 Monte Rey South	4	2	9.3	3.2	5.8	2.8
TA-15 Stations						
76 TA-15-61	4	1	11.2	3.9	8.4	3.5
77 TA-15-IJ Site	4	0	21.5	4.8	11.9	7.1
78 TA-15-N	4	2	98.1	2.3	27.9	46.9
TA-21 Stations						
20 TA-21 Area B	4	1	11.0	4.5	7.3	2.9
71 TA-21.01 (NW Bldg 344)	4	1	16.0	3.8	8.9	5.9
72 TA-21.02 (N Bldg 344)	4	0	13.8	5.1	9.9	4.0
73 TA-21.03 (NE Bldg 344)	4	0	17.2	4.0	11.7	6.6
74 TA-21.04 (SE Bldg 344)	4	1	20.9	6.0	11.6	6.8
75 TA-21.05 (S Bldg 344)	4	0	17.9	4.5	11.5	7.2

Table 4-8. Airborne Uranium-234 Concentrations for 1997 (Cont.)

Station Location		Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
TA-54 Area G Stations							
27	TA-54 Area G (by QA)	4	0	111.9	33.4	56.6	37.1
34	TA-54 Area G-1 (behind trailer)	4	0	26.1	10.9	16.3	6.8
35	TA-54 Area G-2 (back fence)	4	0	14.5	5.4	11.5	4.1
36	TA-54 Area G-3 (by office)	4	0	30.1	10.4	17.9	8.8
45	TA-54 Area G (SE Perimeter)	4	0	56.8	15.0	40.4	20.4
47	TA-54 Area G (N Perimeter)	4	0	16.1	7.9	10.9	3.7
50	TA-54 Area G-expansion	4	0	67.9	24.9	39.0	19.6
51	TA-54 Area G-expansion pit	4	0	57.8	17.0	31.0	18.3
Other On-Site Stations							
23	TA-52 Beta Site	4	0	15.5	6.0	10.1	4.2
25	TA-16-450	4	0	12.0	7.5	9.7	1.9
26	TA-49	4	4	4.6	2.8	3.8	0.7
30	Pajarito Booster 2 (P-2)	4	1	10.8	3.6	6.4	3.3
31	TA-3	4	0	11.9	5.7	8.1	2.9
32	County Landfill (alias TA-48)	4	0	46.9	25.2	34.9	9.0
49	Pajarito Road (TA-36)	4	1	14.0	4.0	8.6	4.6
54	TA-33 East	3	0	10.7	3.6	7.4	3.6
QA Stations							
38	TA-54 Area G (adjacent to station 27)	4	0	83.5	26.0	43.3	27.0
39	TA-49 (adjacent to station 26)	4	3	5.0	1.8	3.6	1.6

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	1 *s*
Regional	14	1	41.5	5.7	16.3	±5.17	9.0
Pueblo	11	0	26.5	12.2	18.4	±3.31	4.9
Perimeter	72	29	22.3	2.0	7.1	±0.88	3.7
TA-15	12	3	98.1	2.3	16.0	±16.74	26.4
TA-21	24	3	20.9	3.8	10.2	±2.27	5.4
TA-54 Area G	32	0	111.9	5.4	28.0	±8.10	22.4
Other On-Site	31	6	46.9	2.8	11.2	±3.73	10.2

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for work place exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 7,700 aCi/m^3.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-9. Airborne Uranium-235 Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
Regional Stations						
01 Española	4	4	1.9	0.2	0.9	0.7
02 Pojoaque	1	1	0.3	0.3	0.3	
03 Santa Fe	4	4	3.5	1.0	2.3	1.0
55 Santa Fe West (Buckman Booster #4)	2	2	1.3	0.5	0.9	0.6
56 El Rancho	3	3	1.1	–0.2[a]	0.6	0.7
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	2.2	0.0	1.0	0.9
42 Taos Pueblo	3	3	1.4	0.9	1.2	0.3
53 Jemez Pueblo-tribal office	4	4	1.5	0.4	1.2	0.5
Perimeter Stations						
04 Barranca School	4	4	1.6	–0.1	0.8	0.7
05 Urban Park	4	4	1.5	0.0	0.8	0.6
06 48th Street	4	4	1.2	–1.0	0.4	1.0
07 Gulf/Exxon/Shell Station	4	4	1.5	0.5	1.0	0.5
08 McDonalds Restaurant	4	4	3.1	–0.1	1.2	1.4
09 Los Alamos Airport	4	4	1.9	–0.1	1.0	0.9
10 East Gate	4	4	1.3	–0.1	0.6	0.6
11 Well PM-1 (E. Jemez Road)	4	4	1.0	–0.7	0.4	0.8
12 Royal Crest Trailer Court	4	4	2.2	0.4	1.2	0.8
13 Piñon School	4	4	2.1	–0.4	0.7	1.2
14 Pajarito Acres	4	4	1.2	0.2	0.7	0.4
15 White Rock Fire Station	4	4	3.4	0.0	1.1	1.6
16 White Rock Nazarene Church	4	4	1.2	0.1	0.7	0.5
17 Bandelier Entrance	4	3	2.2	–0.4	0.5	1.2
60 LA Canyon	4	4	1.5	–0.1	0.9	0.7
61 LA Hospital	4	4	2.5	0.4	1.3	0.9
62 Trinity Bible Church	4	4	1.3	0.7	1.0	0.3
63 Monte Rey South	4	4	1.6	–0.2	0.5	0.9
TA-15 Stations						
76 TA-15-61	4	4	0.9	0.2	0.6	0.3
77 TA-15-IJ Site	4	4	2.1	–0.6	0.8	1.2
78 TA-15-N	4	4	2.9	–1.3	0.8	1.7
TA-21 Stations						
20 TA-21 Area B	4	4	0.9	0.1	0.6	0.4
71 TA-21.01 (NW Bldg 344)	4	4	1.0	0.0	0.4	0.5
72 TA-21.02 (N Bldg 344)	4	4	1.5	0.7	1.0	0.4
73 TA-21.03 (NE Bldg 344)	4	4	1.6	–0.2	0.5	0.8
74 TA-21.04 (SE Bldg 344)	4	3	1.6	–0.1	0.8	0.7
75 TA-21.05 (S Bldg 344)	4	4	2.3	–0.1	0.6	1.2

Table 4-9. Airborne Uranium-235 Concentrations for 1997 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
TA-54 Area G Stations						
27 TA-54 Area G (by QA)	4	3	8.6	2.8	4.8	2.7
34 TA-54 Area G-1 (behind trailer)	4	4	3.4	0.7	1.5	1.3
35 TA-54 Area G-2 (back fence)	4	4	1.7	0.1	0.7	0.7
36 TA-54 Area G-3 (by office)	4	4	3.0	0.6	1.7	1.0
45 TA-54 Area G (SE Perimeter)	4	4	3.4	2.0	2.7	0.7
47 TA-54 Area G (N Perimeter)	4	4	1.8	0.4	1.0	0.7
50 TA-54 Area G-expansion	4	4	3.4	1.5	2.4	0.8
51 TA-54 Area G-expansion pit	4	3	5.0	0.4	2.2	2.0
Other On-Site Stations						
23 TA-52 Beta Site	4	4	2.4	0.6	1.2	0.8
25 TA-16-450	4	4	1.8	0.6	1.0	0.6
26 TA-49	4	4	0.4	0.0	0.3	0.2
30 Pajarito Booster 2 (P-2)	4	4	2.0	–1.0	0.7	1.3
31 TA-3	4	4	1.0	–0.1	0.5	0.5
32 County Landfill (alias TA-48)	4	4	2.5	0.4	1.5	0.9
49 Pajarito Road (TA-36)	4	3	0.2	–0.5	–0.2	0.3
54 TA-33 East	3	3	1.1	–0.9	0.4	1.1
QA Stations						
38 TA-54 Area G (adjacent to station 27)	4	4	2.7	1.3	1.8	0.6
39 TA-49 (adjacent to station 26)	4	4	1.0	–0.4	0.5	0.6

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	1 *s*
Regional	14	14	3.5	–0.2	1.2	±0.57	1.0
Pueblo	11	11	2.2	0.0	1.1	±0.39	0.6
Perimeter	72	71	3.4	–1.0	0.8	±0.19	0.8
TA-15	12	12	2.9	–1.3	0.7	±0.70	1.1
TA-21	24	23	2.3	–0.2	0.7	±0.28	0.7
TA-54 Area G	32	30	8.6	0.1	2.1	±0.63	1.7
Other On-Site	31	30	2.5	–1.0	0.7	±0.32	0.9

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for work place exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 7,100 aCi/m^3.

[a] See Appendix B for an explanation of negative numbers.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-10. Airborne Uranium-238 Concentrations for 1997

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
Regional Stations						
01 Española	4	0	16.9	8.8	13.0	4.5
02 Pojoaque	1	0	19.5	19.5	19.5	
03 Santa Fe	4	0	36.6	12.3	21.2	10.6
55 Santa Fe West (Buckman Booster #4)	2	1	5.8	5.5	5.6	0.2
56 El Rancho	3	0	15.0	7.9	10.3	4.1
Pueblo Stations						
41 San Ildefonso Pueblo	4	0	23.8	11.8	17.3	5.0
42 Taos Pueblo	3	0	26.5	19.2	23.2	3.7
53 Jemez Pueblo-tribal office	4	0	25.5	7.6	16.2	7.3
Perimeter Stations						
04 Barranca School	4	0	27.2	5.9	12.7	9.9
05 Urban Park	4	3	10.4	4.1	6.2	2.8
06 48th Street	4	3	11.6	2.0	5.2	4.3
07 Gulf/Exxon/Shell Station	4	0	34.3	7.3	16.2	12.4
08 McDonalds Restaurant	4	1	41.5	5.1	15.0	17.7
09 Los Alamos Airport	4	1	18.8	3.3	8.9	7.1
10 East Gate	4	2	10.3	2.5	6.3	3.2
11 Well PM-1 (E. Jemez Road)	4	2	11.8	3.7	6.2	3.8
12 Royal Crest Trailer Court	4	2	39.1	3.6	14.2	16.7
13 Piñon School	4	2	8.6	4.1	5.7	2.1
14 Pajarito Acres	4	3	10.9	3.1	5.8	3.5
15 White Rock Fire Station	4	1	9.0	5.5	6.7	1.7
16 White Rock Nazarene Church	4	2	7.8	3.6	5.6	1.7
17 Bandelier Entrance	4	2	9.0	3.1	5.5	2.8
60 LA Canyon	4	0	13.0	6.8	10.2	2.7
61 LA Hospital	4	0	19.2	6.9	12.0	5.7
62 Trinity Bible Church	4	0	28.8	6.0	14.0	10.5
63 Monte Rey South	4	2	9.8	3.7	6.3	2.9
TA-15 Stations						
76 TA-15-61	4	1	18.9	3.8	12.6	6.5
77 TA-15-IJ Site	4	0	108.6	12.4	45.5	43.1
78 TA-15-N	4	1	13.8	3.2	8.2	4.7
TA-21 Stations						
20 TA–21 Area B	4	3	20.5	3.7	8.8	7.9
71 TA-21.01 (NW Bldg 344)	4	1	20.6	2.0	9.9	8.0
72 TA-21.02 (N Bldg 344)	4	0	23.0	4.0	10.8	8.5
73 TA-21.03 (NE Bldg 344)	4	0	26.0	4.3	13.6	9.5
74 TA-21.04 (SE Bldg 344)	4	1	21.9	5.2	9.9	8.0
75 TA-21.05 (S Bldg 344)	4	0	21.5	3.4	10.9	8.2

Table 4-10. Airborne Uranium-238 Concentrations for 1997 (Cont.)

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	1 *s*
TA-54 Area G Stations						
27 TA-54 Area G (by QA)	4	0	109.7	32.6	55.7	36.2
34 TA-54 Area G-1 (behind trailer)	4	0	18.0	7.2	13.7	4.6
35 TA-54 Area G-2 (back fence)	4	0	16.9	5.9	12.6	4.8
36 TA-54 Area G-3 (by office)	4	0	36.0	7.3	19.6	12.2
45 TA-54 Area G (SE Perimeter)	4	0	57.9	16.8	38.5	18.5
47 TA-54 Area G (N Perimeter)	4	0	16.6	7.7	11.8	3.8
50 TA-54 Area G-expansion	4	0	61.7	24.2	40.7	16.2
51 TA-54 Area G-expansion pit	4	0	55.6	14.7	31.2	17.4
Other On-Site Stations						
23 TA-52 Beta Site	4	0	24.3	4.3	13.0	8.7
25 TA-16-450	4	0	13.7	5.8	8.6	3.5
26 TA-49	4	1	6.9	2.8	4.5	1.8
30 Pajarito Booster 2 (P-2)	4	1	17.6	3.9	8.5	6.2
31 TA-3	4	0	13.1	5.3	7.9	3.7
32 County Landfill (alias TA-48)	4	0	54.1	32.1	39.0	10.2
49 Pajarito Road (TA-36)	4	0	12.8	6.6	9.9	3.1
54 TA-33 East	3	2	7.5	3.4	5.6	2.0
QA Stations						
38 TA-54 Area G (adjacent to station 27)	4	0	84.2	27.3	44.9	26.3
39 TA-49 (adjacent to station 26)	4	2	6.7	2.2	4.4	2.3

Group Summaries

Station Location	Number of Results	Number of Results <MDA	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	1 *s*
Regional	14	1	36.6	5.5	14.2	±4.67	8.1
Pueblo	11	0	26.5	7.6	18.5	±3.99	5.9
Perimeter	72	26	41.5	2.0	9.0	±1.86	7.9
TA-15	12	2	108.6	3.2	22.1	±18.24	28.7
TA-21	24	5	26.0	2.0	10.7	±3.20	7.6
TA-54 Area G	32	0	109.7	5.9	28.0	±7.82	21.7
Other On-Site	31	4	54.1	2.8	12.3	±4.33	11.9

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for work place exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 8,300 aCi/m^3.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-11. Airborne Radioactive Emissions from Laboratory Buildings with Sampled Stacks in 1997 (Ci)

TA-Building	^{3}H[a]	^{241}Am	Pu[b]	U[c]	Th	^{90}Sr	P/VAP[d]	G/MAP[e]
TA-03-029		0.00000037	0.0000035	0.000021	0.00000037	0.000000078		
TA-03-035		0.0000000014	0.0000000026	0.00000017				
TA-03-102		0.00000000053	0.0000000014	0.00000082	0.000000011			
TA-16-205	98.							
TA-21-155	38.							
TA-21-209	170.							
TA-33-086	43.							
TA-41-004	42.							
TA-48-001		0.00000000036	0.0000000025			0.0000000015	0.0018	
TA-50-001		0.0000000084	0.000000054			0.00000010		
TA-50-037				0.0000000013		0.000000015		
TA-50-069			0.00000000015			0.00000000020		
TA-53-003	15.						0.52	19000.
TA-53-007	1.8						0.41	570.
TA-55-004	12.		0.00000011	0.000000028	0.000000044			

[a] Includes both gaseous and oxide forms of tritium.
[b] Includes ^{238}Pu, ^{239}Pu and ^{240}Pu.
[c] Includes ^{234}U, ^{235}U, and ^{238}U.
[d] Particulate/vapor activation products.
[e] Gaseous/mixed activation products.

Table 4-12. Detailed Listing of Activation Products Released from Sampled Laboratory Stacks in 1997 (Ci)

TA-Building	Radionuclide	Emission
TA-48-001	^{72}As	0.000029
	^{73}As	0.000012
	^{74}As	0.00000064
	^{77}Br	0.0016
	^{191}Os	0.0000092
	^{75}Se	0.00012
TA-53-003	^{41}Ar	190.
	^{7}B	0.000081
	^{76}Br	0.12
	^{77}Br	0.22
	^{82}Br	0.17
	^{10}C	190.
	^{11}C	12000.
	^{60}Co	0.00024
	^{195}Hg	0.0041
	^{197}Hg	0.0095
	^{13}N	2000.
	^{16}N	130.
	^{24}Na	0.0021
	^{14}O	91.
	^{15}O	4400.
	^{183}Os	0.0037
	^{185}Os	0.0013
	^{182}Ta	0.0013
TA-53-007	^{41}Ar	8.0
	^{192}Au	0.012
	^{76}Br	0.0013
	^{82}Br	0.35
	^{10}C	0.13
	^{11}C	430
	^{193}Hg	0.0043
	^{195}Hg	0.015
	^{195m}Hg	0.00077
	^{197}Hg	0.017
	^{197m}Hg	0.0024
	^{13}N	60.
	^{14}O	0.58
	^{15}O	67.

Table 4-13. Radionuclide: Half-Life Information

Nuclide	Half-Life
^{3}H	12.3 yr
^{7}Be	53.4 d
^{10}C	19.3 s
^{11}C	20.5 min
^{13}N	10.0 min
^{16}N	7.13 s
^{14}O	70.6 s
^{15}O	122.2 s
^{22}Na	2.6 yr
^{24}Na	14.96 h
^{32}P	14.3 d
^{40}K	1,277,000,000 yr
^{41}Ar	1.83 h
^{54}Mn	312.7 d
^{56}Co	78.8 d
^{57}Co	270.9 d
^{58}Co	70.8 d
^{60}Co	5.3 yr
^{72}As	26 h
^{73}As	80.3 d
^{74}As	17.78 d
^{76}Br	16 h
^{77}Br	^{77}Br
^{82}Br	1.47 d
^{75}Se	119.8 d
^{85}Sr	64.8 d
^{89}Sr	50.6 d
^{90}Sr	28.6 yr
^{131}I	8 d
^{134}Cs	2.06 yr
^{137}Cs	30.2 yr
^{183}Os	13 h
^{185}Os	93.6 d
^{191}Os	15.4 d
^{193}Hg	3.8 hr
^{195}Hg	9.5 hr
^{195m}Hg	1.67 d
^{197}Hg	2.67 d
^{197m}Hg	23.8 hr
^{234}U	244,500 yr
^{235}U	703,800,000 yr
^{238}U	4,468,000,000 yr
^{238}Pu	87.7 yr
^{239}Pu	24,131 yr
^{240}Pu	6,569 yr
^{241}Pu	14.4 yr
^{241}Am	432 yr

Table 4-14. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1996–1997

	TLD Station ID #	Location	1997 Annual Dose (mrem)[a,b]	1997 Quarters Monitored	1996 Annual Dose (mrem)
Regional	01	Española	30 ± 5	1[d]	98 ± 11[d]
	03	Santa Fe	98 ± 6	1, 4[d]	105 ± 9[d]
	53	El Rancho	109 ± 6	1–4	82 ± 16[d]
	95	Pueblo of San Ildefonso[c]	71 ± 7	3–4[d]	– – –
Perimeter	05	Barranca School, Los Alamos	139 ± 9	1–4	104 ± 10[d]
	07	Cumbres School, Los Alamos	136 ± 8	1–4	130 ± 12
	08	48th Street, Los Alamos	138 ± 8	1–4	144 ± 11
	09	Los Alamos Airport	130 ± 8	1–4	131 ± 11
	10	Bayo Canyon, Los Alamos	182 ± 10	1–4	170 ± 12
	11	Shell Station, Los Alamos	109 ± 8	1–4	142 ± 11
	12	Royal Crest Trailer Court, Los Alamos	143 ± 8	1–4	140 ± 11
	13	White Rock	141 ± 8	1–4	134 ± 11
	14	Pajarito Acres, White Rock	138 ± 8	1–4	130 ± 11
	15	Bandelier National Monument Lookout Station	152 ± 9	1–4	149 ± 12
	16	Pajarito Ski Area	139 ± 9	1–4	114 ± 10[d]
	41	McDonald’s Restaurant, Los Alamos	126 ± 8	1, 2, 4[d]	78 ± 8[d]
	42	Los Alamos Airport-South	154 ± 10	1–4	147 ± 11
	43	East Gate Business Park, Los Alamos	141 ± 8	1–4	145 ± 11
	44	Big Rock Loop, Los Alamos	137 ± 11	1–4	176 ± 12
	45	Cheyenne Street, Los Alamos	156 ± 9	1–4	165 ± 12
	46	Los Pueblos Street, Los Alamos	157 ± 9	1–4	161 ± 12
	47	Urban Park, Los Alamos	149 ± 9	1–4	144 ± 12
	49	Piñon School, White Rock	129 ± 8	1–4	103 ± 10[d]
	50	White Rock Church of the Nazarene	107 ± 7	1–4	95 ± 10
	51	Bayo Canyon Well, Los Alamos	164 ± 10	1–4	162 ± 12
	55	Monte Rey South, White Rock	136 ± 8	1–4	128 ± 11
	56	East Gate (mid station)	159 ± 10	1–4	– – –
	60	Piedra Drive, White Rock[c]	138 ± 8	1–4	– – –
	67	Los Alamos Hospital	75 ± 7	2–3[d]	– – –
	68	Trinity Church[c]	83 ± 7	2, 4[d]	– – –
	80	TA-16 SR4 Back Gate[c]	111 ± 8	2–4	– – –
	81	TA-16 SR4 Ponderosa Camp[c]	149 ± 11	2–4	– – –
On-Site	17	TA-21 (DP West)	166 ± 10	1–4	155 ± 12
	18	TA-6 (Two Mile Mesa)	148 ± 9	1–4	142 ± 11
	19	TA-53 (LANSCE)	173 ± 10	1–4	159 ± 12
	20	Well PM-1 (SR4 and Truck Rt.)	163 ± 9	1–4	167 ± 12
	21	TA-16 (S-Site)	151 ± 9	1–4	141 ± 11
	22	Booster P-2	147 ± 10	1–4	179 ± 12
	23	TA-3 East Gate of SM 43	135 ± 8	1–4	125 ± 11
	24	State Highway 4	178 ± 11	1–4	178 ± 13
	25	TA-49 (Frijoles Mesa)	148 ± 10	1–4	135 ± 11
	26	TA-2 (Omega Stack)	154 ± 9	1–4	148 ± 12
	27	TA-2 (Omega Canyon)[e]	37 ± 4	1[d]	173 ± 13
	28	TA-18 (Pajarito Site)	166 ± 10	1–4	241 ± 13
	29	TA-35 (Ten Site A)	145 ± 9	1–4	92 ± 10

Table 4-14. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1996–1997 (Cont.)

	TLD Station ID #	Location	1997 Annual Dose (mrem)[a,b]	1997 Quarters Monitored	1996 Annual Dose (mrem)
On-Site (Cont.)	30	TA-35 (Ten Site B)	137 ± 8	1–4	140 ± 12
	31	TA-59 (Occupational Health Lab)	146 ± 9	1–4	144 ± 12
	32	TA-3-16 (Van de Graaff)	148 ± 9	1–4	153 ± 11
	33	TA-3-316 (Ion Beam Bldg.)	150 ± 9	1–4	144 ± 12
	34	TA-3-440 (CAS)	147 ± 9	1–4	113 ± 13
	35	TA-3-420 (CMR Bldg. West Fence)	136 ± 8	1–4	111 ± 11
	36	TA-3-102 (Shop)	146 ± 9	1–4	115 ± 11
	37	TA-72 (Pistol Range)	172 ± 11	1–4	142 ± 12
	38	TA-55 (Plutonium Facility South)	153 ± 10	1–4	132 ± 14
	39	TA-55 (Plutonium Facility West)	165 ± 10	1–4	181 ± 12
	40	TA-55 (Plutonium Facility North)	148 ± 9	1–4	154 ± 11
	48	Los Alamos County Landfill	136 ± 8	1–4	135 ± 11
	56	East Gate Mid Station			119 ± 10[d]
	57	TA-54 West (TLD Lab)	157 ± 9	1–4	129 ± 11[d]
	58	TA-54 Lagoon	159 ± 9	1–4	89 ± 9[d]
	59	Los Alamos Canyon	167 ± 10	1–4	52 ± 8[d]
	61	S. LANSCE Lagoons[c]	934 ± 75	2–4	– – –
	62	N. LANSCE Lagoons[c]	332 ± 24	2–4	– – –
	63	E. LANSCE Lagoons[c]	741 ± 57	2–4	– – –
	64	NE LANSCE Area A Stack[c]	369 ± 27	2–4	– – –
	65	NW LANSCE Area A Stack[c]	222 ± 16	2–4	– – –
	69	TA-50 Old Outfall[c]	82 ± 7	3–4[d]	– – –
	70	TA-50 Dirt Road to Outfall[c]	96 ± 9	3–4[d]	– – –
	71	TA-50 Dirt Road Turnoff[c]	123 ± 10	2–4	– – –
	72	TA-50 East Fence[c]	116 ± 8	2–4	– – –
	73	TA-50 South Corner[c]	113 ± 8	2–4	– – –
	74	TA-50 Pecos Drive[c]	107 ± 8	2–4	– – –
	75	TA-50-37 West[c]	118 ± 8	2–4	– – –
	76	TA-16 WETF[c]	111 ± 8	2–4	– – –
	77	TA-16 Guard Station[c]	82 ± 8	2, 4[d]	– – –
	78	Fitness Trail SW TA-8-24[c]	116 ± 8	2–4	– – –
	79	Fitness Trail SE TA-8-24[c]	115 ± 8	2–4	– – –
	82	TA-15 Phermex N TA-15-185[c]	111 ± 8	2–4	– – –
	83	TA-15 Phermex Entrance[c]	100 ± 7	2–4	– – –
	84	TA-15 Phermex NNE Entrance[c]	105 ± 8	2–4	– – –
	85	TA-15 Phermex N DAHRT[c]	100 ± 7	2–4	– – –
	86	TA-15-312 DAHRT Entrance[c]	96 ± 8	2–4	– – –
	87	TA-15-183 Access Control[c]	114 ± 9	2–4	– – –
	88	TA-15 R-Site Road[c]	107 ± 8	2–4	– – –
	89	TA-15-45 SW[c]	110 ± 8	2–4	– – –
	90	TA-15-306 North[c]	105 ± 8	2–4	– – –
	91	TA-15, IJ Firing Pit[c]	63 ± 5	3–4[d]	– – –
	92	TA-36 Kappa Site[c]	111 ± 8	2–4	– – –
	93	TA-15 Ridge Road Gate[c]	25 ± 3	3[d]	– – –
	94	TA-33 VLBA Dish[c]	60 ± 5	3–4	– – –
	97	TA-50, GS-1-1, Mortandad Canyon[c]	74 ± 6	3–4	– – –
	98	TA-50, GS-1-2, Mortandad Canyon[c]	160 ± 14	3–4	– – –
	99	Mortandad Canyon, MCO-5[c]	170 ± 149	3–4	– – –
	100	Mortandad Canyon, MCO-13[c]	63 ± 5	3–4	– – –

Table 4-14. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1996–1997 (Cont.)

TLD Station ID #	Location	1997 Annual Dose (mrem)[a,b]	1997 Quarters Monitored	1996 Annual Dose (mrem)

[a]Dose is the sum of all quarterly data accepted upon quality assurance review.
[b]The uncertainty of each measurement is the propagated error of the quarterly measurements.
[c]New stations placed into operation in 1997.
[d]One or more quarters of data not reported due to loss of TLDs or analytical problems.
[e]Station ceased operation in 1997.

Table 4-15. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1997

	TLD Station ID #	Location	1997 Annual Dose (mrem)[a,b]	1997 Quarters Monitored
Area W	381	TA-35 Area W-1	156 ± 10	1–4
	382	TA-35 Area W-2	153 ± 10	1–4
	383	TA-35 Area X	132 ± 10	1–4
Area V	361	TA-21 Area V-1	141 ± 11	1–4
	362	TA-21 Area V-2	156 ± 16	1–4
	363	TA-21 Area V-3	159 ± 12	1–4
	364	TA-21 Area V-4	145 ± 12	1–4
Area U	341	TA-21 Area U-1	142 ± 11	1–4
	342	TA-21 Area U-2	149 ± 11	1–4
	343	TA-21 Area U-3	157 ± 13	1–4
	344	TA-21 Area U-4	145 ± 11	1–4
Area T	321	TA-21 Area T-1	161 ± 12	1–4
	322	TA-21 Area T-2	157 ± 12	1–4
	323	TA-21 Area T-3	307 ± 17	1–4
	324	TA-21 Area T-4	151 ± 11	1–4
	325	TA-21 Area T-5	143 ± 11	1–4
	326	TA-21 Area T-6	148 ± 11	1–4
	327	TA-21 Area T-7	152 ± 11	1–4
Area G	601	TA-54 Area G, 1	169 ± 10	1–4
	602	TA-54 Area G, 2	219 ± 13	1–4
	603	TA-54 Area G, 3	152 ± 9	1–4
	604	TA-54 Area G, 4	158 ± 9	1–4
	605	TA-54 Area G, 5	165 ± 10	1–4
	606	TA-54 Area G, 6	160 ± 9	1–4
	607	TA-54 Area G, 7	207 ± 12	1–4
	608	TA-54 Area G, 8	195 ± 11	1–4
	610	TA-54 Area G, 10	179 ± 11	1–4
	611	TA-54 Area G, 11	160 ± 11	2–4[d]
	613	TA-54 Area G, 13	220 ± 13	1–4
	614	TA-54 Area G, 14	205 ± 13	1–4
	615	TA-54 Area G, 15	175 ± 11	1–4
	616	TA-54 Area G, 16	166 ± 9	1–4
	617	TA-54 Area G, 17	168 ± 10	1–4
	618	TA-54 Area G, 18	187 ± 11	1–4
	619	TA-54 Area G, 19	211 ± 12	1–4
	620	TA-54 Area G, 20	172 ± 10	1–4
	622	TA-54 Area G, 22	223 ± 13	1–4
	623	TA-54 Area G, 23	278 ± 16	1–4
	624	TA-54 Area G, 24	174 ± 10	1–4
	625	TA-54 Area G, 25	189 ± 11	1–4
	626	TA-54 Area G, 26	166 ± 10	1–4

Table 4-15. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1997 (Cont.)

	TLD Station ID #	Location	1997 Annual Dose (mrem)[a,b]	1997 Quarters Monitored
Area G (Cont.)	628	TA-54 Area G, 28	201 ± 11	1–4
	629	TA-54 Area G, 29	250 ± 16	1–4
	630	TA-54 Area G, 30	209 ± 12	1–4
	631	TA-54 Area G, 31	183 ± 11	1–4
	634	TA-54 Area G, 34[c]	166 ± 11	2–4
	635	TA-54 Area G, 35[c]	158 ± 11	2–4
	636	TA-54 Area G, 36[c]	83 ± 7	2, 4[d]
	637	TA-54 Area G, 37[c]	117 ± 8	2–4
	638	TA-54 Area G, 38[c]	117 ± 9	2–4
Area F	301	TA-6 Area F-1	153 ± 11	1–4
	302	TA-6 Area F-2	150 ± 11	1–4
	303	TA-6 Area F-3	146 ± 11	1–4
	304	TA-6 Area F-4	150 ± 11	1–4
Area E	281	TA-33 Area E-1	115 ± 11	1 - 3[d]
	282	TA-33 Area E-2	159 ± 12	1–4
	283	TA-33 Area E-3	162 ± 12	1–4
	284	TA-33 Area E-4	157 ± 13	1–4
Area C	261	TA-50 N Area (C-1) SW Bldg 37	141 ± 11	1–4
	262	TA-50 N Area (C-2) Bldg 1	162 ± 12	1–4
	263	TA-50 Area C-3	44 ± 5	4[d]
	264	TA-50 Area C-4	172 ± 12	1–4
	265	TA-50 SE Area (C-5)	161 ± 12	1–4
	266	TA-50 Area C-6	161 ± 12	1–4
	267	TA-50 Area C-7	150 ± 11	1–4
	268	TA-50 S Area (C-8)	150 ± 11	1–4
	269	TA-50 Area C-9	118 ± 11	2, 4[d]
	270	TA-50 W Area (C-10)	152 ± 11	1–4
Area B	241	TA-21 Area B-1	100 ± 9	2–3[d]
	242	TA-21 Area B-2	141 ± 11	1–4
	243	TA-21 Area B-3	116 ± 9	2–3[d]
	244	TA-21 Area B-4	138 ± 10	1–4
	245	TA-21 Area B-5	126 ± 10	1–4
	246	TA-21 Area B-6	149 ± 10	1–4
	247	TA-21 Area B-7	155 ± 11	1–4
	248	TA-21 Area B-8	163 ± 10	1–4
	249	TA-21 Area B-9	146 ± 10	1–4
	250	TA-21 Area B-10	158 ± 11	1–4
	251	TA-21 Area B-11	155 ± 11	1–4
	252	TA-21 Area B-12	163 ± 11	1–4
	253	TA-21 Area B-13	159 ± 10	1–4
	254	TA-21 Area (B-14) S AirNet#20	153 ± 11	1–4

Table 4-15. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1997 (Cont.)

	TLD Station ID #	Location	1997 Annual Dose (mrem)[a,b]	1997 Quarters Monitored
Area AB	221	TA-49 (AB-1)	145 ± 11	1–4
	222	TA-49 (AB-2)	146 ± 11	1–4
	223	TA-49 (AB-3)	146 ± 11	1–4
	224	TA-49 (AB-4)	143 ± 12	1–4
	225	TA-49 (AB-5)	149 ± 11	1–4
	226	TA-49 (AB-6)	149 ± 11	1–4
	227	TA-49 (AB-7)	145 ± 11	1–4
	228	TA-49 NW (AB-8)	145 ± 11	1–4
	229	TA-49 W (AB-9, near gate)	140 ± 12	1–4
	230	TA-49 SW (AB-10)	148 ± 12	1–4
Area A	201	TA-21 Area A-1	143 ± 12	1–4
	202	TA-21 Area A-2	145 ± 11	1–4
	203	TA-21 Area A-3	146 ± 12	1–4
	204	TA-21 Area A-4	144 ± 11	1–4
	205	TA-21 Area A-5	142 ± 11	1–4

[a] Dose is the sum of all quarterly data accepted upon quality assurance review.
[b] The uncertainty of each measurement is the propagated error of the quarterly measurements.
[c] New stations placed into operation in 1997.
[d] One or more quarters of data not reported due to loss of TLDs or analytical problems.

Table 4-16. TA-18 Albedo Dosimeter Network

Location ID #	Location	Dosimeter Reading (mrem) Continuous[a]	Dosimeter Reading (mrem) Road Open[a]
1	NEWNET Kappa Site	15	4.8
2	TA-36 Entrance	5.2	4.5
3	TA-18 Personnel Gate at Parking Lot	50	18
4	P2 Booster Station at TA-54 Entrance	3.9	3.6
5	TA-51 Entrance	1.1	1.4
6	Pajarito Hill West of TA-18 Entrance	18	6.1
7	TA-18 Entrance at Pajarito Road	24	5.0
8	Santa Fe Background	0.3	NA[b]
8	TA-49 Background	0.33	NA[b]
9	Vault Control	0.07	NA[b]

[a] Reported dose is the sum of results from quarters 2–4. Only quarter 2 data available for Santa Fe.
[b] Not Applicable—background or control location with continuous exposure.

Table 4-17. Estimated Concentrations of Materials[a] Released by Dynamic Experiments

	Total Usage (kg)	Respirable Release (%)	Amount Released (kg)	Maximum Impact (2,767 m) (μg/m³)	Nearest Public Access Point (1,500 m) (μg/m³)	Nearest Off-Site Receptor (3,800 m) (μg/m³)
Beryllium	0.1	2	0.002	2×10^{-7}	1×10^{-7}	9×10^{-7}
Molybdenum	0.4	10	0.04	2×10^{-5}	2×10^{-5}	2×10^{-5}
Tin	1.085	10	0.11	8×10^{-5}	5×10^{-5}	7×10^{-5}
Iron	4.4	10	0.44	4×10^{-4}	2×10^{-4}	3×10^{-4}
Lithium Hydride	7	10	0.70	6×10^{-4}	4×10^{-4}	5×10^{-4}
Lead	7.096	10	0.71	6×10^{-4}	4×10^{-4}	5×10^{-4}
Tantalum	7.103	10	0.71	6×10^{-4}	4×10^{-4}	5×10^{-4}
Brass	156.6	10	15.66	2×10^{-3}	1×10^{-3}	2×10^{-3}
Copper	276.34	10	27.63	3×10^{-3}	1×10^{-3}	2×10^{-3}
Steel	323.85	10	32.39	3×10^{-3}	2×10^{-3}	2×10^{-3}
Aluminum	889.05	10	88.91	9×10^{-3}	4×10^{-3}	7×10^{-3}

[a] Materials that exceeded 70 kg, that are toxic air pollutants as listed in 20 NMAC 2.72 (Construction Permits), and/or that have national ambient air quality standards.

Table 4-18. Calculated Actual Emissions for Criteria Pollutants (Tons)

Source	PM	CO	NO_X	SO_X	VOC
Asphalt Plant	0.05	0.22	0.02	0.00	0.01
TA-3 Power Plant	1.74	13.90	56.65	0.21	0.49
TA-16 Power Plant	0.43	1.32	1.32	0.02	0.19
TA-21 Power Plant	0.41	1.02	4.10	0.02	0.08
Water Pump	0.01	6.61	20.64	0.01	0.41
Large Boilers[a]	0.53	0.92	4.40	0.03	0.23
Total	3.16	23.99	87.13	0.29	1.42

[a]Boilers located at TA-48, -53, and -55.

Table 4-19. 1997 Precipitation (in.)

	North Community	TA-16	TA-6	TA-49	TA-53	TA-54	TA-74
January	1.54	1.77	1.68	1.51	1.12	1.05	1.16
February	1.67	2.26	2.18	2.48	2.29	1.56	1.71
March	0.07	0.19	0.09	0.18	0.09	0.17	0.08
April	1.79	2.16	2.04	1.95	1.79	1.74	1.72
May	2.50	1.81	1.55	1.50	0.81	0.96	1.31
June	2.29	2.18	1.91	1.87	1.71	1.72	1.55
July	2.75	2.25	2.63	2.01	1.99	1.64	1.87
August	6.69	6.47	6.44	3.44	4.48	3.98	5.16
September	2.88	4.96	3.40	3.75	1.70	2.06	1.58
October	0.98	0.80	0.59	0.49	0.82	0.85	0.61
November	0.71	1.17	1.16	1.40	0.83	0.88	0.66
December	1.01	2.11	1.83	1.69	1.39	1.17	1.13
Total	24.88	28.13	25.50	22.27	19.02	17.78	18.54

J. Figures

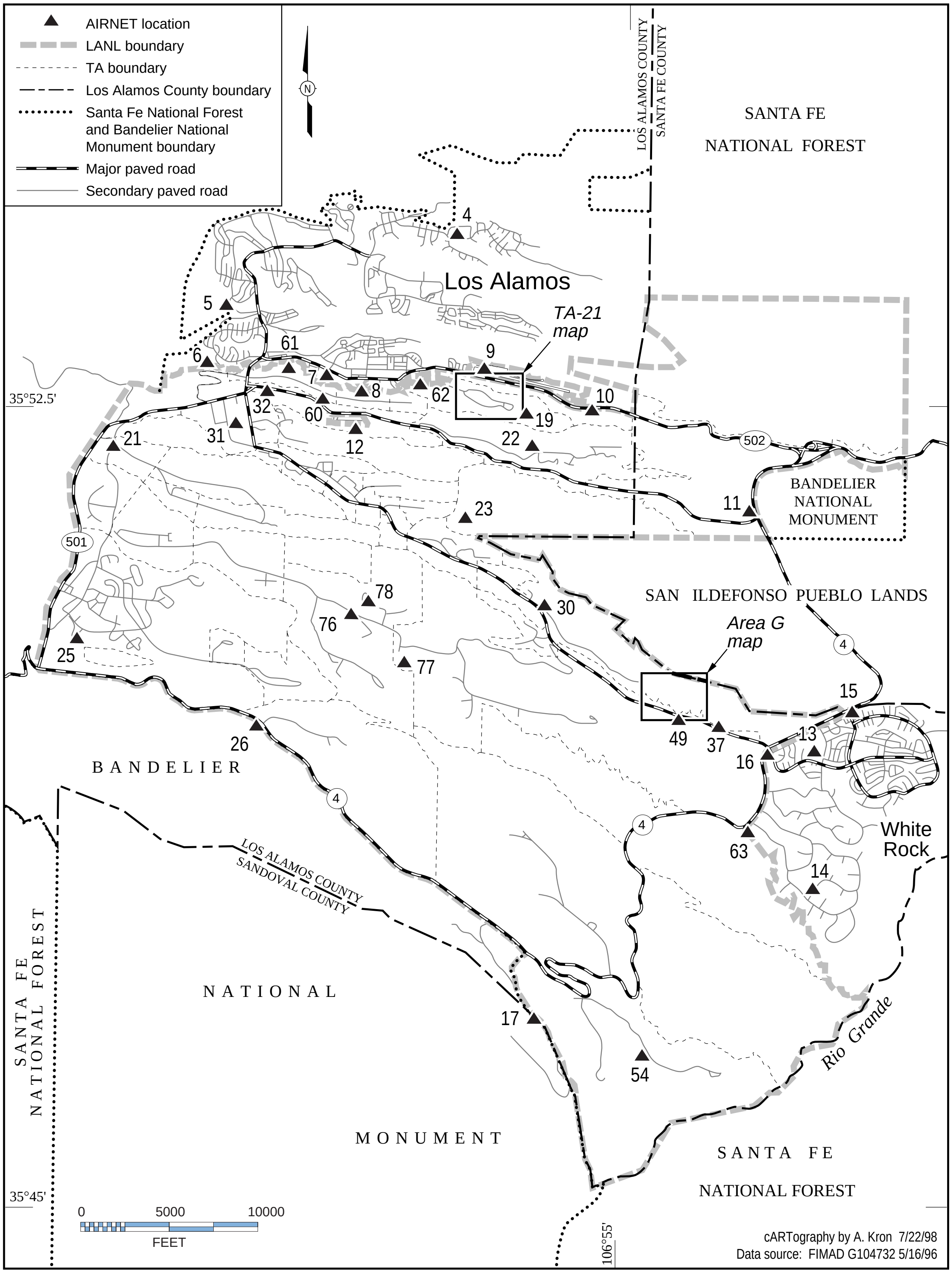

Figure 4-1. Off-site perimeter and on-site Laboratory AIRNET locations.

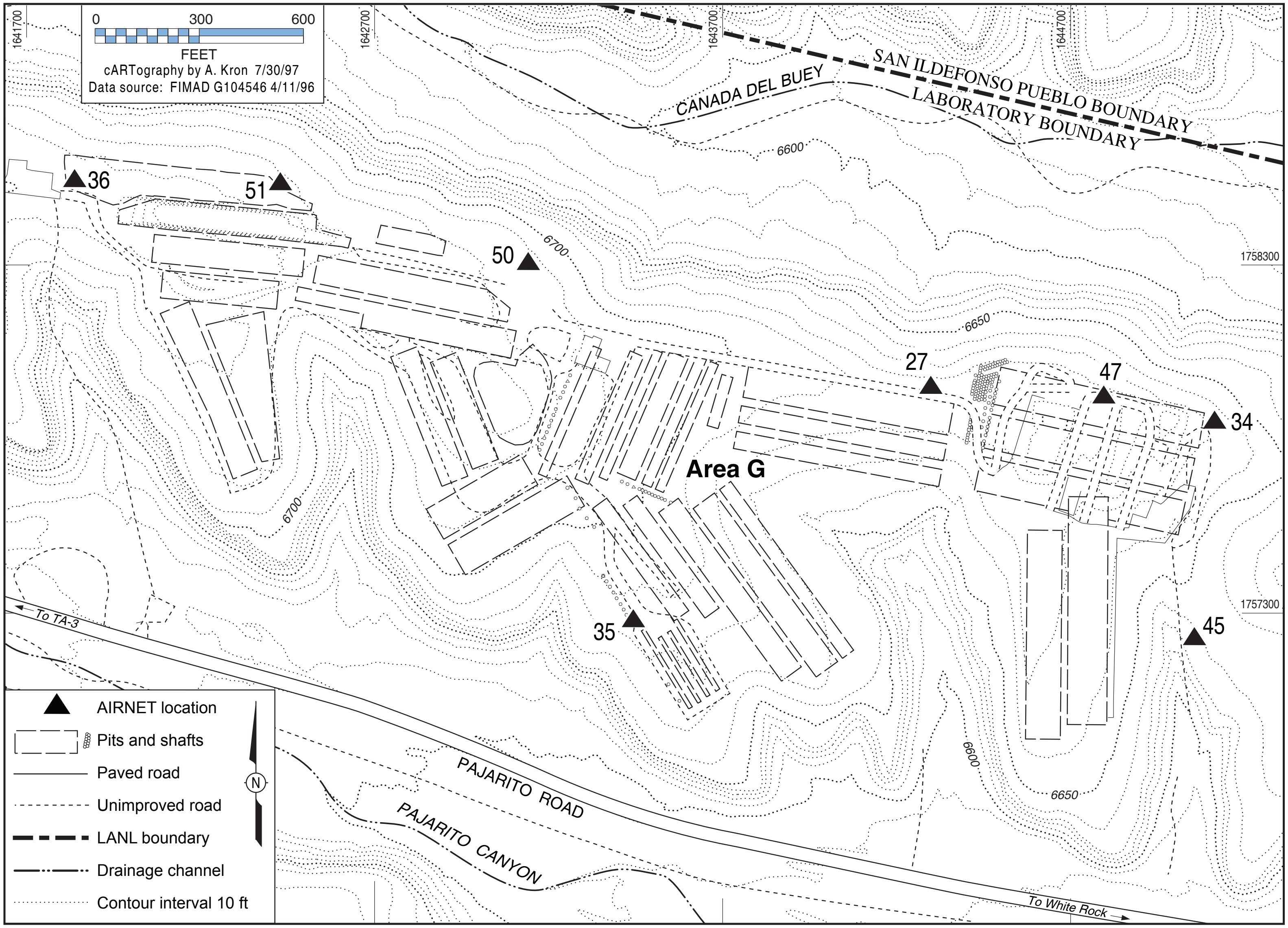

Figure 4-2. Technical Area 54, Area G map of AIRNET locations.

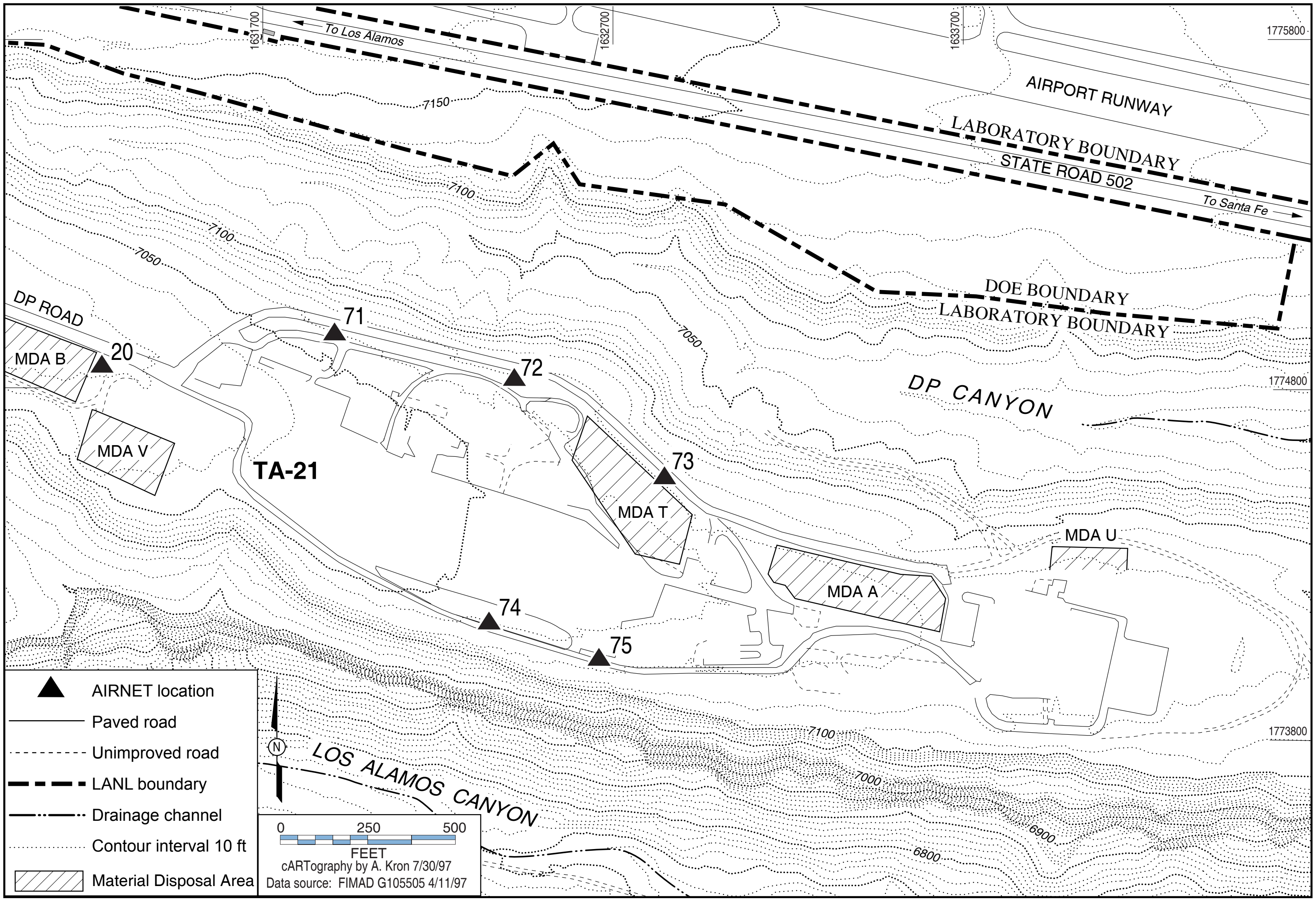

Figure 4-3. Technical Area 21 map of AIRNET locations.

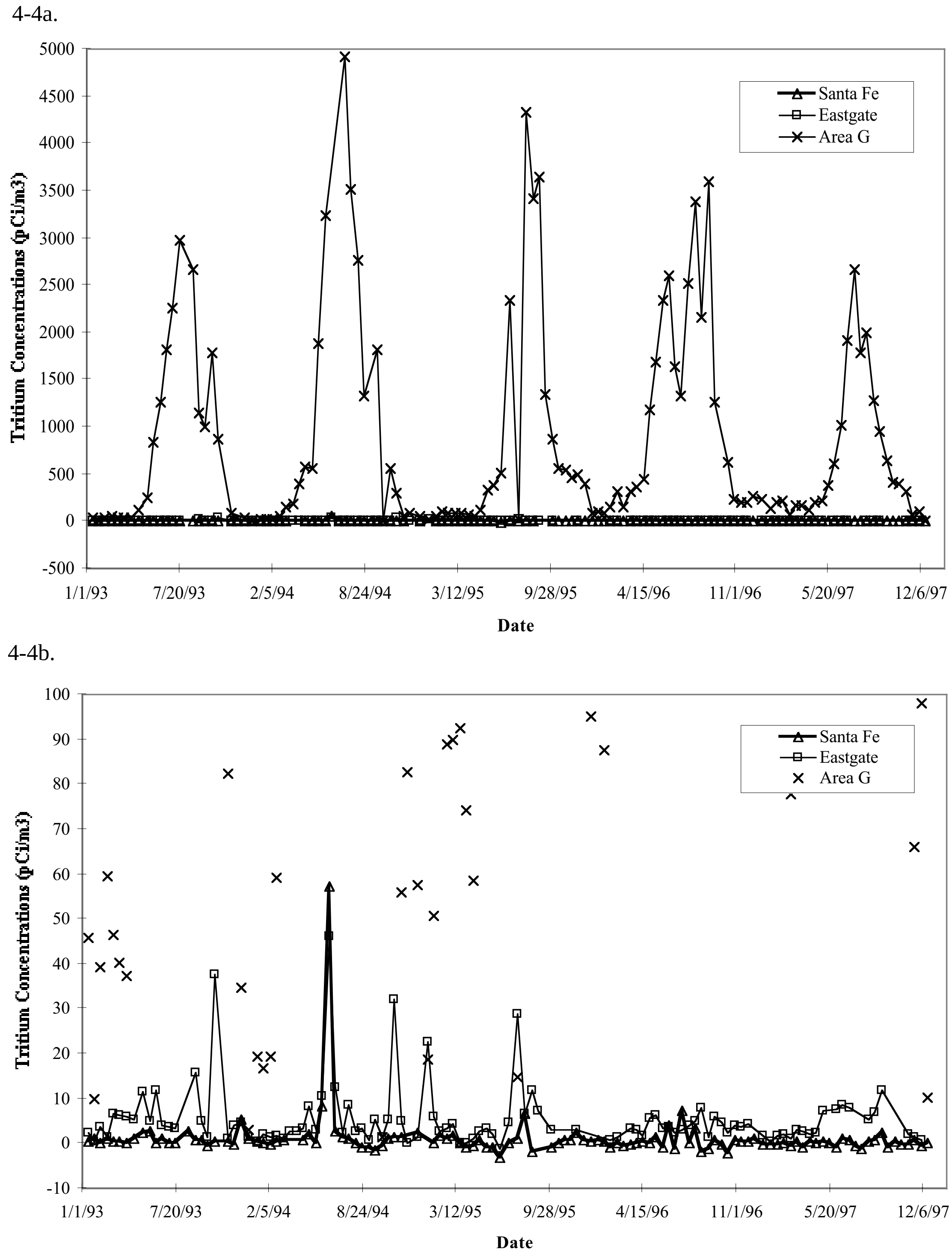

Figure 4-4. Two week tritium concentrations at three selected AIRNET sampling sites.

Note: The bottom graph (4-4b) is a magnified view of the tritium concentration range from 0 to 100 pCi/m^3 that is shown in the top graph (4-4a).

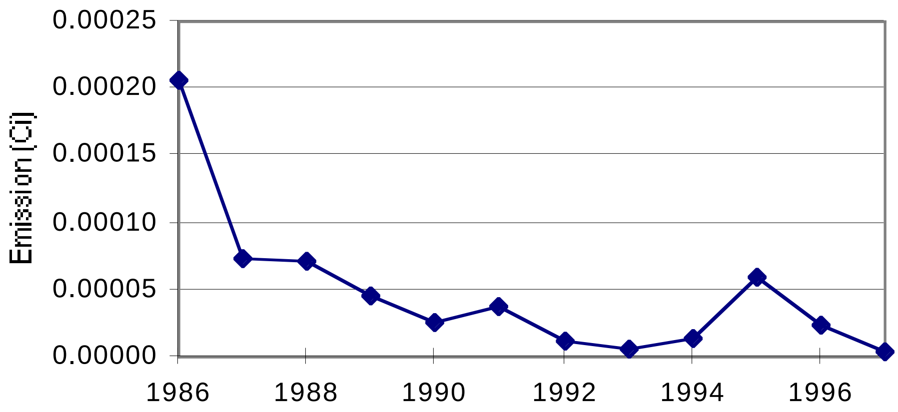

Figure 4-5. Plutonium emissions from sampled Laboratory stacks since 1986.

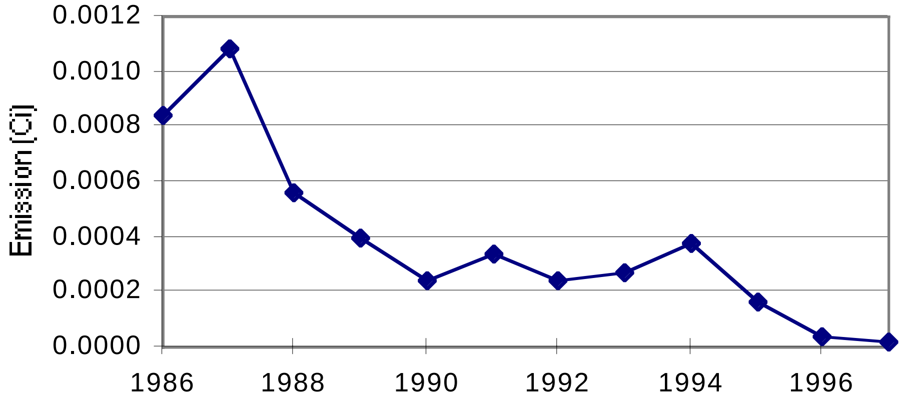

Figure 4-6. Uranium emissions from sampled Laboratory stacks since 1986.

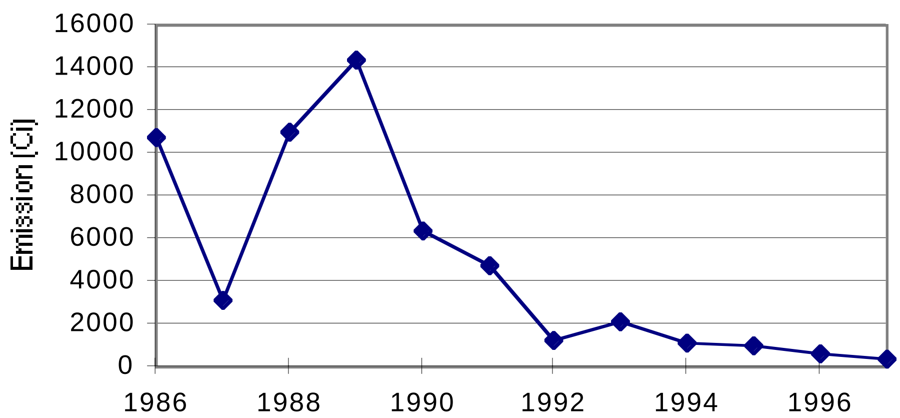

Figure 4-7. Tritium emissions from sampled Laboratory stacks since 1986.

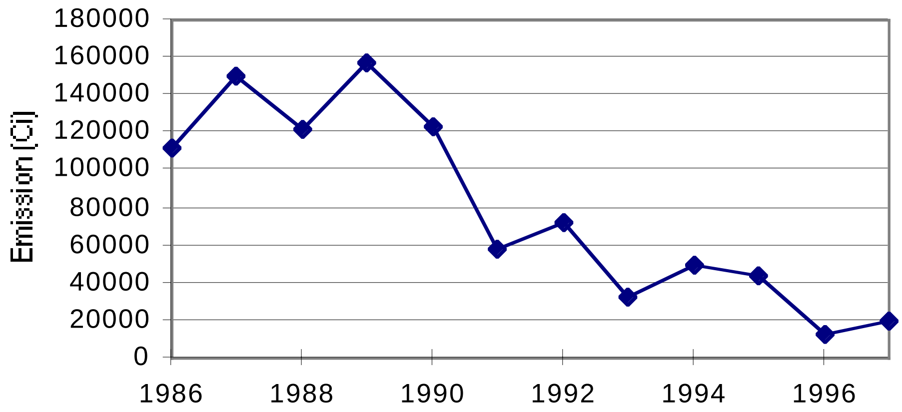

Figure 4-8. G/MAP emissions from sampled Laboratory stacks since 1986.

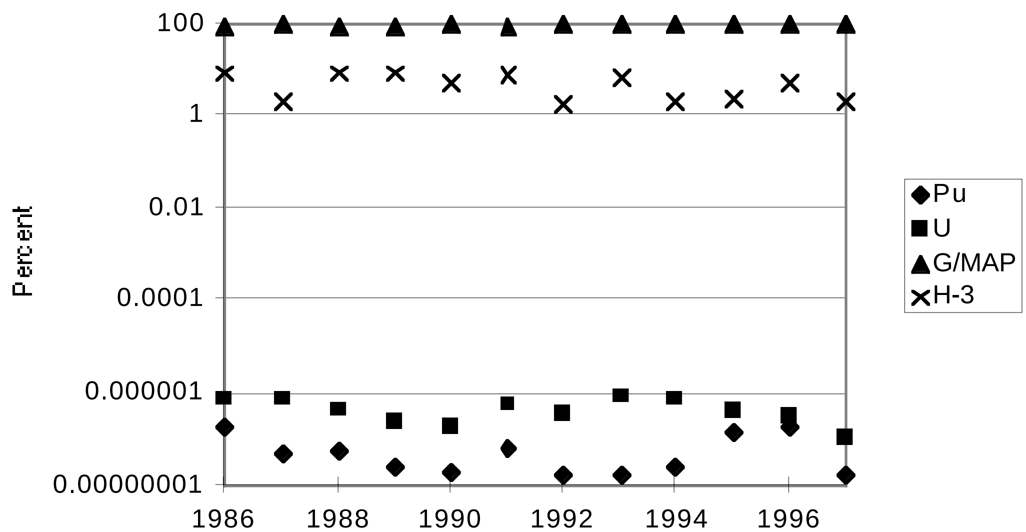

Figure 4-9. Percentage of total emissions resulting from plutonium, uranium, tritium, and G/MAP.

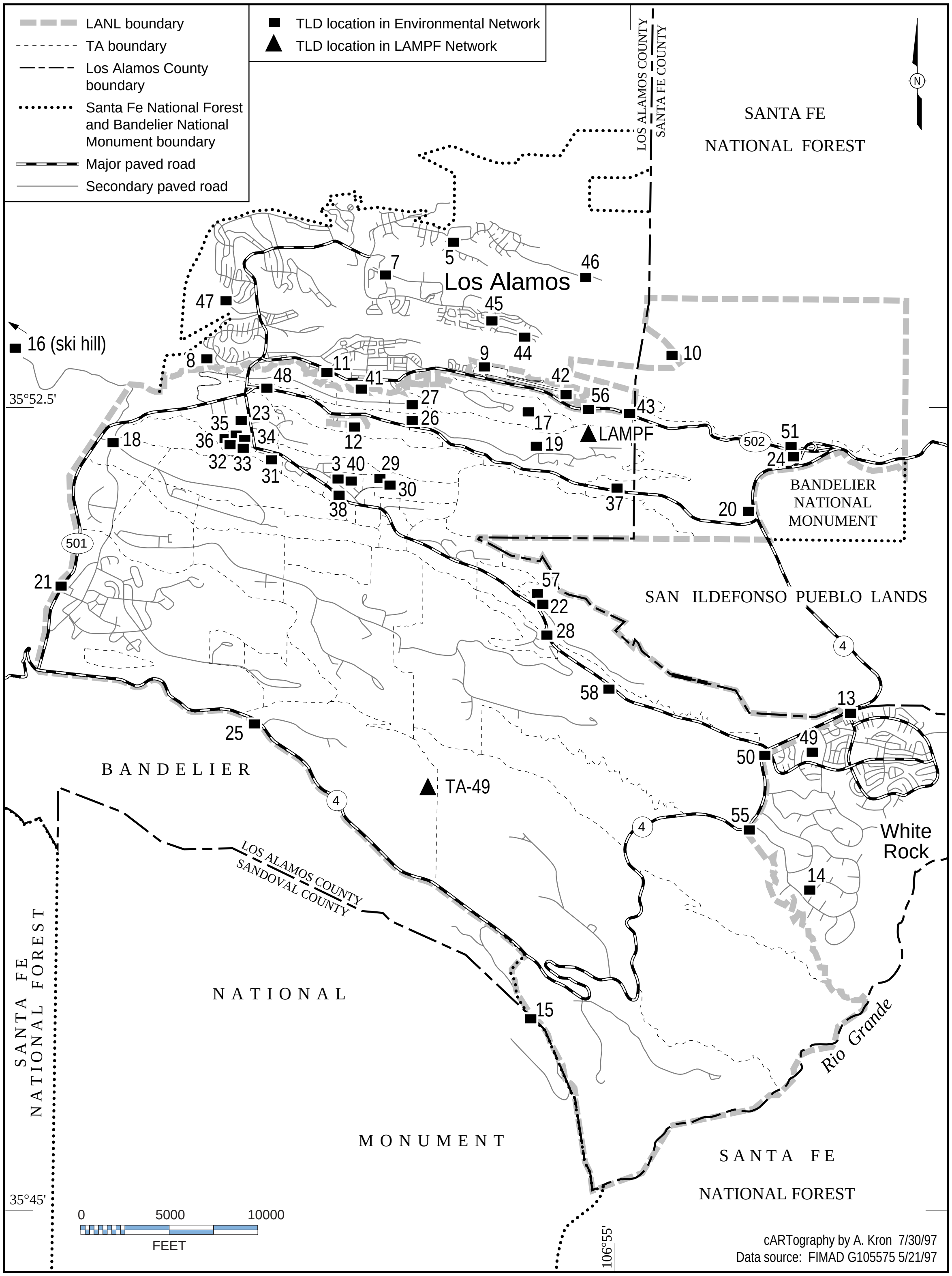

Figure 4-10. Off-site perimeter and on-site Laboratory TLD locations..

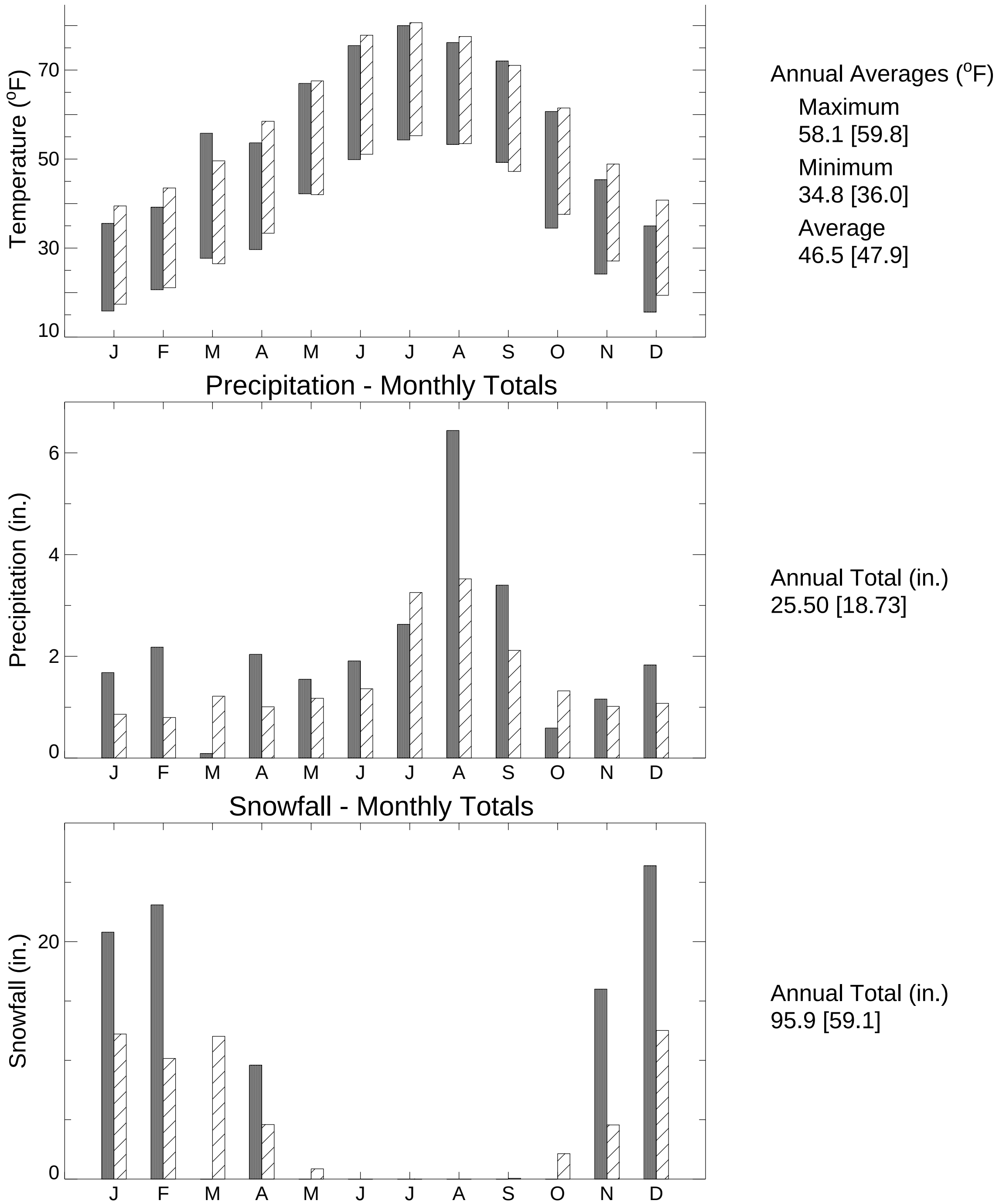

Figure 4-11. 1997 weather summary for Los Alamos.

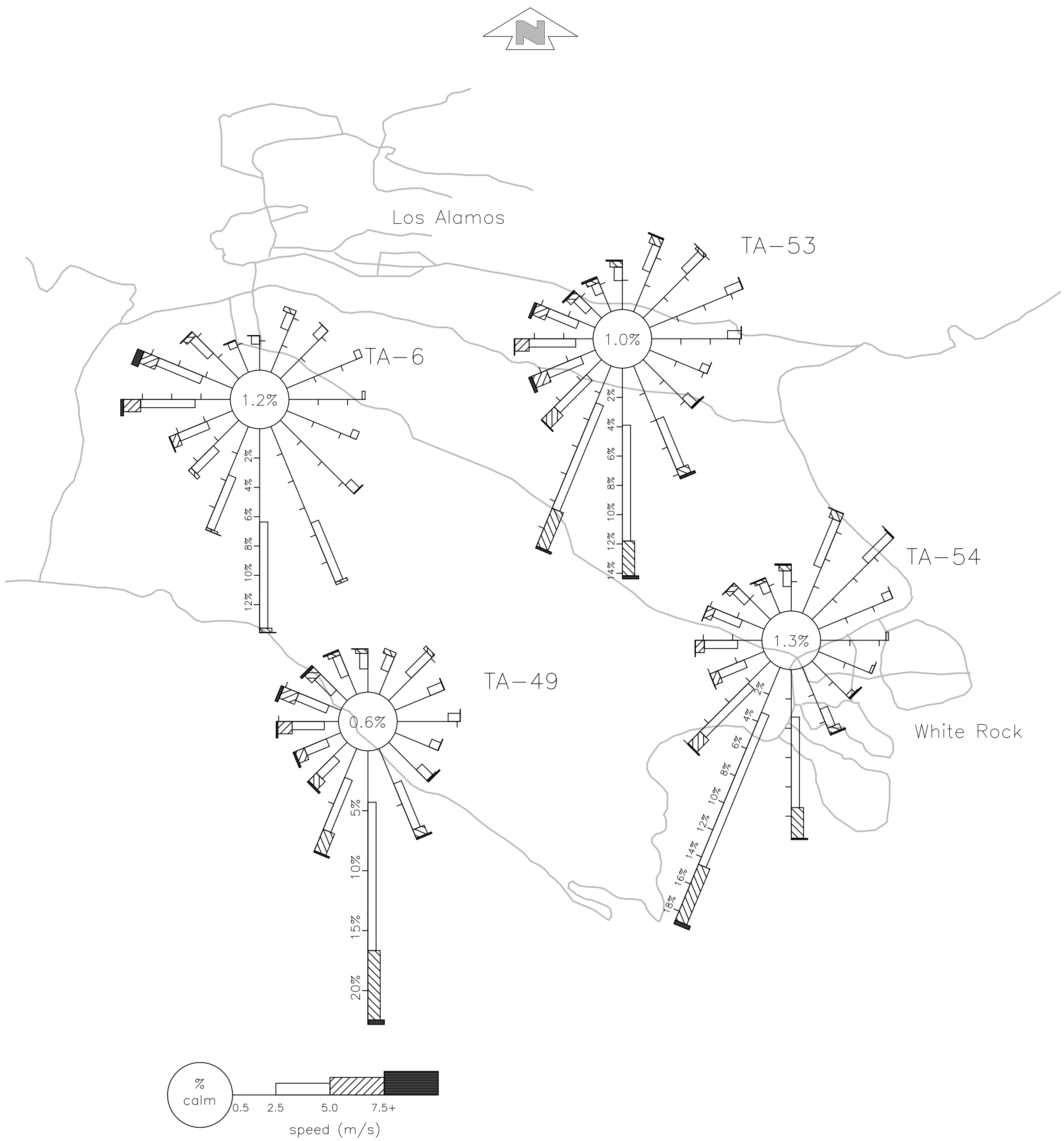

Figure 4-12. Daytime wind roses.

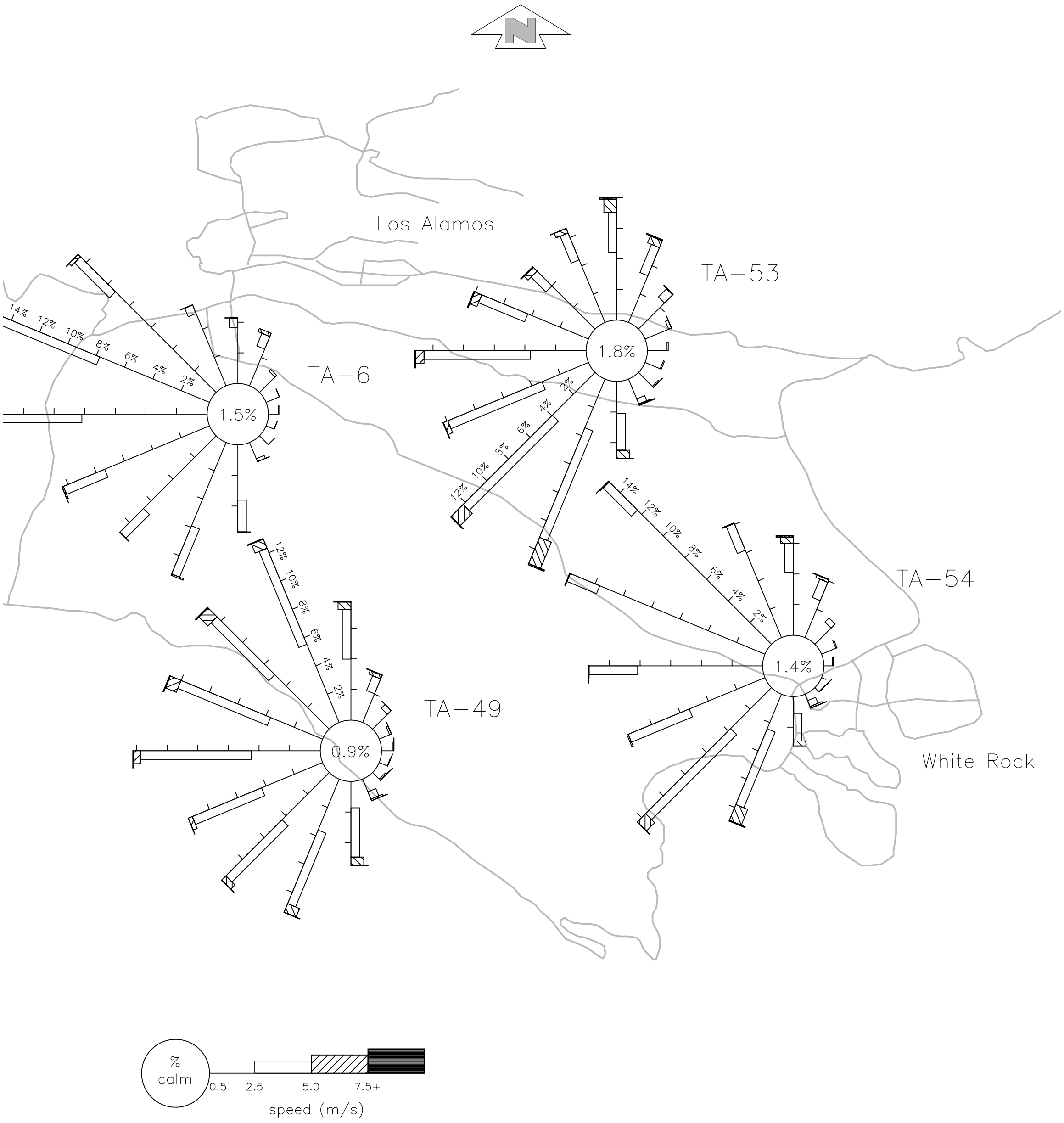

Figure 4-13. Nighttime wind roses.

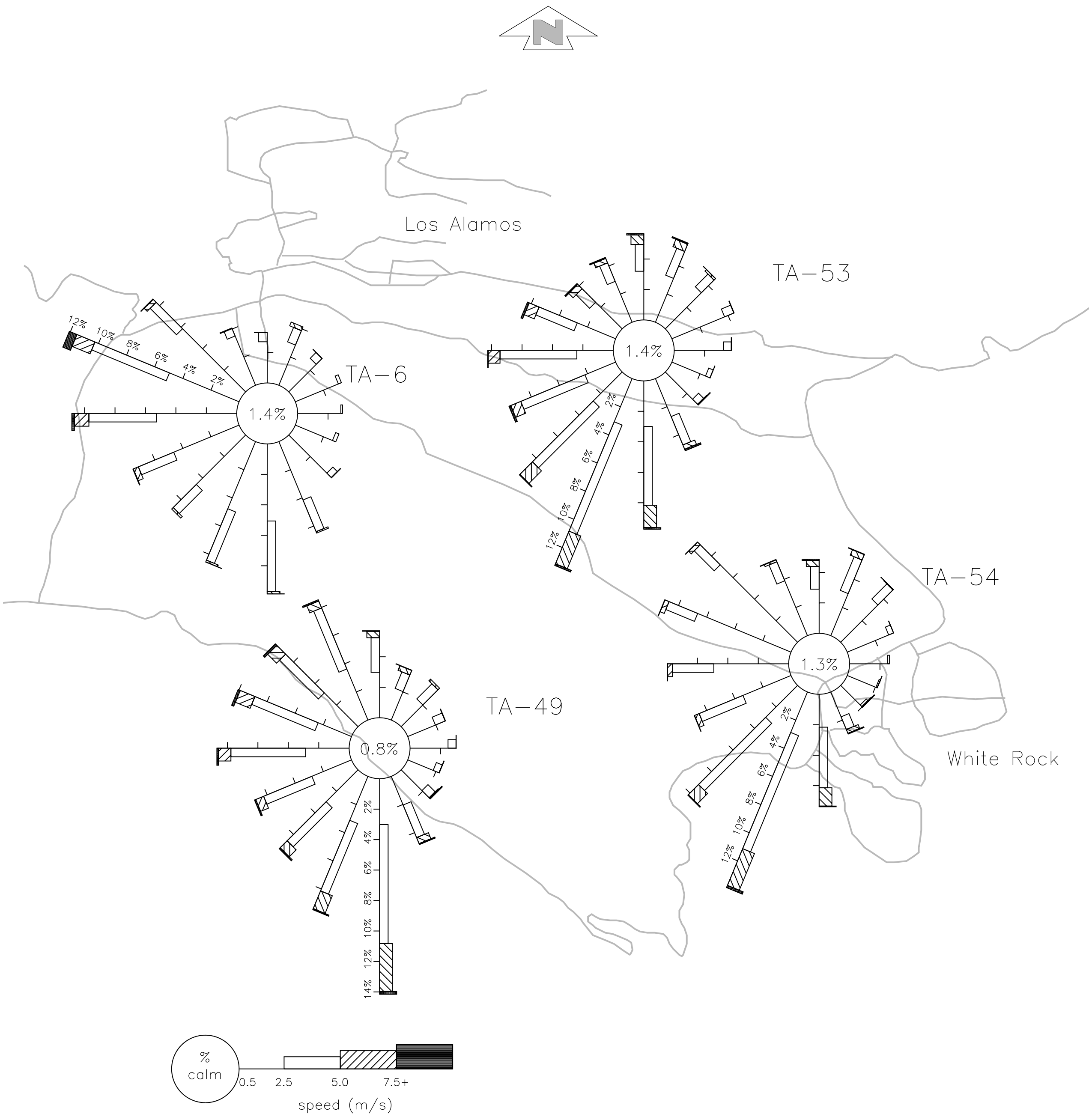

Figure 4-14. Total wind roses.

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