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Environmental Surveillance at Los Alamos during 1999

30th Anniversary Edition

Los Alamos
NATIONAL LABORATORY

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Cerro Grande Fire

On May 4, 2000, the National Park Service at Bandelier National Monument set a prescribed fire that subsequently burned out of control. The Cerro Grande wildfire was one of the largest in New Mexico state history and burned about 43,000 acres of forest and residential land, including about 7,500 acres of the Los Alamos National Laboratory site. The Laboratory was closed for two-and-a-half weeks, and the towns of Los Alamos and White Rock were evacuated for several days. The fire was fully contained by June 6 and declared out on July 20. One-hundred twelve Laboratory structures and 235 residential structures were either damaged or destroyed. An estimated 37 million trees were lost in the fire. The human and environmental impacts from this devastating wildfire are still being felt and evaluated.

This annual environmental report focuses on issues and impacts from Laboratory operations in 1999. Its scheduled publication date of October 1, 2000, was delayed largely by the fire and post-fire monitoring and mitigation activities. The next edition, Environmental Surveillance at Los Alamos during 2000, will be published in October 2001 and will include surveillance data and analyses of the fire's impacts and its aftermath.

At this time, the Laboratory is conducting an extensive environmental monitoring and sampling program to evaluate the effects of the Cerro Grande fire at the Laboratory and especially to evaluate if public and worker health and the environment were adversely impacted by the fire on Laboratory land. Just as importantly, the program will identify changes in pre-fire baseline conditions that will aid in evaluating any future impacts the Laboratory may have, especially those resulting from contaminant transport off-site.

The program involves a number of different organizations within the Laboratory, as well as coordination with outside organizations and agencies. The primary Laboratory organizations involved are the Hazardous Materials Response Group (ESH-10), the Air Quality Group (ESH-17), the Water Quality and Hydrology Group (ESH-18), the Ecology Group (ESH-20), the Integrated Geosciences Group (EES-13), the Environmental Sciences Group (EES-15), and the Environmental Restoration Project (ER). In addition, the US Department of Energy Radiological Assistance Program (USDOE/RAP) also performed environmental measurements during the Cerro Grande fire.

External organizations participating in the program include the New Mexico Environment Department (NMED), San Ildefonso Pueblo, Santa Clara Pueblo, Cochiti Pueblo, Jemez Pueblo, Los Alamos County, the US Army Corps of Engineers (USACE), the US Environmental Protection Agency (USEPA), the US Fish and Wildlife Service, the US Forest Service, the US Geological Survey (USGS), and the US Park Service (Bandelier National Monument). The Department of Energy has an Agreement-in-Principle in place with NMED that provides for independent oversight monitoring of the Laboratory's activities. The NMED DOE Oversight Bureau (NMED/DOB) performs this monitoring, which involves routine air, water, soil, and sediment sampling and measuring external radiation fields in the environment. All routine monitoring will continue, as well as NMED's special sampling to address specific concerns that the Cerro Grande fire and its aftermath raised.

Through this monitoring and sampling plan, the Laboratory will determine what special sampling is needed as a result of the fire. This special sampling will take place in addition to the extensive and ongoing Environmental Surveillance and Compliance Program the Laboratory routinely operates and maintains. Under the ongoing program, the Laboratory collects more than 11,000 environmental samples each year from more than 450 sampling stations in and around the Laboratory. Many of these sampling and measurement activities are included in this document.

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Environmental Surveillance Program:

Air Quality (Group ESH-17)
505-665-8855

Water Quality and Hydrology (Group ESH-18)
505-665-0453

Hazardous and Solid Waste (Group ESH-19)
505-665-9527

Ecology (Group ESH-20)
505-665-8961

Los Alamos
NATIONAL LABORATORY
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APPENDIXES

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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 1999. 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, foodstuffs, and biota) 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 1999* 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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This report is also available on the World Wide Web at
http://lib-www.lanl.gov/pubs/la-13775.htm

This report presents environmental data and analyses that characterize environmental performance and addresses compliance with environmental laws at Los Alamos National Laboratory (LANL or the Laboratory) during 1999. Using comparisons with standards and regulations, this report concludes that environmental effects from Laboratory operations are small and did not pose a threat to the public, Laboratory employees, or the environment in 1999.

Laboratory operations were in compliance with all environmental regulations. All newly proposed activities at the Laboratory that could impact the environment were evaluated through the National Environmental Policy Act (NEPA) to determine potential impacts. In 1999, the Laboratory sent 159 National Environmental Policy Act Environmental Review Forms to the Department of Energy (DOE) for review. A Site-Wide Environmental Impact Statement (SWEIS) and the first annual SWEIS Yearbook were completed under DOE's compliance strategy for NEPA. The Laboratory also completed an Environmental Impact Statement assessing the conveyance and transfer of certain land tracts under the administrative control of DOE within Los Alamos and Santa Fe Counties. DOE and LANL began planning and developing an Integrated Resources Management Plan in 1999 to integrate existing resource management plans and the development of other management plans with LANL site planning and mission activities.

In this report, we calculate potential radiological doses to members of the public who may be exposed to Laboratory operations. The 1999 Effective Dose Equivalent (EDE) was 0.32 mrem. We calculated this dose using EPA-approved methods for air compliance. A maximum dose considering all pathways (not just air) was 0.6 mrem (see Section 3.C.2). Health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem. We conclude that the doses calculated here, which are in the mrem (one one-thousandth of a rem) or lower range, would cause no adverse human health effects. The total dose from background radiation, greater than 99% of which is from natural sources, is about 360 mrem in this area and can vary by 10 mrem from year to year.

Air surveillance at Los Alamos includes monitoring emissions, ambient air quality, direct penetrating radiation, and meteorological parameters to determine the air quality impacts of Laboratory operations. The ambient air quality in and around the Laboratory meets all Environmental Protection Agency (EPA) and DOE standards for protecting the public and workers.

During 1999, a greatly reduced run cycle at Los Alamos Neutron Science Center resulted in radioactive air emissions that were less than one-fourth of 1998 emissions. Tritium emissions doubled over 1998 emissions, primarily as a result of tritium facility deactivation work. Plutonium emissions were higher in 1999 because of increased plutonium powder operations.

We investigated several instances of elevated air concentrations in 1999 that resulted from routine Laboratory operations and, in one case, from construction activity in the Los Alamos town-site that resuspended contaminants from the original Laboratory Technical Area (TA)-1. None of these elevated air concentrations exceeded DOE or EPA protection standards for workers or the public.

An evaluation of alternate direct penetrating radiation measurement systems supports the conclusion that our thermoluminescent dosimeters overrespond by about 50% to low-energy gamma radiation; therefore, actual doses were smaller than those reported.

Sixteen gross alpha measurements and one gross beta measurement exceeded the DOE derived concentration guidelines (DCG) for public dose values in water runoff samples in 1999. The DOE DCGs for public dose are determined assuming that two liters per day of water are consumed each year. This assumption will not be met for runoff, which is present only a few days each year.

In 1998, LANL found high-explosives constituents in the regional aquifer at TA-16 in the southwest portion of the Laboratory at concentrations above the EPA Health Advisory guidance values for drinking water, although water from these wells is not used for drinking water. Continued testing of water supply wells in 1999 showed that these compounds are not present in Los Alamos County drinking water. Trace levels of tritium are present in the regional aquifer in a few areas where liquid waste discharges occurred, notably beneath Los Alamos, Pueblo, and Mortandad Canyons. The highest tritium level found in a regional aquifer test well was about 2% of the drinking water standard. Nitrate concentrations in a test well were about half the drinking water standard. In 1999, we detected no radionuclides other than naturally occurring uranium in Los Alamos County or San Ildefonso Pueblo water supply wells. Gross beta and americium-241 exceeded drinking water DCGs in alluvial groundwater samples. Alluvial groundwater is not used for drinking water. We found above background levels of plutonium and americium in sediments.

Most radionuclide concentrations in soils collected from on-site and perimeter areas were nondetectable and/or within the upper range of background concentrations. We also analyzed soils for trace elements, and most constituents, with the exception of lead in perimeter soils, were within background mean concentrations; lead concentrations, however, were well below LANL screening action levels.

We collected samples of foodstuffs and associated biota (produce, eggs, milk, fish, elk, deer, beef cattle, herbal tea, piñon, honey, and wild spinach) from Laboratory and/or surrounding perimeter areas, including several Native American Pueblo communities, to determine the impact of LANL operations on the human food chain. All radionuclides in foodstuffs and biota collected from the Laboratory and perimeter locations were low and, for the most part, were indistinguishable from worldwide fallout and/or natural sources. Plutonium-238 concentrations in produce collected from all perimeter sites, although low, were statistically higher than background concentrations and were higher than in past years.

Special studies included ecological risk assessments; organics in fish collected from the Rio Grande; depleted uranium effects on aquatic organisms; resource use, activity patterns, and disease analysis of elk; and polychlorinated biphenyl (PCB) concentrations in small mammals around the Laboratory. We also monitored reptiles, amphibians, and forest fire (fuel) risk to the Los Alamos region.

The 1999 strontium-90 data LANL collected in sediments, surface water, and groundwater are not valid because the analytical laboratory failed to properly apply the analytical technique. The data at every location for 1999 are questionable, and this represents the loss of an entire year's monitoring data for strontium-90. We present the data in this report for documentary purposes only. If taken at face value, the 1999 strontium-90 values would indicate unusually high levels in sediments, surface water, and groundwater. LANL has resolved the analytical laboratory problems and will continue monitoring strontium-90 at all locations in 2000. In 1999, the New Mexico Environment Department (NMED) collected split samples at many wells where LANL data appeared to show unusually high strontium-90 values. NMED samples show only one detection of strontium-90, supporting our conclusion that the 1999 strontium-90 data are not valid.

1. Introduction

1. Introduction

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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 1999. 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. This information is then used for environmental impact analyses, site planning, and annual operational improvements. The Laboratory collected data in 1999 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, foodstuffs, and biota. Using comparisons with standards and regulations, this report concludes that environmental effects from Laboratory operations are small and do not pose a threat to the public, Laboratory employees, or the environment. Laboratory operations were in compliance with all environmental regulations.

Among many significant strides forward in cooperative resource management, the Pajarito Plateau Watershed Partnership was established, and the Department of Energy dedicated the White Rock Canyon Reserve.

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) under a contract that is administered through the Department of Energy (DOE) Los Alamos Area Office (LAAO) 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 enhances global security by

- ensuring the safety and reliability of the US nuclear weapons stockpile,
- reducing threats to US security with a focus on weapons of mass destruction,
- cleaning up the wastes created from weapons research and development during the Cold War, and
- providing technical solutions to energy, environment, health, infrastructure, and security problems (LANL 1999a).

In its Strategic Plan (1999–2004), Los Alamos National Laboratory expresses its vision as follows:

> Los Alamos National Laboratory is a key national resource for the development and integration of leading-edge science and technology to solve problems of national and global security.

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 (LANL 1999a).

2. Geographic Setting

The Laboratory and the associated residential and commercial 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 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. San Ildefonso Pueblo borders the Laboratory to the east.

The Laboratory is divided into technical areas (TAs) that are used for building sites, experimental areas, support facilities, 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; much land provides buffer areas for security and safety and is held in reserve for future use.

3. Geology and Hydrology

The Laboratory lies at the western boundary of the Rio Grande Rift, a major North American tectonic feature. Three major local faults constitute the modern rift boundary, and each is potentially seismogenic. Recent studies indicate that the seismic surface rupture hazard associated with these faults is localized (Gardner et al., 1999). 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 by 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. The Cerros del Rio 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 regional aquifer of the Los Alamos area.

The regional aquifer of the Los Alamos area is the only aquifer in the area capable of serving as a municipal water supply. Water in the regional aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande (Purtymun and Johansen 1974). The source of most recharge to the aquifer appears to be infiltration of precipitation that falls on the Jemez Mountains. The regional 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. This diversity is illustrated by the presence of over 900 species of vascular plants; 57 species of mammals; 200 species of birds, including 112 species known to breed in Los Alamos County; 28 species of reptiles; 9 species of amphibians; over 1,200 species of arthropods; and 12 species of fish (primarily found in the Rio Grande, Cochiti Reservoir, and the Rito de los Frijoles). No fish species have been found within LANL boundaries. Roughly 20 plant and animal species are designated as

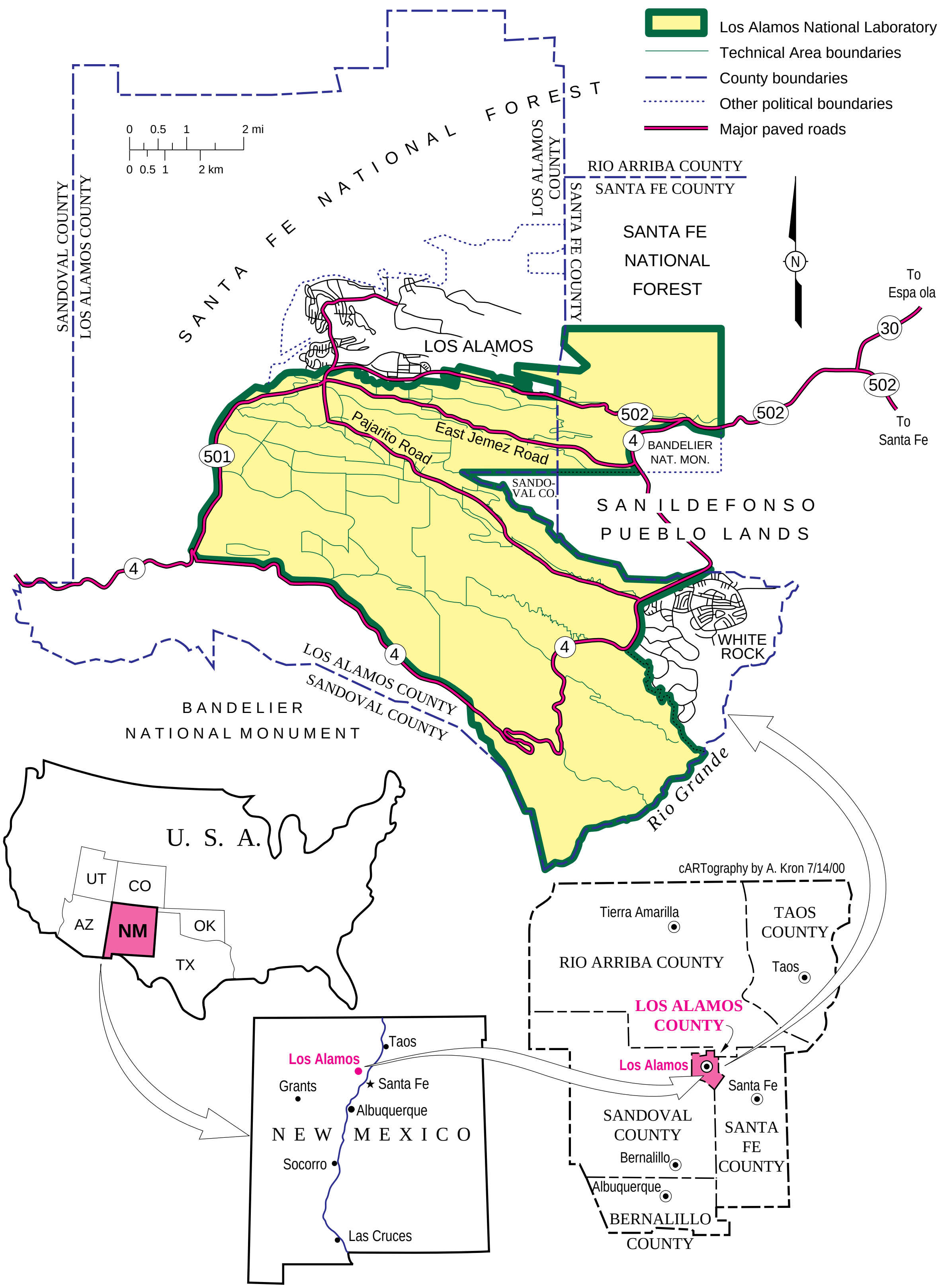

Figure 1-1. Regional location of Los Alamos National Laboratory.

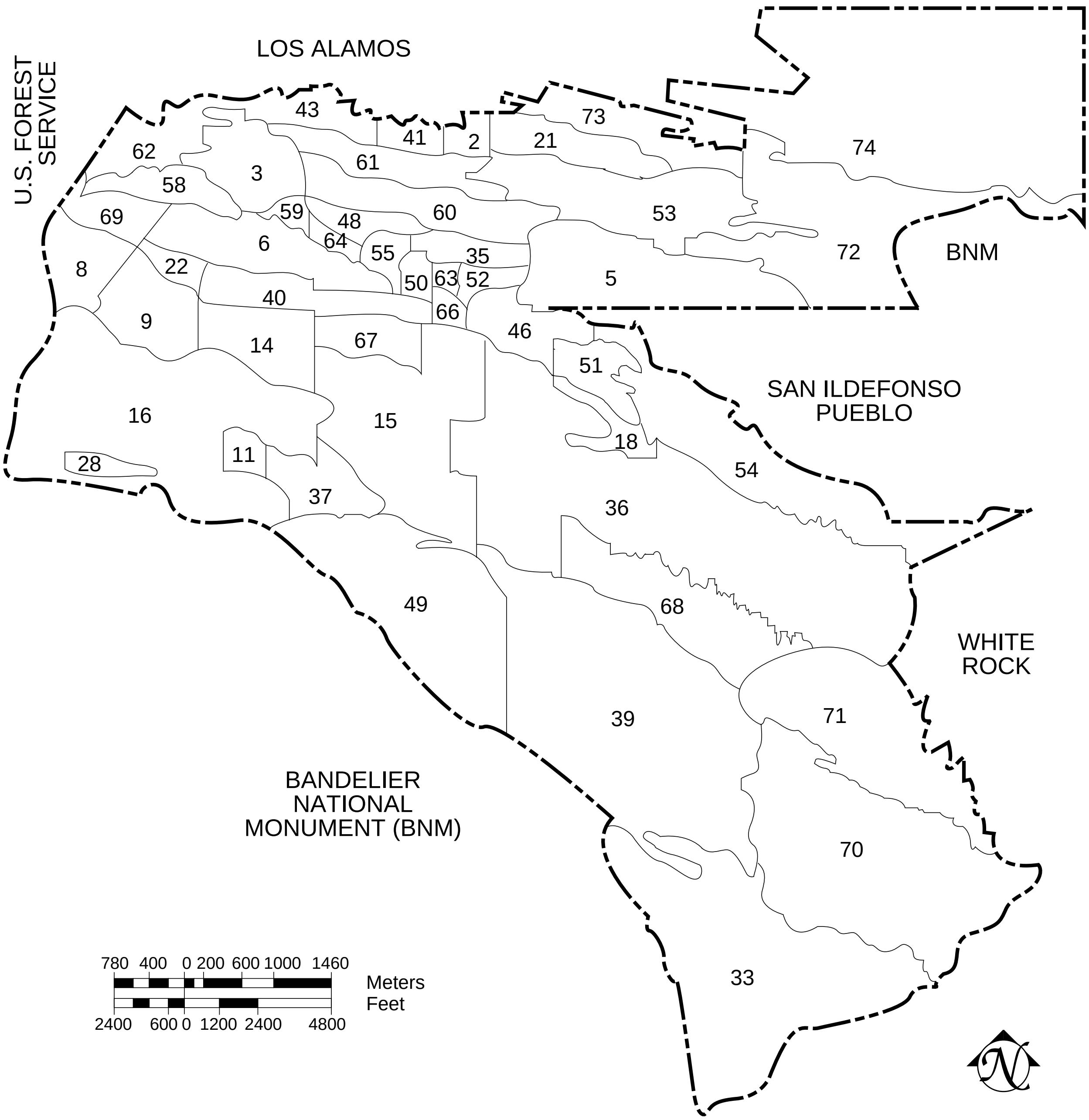

Figure 1-2. Technical Areas of Los Alamos National Laboratory in relation to surrounding landholdings.

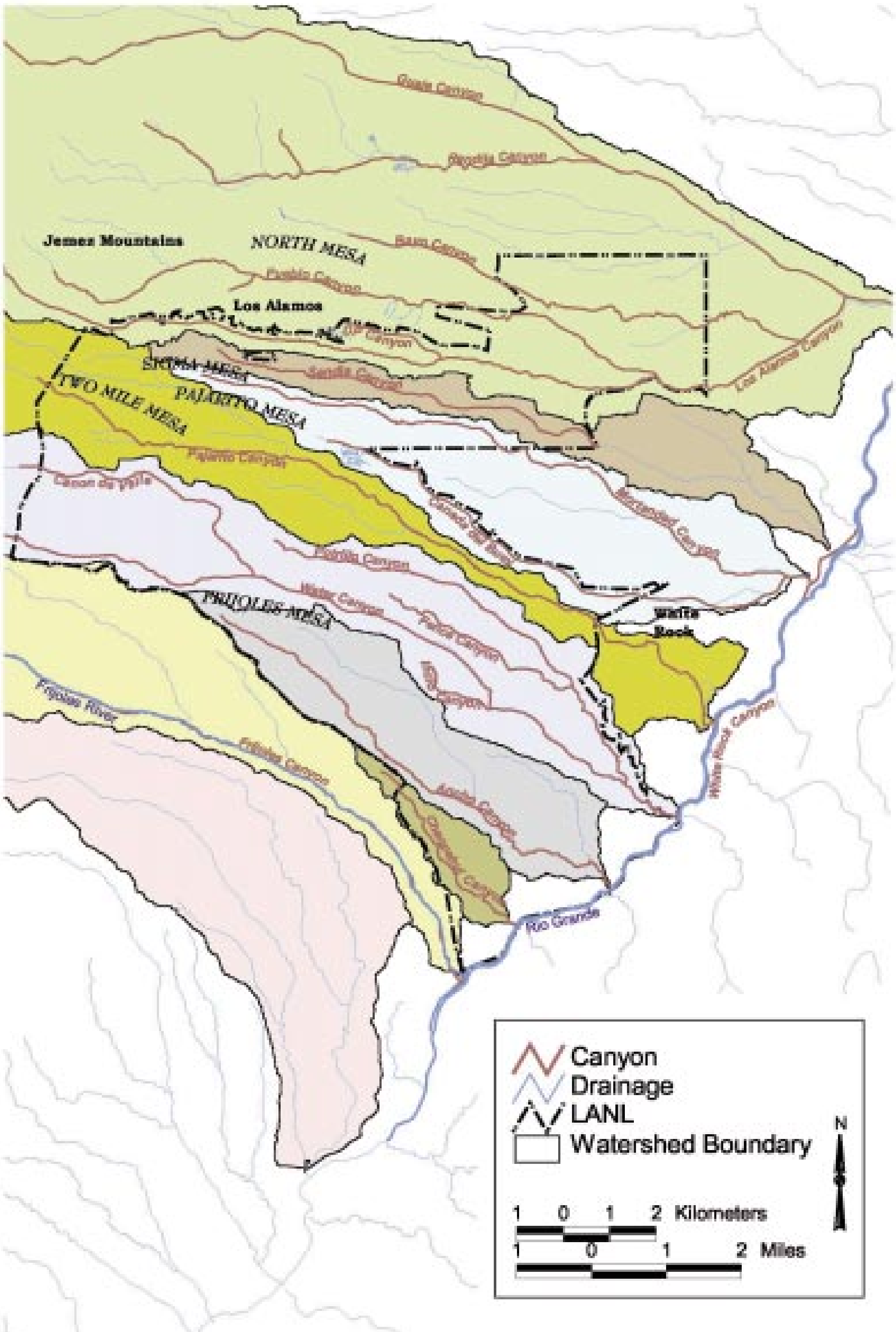

Figure 1-3. Major canyons and mesas.

threatened species, endangered species, or 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 1,550 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. Buildings and structures from the Manhatten Project and the early Cold War period (1943–1963) are being evaluated for eligibility to the Natural Register of Historic Places.

B. Management of Environment, Safety, and Health

1. Introduction

The Laboratory's environmental, safety, and health (ES&H) goal is to accomplish its mission cost effectively, while striving for an injury-free workplace, protecting worker and public health, minimizing waste streams, and avoiding unnecessary adverse impacts to the environment from its operations.

2. Integrated Safety Management

Throughout the Laboratory, the goal of Integrated Safety Management (ISM) is the systematic integration of ES&H into work practices at all levels. Safety and environmental responsibility involve every worker. Management of ES&H functions and activities is an integral, visible part of the Laboratory's work-planning and work-execution processes.

In 1998, the Laboratory Director issued an ES&H policy that stated that "safety is first at LANL." One of the "six zeroes" adopted under Director Browne is "zero environmental incidents." ISM is the Laboratory's management system for performing work safely and for protecting employees, the public, and the environment. The term "integrated" indicates that the safety management system is a normal and natural element in performing the work; safety isn't a workplace addition, it is how the Laboratory does business.

The ISM system provides the framework for an environmental management system with the following objectives (LANL 1999b):

- conduct Laboratory operations in full compliance with all environmental laws and regulations;
- prevent adverse environmental impacts and enhance environmental protection; and
- adopt proactive approaches to achieve environmental excellence. For example, it is better to minimize waste generation, wastewater discharges, air emissions, ecological impacts, and cultural impacts than to have to cleanup problems.

3. Environment, Safety, & Health Division

The Environment, Safety, & Health (ESH) Division is primarily a Laboratory support organization that provides a broad range of technical expertise and assistance in areas such as worker health and safety, environmental protection, facility safety, nuclear safety, hazardous materials response, ES&H training, occurrence investigation and lessons learned, and quality. ESH Division is in charge of performing environmental monitoring, surveillance, and compliance activities to help ensure that Laboratory operations do not adversely affect human health and safety 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).

ESH Division has responsibility and authority for serving as the central point of institutional contact, coordination, and support for interfaces with ESH regulators, stakeholders, and the public, including the DOE, the Defense Nuclear Facilities Safety Board, the New Mexico Environmental Department (NMED), and the Environmental Protection Agency (EPA). 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 Laboratory Counsel, ESH Division helps to define and recommend Laboratory policies for 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 makes appropriate environmental training programs available. The environmental surveillance program resides in 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.

The Laboratory uses approximately 600 sampling locations for routine environmental monitoring. The maps in this report present the general location of monitoring stations. For 1999, 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, foodstuffs, and associated biota are routinely collected at monitoring stations and then analyzed. The results of these analyses help identify impacts of LANL operations on the environment. ESH personnel collect and analyze additional samples to obtain information about particular events, such as major surface water runoff events, nonroutine releases, or special studies. See Chapters 2, 3, 4, 5, and 6 of this report for methods and procedures for acquiring, analyzing, and recording data. Appendix A presents information about environmental standards.

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 and conduct various environmental surveillance programs 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 1999. 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 1999 and provides a climatological overview of the Pajarito Plateau.

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

b. Water Quality and Hydrology. ESH-18 personnel provide 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), and Section 404/401 Dredge and Fill Permitting; 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. Chapter 5 summarizes the data ESH-18 personnel collected and analyzed during routine 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. Chapter 2 presents the Laboratory's compliance status with hazardous and solid waste regulations.

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, foodstuffs, and associated biota. Chapter 2 documents the 1999 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 and related research and development activities.

e. Site-Wide Environmental Impact Statement Project Office. The Site-Wide Environmental Impact Statement (SWEIS) Project Office was established in October 1994 to provide a single point-of-contact to support DOE and its contractor in the agency's preparation of a SWEIS for the Laboratory. Although work began in 1995, the major accomplishments were primarily in 1997, 1998, and 1999. The effort culminated with the issuance of a final SWEIS in January 1999, a Record of Decision in September 1999, and a Mitigation Action Plan in October 1999.

In 1999, the SWEIS Project Office was renamed the Site-Wide Issues Program Office (SWIPO). The SWIPO functions as the land transfer (see Section 1.B.5 for more information) point-of-contact for LANL. During 1999, the SWIPO developed the initial scenarios, costs, and schedules for cleaning up and transferring all 10 tracts of land within the time frame allocated by Congress. In addition, SWIPO outlined each major step DOE would have to accomplish and provided input to all major deliverables required under Public Law 105-119.

4. Environmental Management Program

a. Waste Management. Waste management activities focus on minimizing the adverse effects of chemical and 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 (TRU) waste, hazardous waste, mixed low-level waste, and radioactive liquid waste.

The Waste Management Program has made significant accomplishments in several areas, including mixed low-level waste work-off, retrieval of TRU waste from earth-covered storage, and TRU waste characterization, certification, and shipment.

Mixed Low-Level Waste Work-Off. In 1994, LANL had the equivalent of about 3,000 55-gallon drums of mixed low-level waste (waste that is both hazardous and radioactive) in storage because no capability existed at either LANL or other locations in the United States for proper treatment and disposal of the waste. At that time, NMED approved a plan called the Mixed Waste Site Treatment Plan for development and operation of treatment technologies and facilities at LANL. The original estimate called for completing the treatment and disposal of the mixed low-level waste in storage in 2006.

In cooperation with DOE/LAAO, a team worked to evaluate ways to reduce costs and accelerate the schedule. The team identified new treatment capabilities that were being developed commercially and at other DOE sites, and decisions were made to use those capabilities rather than to continue with new facilities at LANL. NMED also approved these efforts. In addition, efforts began to perform extensive characterization of waste that was only suspected of being both hazardous and radioactive. More than 75% of the mixed low-level waste in storage at LANL since 1994 has been treated and disposed of, and it is expected that this task will be completed three years earlier than originally projected, with about $14 million in cost savings.

Transuranic Waste Inspectable Storage Project. The Transuranic Waste Inspectable Storage Project (TWISP) has been established to retrieve 187 fiberglass-reinforced plywood crates and 16,641 metal drums containing solid-form, TRU waste from three earth-covered storage pads. This waste is being retrieved under a compliance order from NMED because it was not possible to inspect the waste as required by the state hazardous waste regulations. After the waste is retrieved, any damaged containers are over-packed in new containers. The containers are vented and have high-efficiency particulate air (HEPA) filters installed in drum lids. The waste is then placed in structures that can be inspected.

After several years of preparation, DOE granted start-up authority for TWISP in March 1997. Retrieval operations have been completed on the first two waste storage pads. We now expect to complete the project one to two years ahead of schedule, which will result in cost savings of about $12 million. The skills employed, technology used, and lessons learned will also assist other DOE sites in planning and performing similar projects.

Transuranic Waste Characterization, Certification, and Shipment. TRU waste must be characterized and certified to meet the Waste Acceptance Criteria at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. LANL was the first DOE site to be granted authorization from DOE to certify TRU waste in September 1997. Activities for characterization and certification of TRU waste have begun, and LANL made the first shipment of TRU waste to WIPP in March 1999. During 1999, LANL completed 17 shipments to WIPP.

b. Pollution Prevention. The Laboratory's Environmental Stewardship Office (ESO) manages the Laboratory's pollution prevention program. Section 2.B.1.i provides specific waste minimization accomplishments. See Section 2.E.3 for descriptions of successful pollution prevention projects. Other waste management activities that reduce waste generation include the following:

- Continuing financial incentives for waste reduction and innovative pollution prevention ideas and accomplishments such as the annual Pollution Prevention Awards and Generator Set Aside Fee funding;
- Developing databases to track waste generation and pollution prevention/recycling projects;
- Providing pollution prevention expertise to Laboratory organizations in source reduction, material substitution, internal recycle/reuse, lifetime extension, segregation, external recycle/reuse, volume reduction, and treatment; and
- Providing guidance to divisions within the Laboratory for minimizing waste and pollution through application of the Green Zia tools. Green Zia is a pollution prevention program administered by NMED.

In 1999, the ESO published *The Los Alamos National Laboratory 1999 Environmental Stewardship Roadmap,* in accordance with the Hazardous and Solid Waste Amendments Module VIII of the RCRA Hazardous Waste Permit and 40 CFR 264.73. This document is available at *http://eso.lanl.gov/info/publications/default.htm* on the World Wide Web.

One of the six Laboratory excellence goals has an environmental focus: zero environmental incidents. The roadmap document describes the Laboratory's current operations and the improvements that will eliminate the sources of environmental incidents.

The stewardship solution for zero incidents is to eliminate the incident source. This goal is being accomplished by continuously improving operations to achieve

- zero waste,
- zero pollutants released,
- zero natural resources wasted, and
- zero natural resources damaged.

c. Environmental Restoration Project. The Environmental Restoration (ER) Project at the Laboratory complements the Laboratory's environmental surveillance program by identifying and characterizing potential threats to human health, the area's ecology, and the environment from past Laboratory operations. The ER Project's mission is to mitigate those threats, where necessary, through cleanup actions that comply with applicable environmental regulations. Cleanup actions may include covering and containing a source of contamination to prevent its spread, placing controls on future land use, and excavating and/or treating the contamination source. Often these sources are places where wastes were improperly disposed in the past or where the disposal practices of the past would not meet the standards of today. As a result, contamination may have spilled or leaked into the environment from such places (called potential release sites or PRSs) over time, with the possibility of causing hazards to human health and/or the environment. The ER Project then must confirm or deny the existence of these hazards.

The ER Project reorganized its activities during 1999 according to the natural watersheds across the Laboratory in which the various PRSs are located. Each watershed is made up of one or more pieces (called aggregates), each containing several PRSs that will be investigated, assessed, and remediated (if necessary) as a group. This watershed approach ensures that drinking water sources and sensitive natural resources will be protected as it accounts for potential cumulative impacts of multiple contaminant sources located on mesa tops and slopes.

An exposure scenario serves as the basis for assessing a site for potential risk to human health and defines the pathways by which receptors are exposed. A human health exposure scenario is determined by the current and future land use of the site. Standard land-use scenarios the ER Project uses to determine exposure to human health receptors include

- residential,
- industrial,
- recreational, and
- resource user.

Mirenda and Soholt (1999) fully describe standard land-use scenarios. The Laboratory Site Development Plan (LANL 1995) is used to determine which Laboratory lands fall into the industrial and recreational categories of land use, both currently and in the future. Industrial land use affects Laboratory workers and is prescribed by the 30-year planning horizon for the Laboratory's mission and the continued operation of present-day facilities. Buffer zone land use may affect recreational users and is based on present and future access to Laboratory property, as prescribed in the Laboratory's Site Development Plan.

The ER Project is also in the process of developing a set of pathways that would appropriately describe how members of neighboring pueblos use Laboratory lands and environs.

The ER Project makes cleanup decisions on the basis of ecological risks and risks to the environment, in addition to human-health risks. While human-health risk can be evaluated over a relatively small area, ecological risk assessment requires an understanding of the nature and extent of contamination across much larger areas. Decisions that are protective of water resources in general also require an understanding of the presence and movement of contamination within an entire watershed.

The ER Project at the Laboratory is structured primarily according to the requirements of the Hazardous and Solid Waste Amendments to RCRA, which refer to these cleanup activities as "corrective actions." Module VIII of the Laboratory's Hazardous Waste Facility Permit contains the corrective action provisions. The EPA and NMED regulate the Laboratory's corrective action program under RCRA. In addition, the Comprehensive Environmental Response, Compensation, and Liability Act specifies requirements for cleaning up sites that contain certain hazardous substances not covered by RCRA and for identifying and reporting historical contamination when federal agencies such as DOE transfer surplus property to other agencies or the public. DOE has oversight for those PRSs at the Laboratory that are not subject to RCRA and for the Laboratory's decommissioning program for surplus buildings and facilities. Additional information about the ER Project and the new watershed approach is presented at *http://erproject.lanl.gov* on the World Wide Web. See Chapter 2 for summaries of ER Project activities performed in 1999.

5. Land Conveyance and Transfer under Public Law 105-119

On November 26, 1997, Congress passed Public Law 105-119. Section 632 of the Act directed the Secretary of Energy to identify parcels of land at or near the Laboratory for conveyance and transfer to one of two entities: either Los Alamos County or the Secretary of the Interior (to be held in trust for San Ildefonso Pueblo). Pursuant to this legislation, DOE determined that an Environmental Impact Statement (EIS) would be required under NEPA to satisfy the requirements for review of environmental impacts of the conveyance or transfer of each of the ten tracts of land (4,800 acres) slated for transfer. DOE may retain portions of other tracts because of current or future national security mission needs or the inability to complete restoration and remediation for the intended use within the time frame prescribed in the Act. The Final Conveyance and Transfer (CT) EIS is dated October 1999 (DOE 1999).

Public Law 105-119 also required DOE to evaluate those environmental restoration activities that would be required to support land conveyance and transfer and to identify how this cleanup could be achieved within the ten-year window established by law. The resultant report, the *Environmental Restoration Report to Support Land Conveyance and Transfer under Public Law 105-119*, was dated August 1999. In addition, Congress required DOE to issue a Combined Data Report that summarized the material contained in the CT EIS and Environmental Restoration Report. The Combined Data Report to Congress was released in January 2000, and the official notification that these documents were available from the EPA appeared in February 2000.

6. Cooperative Resource Management

Interagency Wildfire Management Team. The Interagency Wildfire Management Team continues to be a vehicle for addressing wildfire issues of mutual concern to the regional land management agencies. The team collaborates in public outreach activities, establishes lines of authority to go into place during a wildfire, provides cross-disciplinary training, and shares the expertise that is available from agency to agency. The result of this collaboration has been an increased coordination of management activities between agencies and a heightened response capability in wildfire situations. In addition to DOE and UC/LANL, regular participants of the Interagency Wildfire Management Team include representatives of the Los Alamos County Fire Department, Santa Fe National Forest, Bandelier National Monument, San Ildefonso Pueblo, NM State Forester's Office, and NMED Oversight Bureau.

During 1999, under a Memorandum of Understanding between DOE/LAAO and the National Park Service, Bandelier National Monument constructed a

2,500-square-foot building at TA-49. Bandelier uses this building as a cache for storing fire tools and equipment as well as for stationing fire personnel and Bandelier fire engines. UC/LANL constructed a helipad close to the building to provide helicopter support during a fire or other emergency. The helipad contains an area for the setup of a 5,000-gallon storage tank. The fire cache and helipad were opened for use in a multiagency dedication ceremony on December 7, 1999.

East Jemez Resource Council. In 1999, the East Jemez Resource Council remains a highly effective means of improving interagency communication and cooperation in the management of resources on a regional basis. The council established the Cultural Resources and the LANL Biological Resources Working Groups. These council working groups give resource specialists a forum for a more detailed and technical assessment of resource-specific issues and solutions. The working groups report on progress and issues during the quarterly council meetings. The council is also providing a forum for soliciting regional agency and stakeholder input during the development of the LANL Biological Resources Management Plan, Ecological Risk Assessment Project, and the Comprehensive Site Plan. Council participants include Bandelier National Monument, Santa Fe National Forest, NMED, New Mexico State Forestry Division, US Fish and Wildlife Service, NM Department of Game and Fish, San Ildefonso Pueblo, Santa Clara Pueblo, Cochiti Pueblo, DOE, and UC/LANL.

Cochiti Lake Ecological Resources Team. In 1999, the Cochiti Lake Ecological Resources Team completed a final Memorandum of Understanding between the US Army Corps of Engineers, Bandelier National Monument, DOE/LAAO, US Geological Survey, US Fish and Wildlife Service, NM Game and Fish, Cochiti Pueblo, US Forest Service, and UC/LANL. The Cochiti Lake Ecological Resources Team assisted the US Army Corps of Engineers in evaluating the role Cochiti Lake may play in the protection of the Rio Grande silvery minnow. The team serves as an interagency forum for discussing issues pertaining to the status or management of physical, biological, and recreational resources in the vicinity of Cochiti Lake and White Rock Canyon.

White Rock Canyon Reserve. In late July 1999, Secretary of Energy Richardson tasked the DOE Albuquerque Field Office and LAAO to assess New Mexico lands DOE administers to determine what land might be suitable for designation and use as a wildlife reserve. The Reserve's objective is to conserve, protect, and enhance the habitat for the plants and animals that inhabit the site or use the site intermittently. Using a specific set of mission and environmental criteria, DOE and UC/LANL selected a portion of White Rock Canyon that consists of approximately 1,000 acres in the eastern portion of LANL along the Rio Grande and adjacent to Bandelier National Monument and Santa Fe National Forest lands. The area is relatively remote and biologically diverse and contains threatened or endangered species habitat as well as a variety of cultural resources. Secretary Richardson officially dedicated the White Rock Canyon Reserve on October 30, 1999. Bandelier National Monument will manage the reserve with programmatic and technical assistance from DOE and UC/LANL.

Pajarito Plateau Watershed Partnership. In 1999, regional landowners and managers with a common interest in the quality of water in north central New Mexico's Pajarito Plateau Watershed established the Pajarito Plateau Watershed Partnership. The partnership's mission is to work together to protect, improve, and/or restore the quality of water in the Pajarito Plateau Watershed. Toward this end, the partnership is preparing a multiagency program and plan to identify and resolve the primary regulatory and stakeholder issues affecting water quality in the watershed. Partnership members include Bandelier National Monument, San Ildefonso Pueblo, Santa Clara Pueblo, Los Alamos County, NMED, Santa Fe National Forest, DOE, and UC/LANL.

7. 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 Relations Office has the responsibility to help coordinate activities between the Laboratory and northern New Mexico, many organizations at the Laboratory are actively working with the public. Frequently, the subject of these interactions is related to environmental issues because of the Laboratory's potential impact on local environment, safety, and health.

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

Outreach Centers

During 1999, the Community Relations Office operated outreach centers in Los Alamos (505-665-4400), Española (505-753-3682), and Santa Fe (505-

982-3771). The Los Alamos center includes a reading room with access to Laboratory documents. Approximately 200 people visited the reading room last year. Access to environmental information is available at all the outreach centers.

Environmental Restoration Project's Communications and Outreach Team

The Communications and Outreach Team of the ER Project works actively with the public. The team coordinates public involvement activities such as public meetings, tours, media, and general outreach activities for issues concerning the ER Project and the CT EIS. In 1999, the team produced a Web site on the ER Project—*http://erproject.lanl.gov* on the World Wide Web.

Bradbury Science Museum

Because many of the Laboratory's facilities are not accessible 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 assess air pollution or demonstrating ecology concepts. In 1999, the museum hosted approximately 103,000 visitors.

Inquiries

In 1999, the Community Relations Office—with the assistance of a wide variety of Laboratory organizations—responded to more than 400 public inquiries, many of which had an environmental theme. These inquiries came to the Community Relations Office by letter, phone, fax, e-mail, and personal visits.

To learn more about the Community Relations Office and the Laboratory's community involvement efforts, you can read the Community Relations Office Annual Report at http://www.lanl.gov/orgs/cr/final.pdf on the World Wide Web.

8. Public Meetings

The Laboratory holds public meetings to inform residents of surrounding communities about environmental activities and operations at the Laboratory. During 1999, the Laboratory held three public meetings as part of a continuing series called the "Community Environmental Meetings." The first of these meetings, titled "Environmental Monitoring," was held in April 1999 in Española. A second meeting, "High-Explosives Contamination in the Groundwater," took place in June 1999. The third meeting, "Cancer Trends in Los Alamos," was held in Los Alamos in July 1999.

The ER Project also sponsored public meetings during 1999. Topics included quarterly status reports on the progress of the program groundwater monitoring and wells, water quality, the CT EIS, contaminants found in Acid Canyon, and contaminants found at Area P.

In addition, the ER Project began a series of Availability Sessions in December 1999. These sessions take place once a month, and DOE and ER Project staff discuss current project issues and activities with the public in an informal one-on-one setting.

During 1999, the ER Project conducted or coordinated 30 tours of Laboratory facilities and sites for DOE, EPA, and NMED regulators, the Citizens' Advisory Board (CAB), and tribal and local governments and environmental staffs.

9. Tribal Interactions

During 1999, executive and staff meetings were held with Cochiti Pueblo, Jemez Pueblo, San Ildefonso Pueblo, Santa Clara Pueblo, and 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.

The Laboratory's Tribal Relations Team continues to work with tribes on hazardous material shipment through pueblo lands. Technical assistance was provided for development of emergency management plans and improvement of procedures for incident notification. Additional interactions included

- a briefing and tour for tribal officials on the R-25 well, where traces of high explosives were found in deep groundwater;
- a briefing and tour of the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility because of the tribes' concern about impacts from the facility on pueblo lands, adjacent areas, and local cultural resource sites; and
- preliminary work with tribal environmental staff on a formal initiative with the four Accord tribes to develop risk assessment approaches to appropriately evaluate human-health risks that might occur as a result of traditional cultural use of their lands and resources.

The ER Project conducted monthly meetings with tribal officials to discuss topics of mutual concern:

land conveyance and transfer; risk assessment techniques and specifically the Native American Risk Scenario human-health risk assessment technique; and the reorganization of the ER Project with its emphasis on the watershed approach.

10. A Report for Our Communities

In October 1999, ESH Division published 20,000 copies of the annual report, *For the Seventh Generation: Environment, Safety, and Health at Los Alamos National Laboratory: A Report to Our Communities 1998–1999 Volume III* (ESH 1999). This report gives the Laboratory, its neighbors, and other stakeholders a snapshot of some of the Laboratory ESH programs and issues.

Feature articles in this volume include

The Land Ethic and Environmental Monitoring

WIPP's First Shipment—A Historic Event

Preventing Waste, Saving the Future

Know Fuel, Know Fire

Tapping the Earth Below

DARHT: Understanding Environmental Issues

This report is available from the Laboratory's Outreach Centers and reading room. It is also available at *http://lib-www.lanl.gov/la-pubs/00416768.pdf* on the World Wide Web.

11. Citizens' Advisory Board

The Northern New Mexico Citizens' Advisory Board on Environmental Management was formed in 1995 to provide opportunities for effective communications between the diverse multicultural communities of northern New Mexico, the DOE, the Laboratory, and state and federal regulatory agencies on environmental restoration, environmental surveillance, and waste management activities at the Laboratory. More information on the CAB is available at *http://www.nnmcab.org* on the World Wide Web.

C. 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 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. Each monitoring activity ESH Division sponsors has its own Quality Assurance Plan and implementing procedures. These plans and procedures establish policies, requirements, and guidelines to effectively implement regulatory requirements and to meet the requirements for DOE Orders 5400.1 (DOE 1988), 5400.5 (DOE 1990), and 5700.6C (DOE 1991). Each Quality Assurance Plan must address the criteria for management, performance, and assessments.

The ESH groups performing environmental monitoring activities either provide their own quality assurance support staff or can obtain support for quality assurance functions from the Quality Assurance Support Group (ESH-14). ESH-14 personnel perform quality assurance and quality control audits and surveillance of Laboratory and subcontractor activities in accordance with the Quality Assurance Plan 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 implementation of environmental requirements. The Quality and Planning Program Office manages and coordinates the effort to become a customer-focused, unified Laboratory.

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

During 1999, UC and DOE evaluated the Laboratory based on mutually negotiated ES&H performance measures. The performance measure rating period runs from July to June. The performance measures are linked to the principles and key functions of ISM. The performance assessment program is a process-oriented approach intended to enhance the existing ISM system by identifying performance goals.

Performance measures include the following categories:

- environmental performance;
- radiation protection of workers;
- waste minimization, affirmative procurement, and energy and natural resources conservation;
- management walkarounds;
- hazard analysis and control;

- maintenance of authorization basis; and
- injury/illness prevention.

Specific information on the categories and the assessment scoring can be obtained at *http://drambuie.lanl.gov/~eshiep/* on the World Wide Web.

3. Environment, Safety, & Health Panel of the University of California President's Council on the National Laboratories (UC-ES&H)

The UC-ES&H Panel met at the Laboratory July 27–29, 1999, and discussed the following topics:

- status of LANL special provisions (Contract Clause 5.14),
- WIPP shipments & packaging operations,
- biotechnology & biosafety issues,
- Pajarito Canyon Site (TA-18) operations and programmatic future,
- occurrence review of the personal burn injury during welding operations at the Engineering and Sciences Applications Division,
- environment—how does it fit into ISM, and
- community, Native American, and public comment issues.

The UC-ES&H Panel has forwarded its observations and recommendations on these topics to the Laboratory Director and the Chair of the UC President's Council on the National Laboratories.

4. Division Review Committee

The ES&H Division Review Committee reviewed 31 research projects in 1999. The primary purpose of the meeting was to perform the Science & Technology Assessment of ESH Division. The Division Review Committee based its evaluation on the four criteria provided by the UC President's Council on the National Laboratories:

- quality of science and technology,
- relevance to national needs and agency missions,
- support of ES&H performance at LANL facilities, and
- programmatic performance and planning.

The committee assigned an overall grade of excellent to the performance of the division for science and technology. Of the 31 projects evaluated, nine were truly outstanding, and twelve were in the excellent range. The outstanding projects were

- automated chemical inventory tracking system on the World Wide Web;
- service life modeling for organic vapor air-purifying respiratory cartridges;
- pressure effects and deformation of waste containers;
- Monte Carlo bioassay simulators;
- use of absolute humidity and radiochemical analysis of water vapor samples to correct underestimated atmospheric tritium concentrations;
- Monte Carlo simulation of analytical uncertainty in radiochemical data sets with trends;
- radionuclides and trace elements in fish collected from canyons;
- resource use, activity patterns, and disease analysis of Rocky Mountain elk at Los Alamos;
- hydrogeological characterization of Pajarito Plateau through the implementation of the Hydrogeologic Work Plan.

5. Cooperative and Independent Monitoring by Other State and Federal Agencies

The Agreement-in-Principle between DOE and the State of New Mexico for Environmental Oversight and Monitoring provides technical and financial support for state activities in environmental oversight and monitoring. The requirements of the agreement are carried out by the DOE Oversight Bureau of the NMED. The Oversight Bureau holds public meetings and publishes reports on its assessments of Laboratory activities. Highlights of the Oversight Bureau's activities are reported in Section 2.C.2 and are available at *http://www.nmenv.state.nm.us/*.

Environmental monitoring at and near the Laboratory involves other state and federal agencies such as the Defense Nuclear Facilities Safety Board, the Agency for Toxic Substances and Disease Registry, the Bureau of Indian Affairs, the US Geological Survey, the US Fish and Wildlife Service, the US Forest Service, and the National Park Service.

6. Cooperative and Independent Monitoring by the Surrounding Pueblos

DOE and UC have signed agreements with the four surrounding pueblos. 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 allow access to monitoring locations at and near the Laboratory and encourage cooperative sampling activities, improve data sharing, and enhance communications on technical subjects. The agreements also provide frameworks for grant support that allow development and implementation of independent monitoring programs.

D. References

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2. Compliance Summary

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Abstract

Los Alamos National Laboratory (LANL or the Laboratory) staff frequently interacted with regulatory personnel during 1999 on Resource Conservation and Recovery Act and New Mexico Hazardous Waste Act requirements and compliance activities. During 1999, the Laboratory continued to work on the application process to renew its Hazardous Waste Facility permit. The Laboratory received Compliance Orders (COs) for the 1997 and 1998 New Mexico Environment Department (NMED) annual inspections. The NMED has not yet begun the process to negotiate and resolve the apparent findings or the proposed civil penalties. The Environmental Restoration Project reorganized its activities during 1999 according to the natural watersheds that cross the Laboratory.

During 1999, the Laboratory performed over 300 air quality reviews for new and modified projects, activities, and operations to identify all applicable air quality requirements; none of these projects required permits. The Environmental Protection Agency's (EPA's) effective dose equivalent (EDE) to any member of the public from radioactive airborne releases from a DOE facility is limited to 10 mrem/yr. The 1999 EDE was 0.32 mrem.

In 1999, the Laboratory was in compliance with its National Pollutant Discharge Elimination System (NPDES) permit liquid discharge requirements in 100% of the samples from its sanitary effluent outfalls and in 98.6% of the samples from its industrial effluent outfalls. The Laboratory was in compliance with its NPDES permit liquid discharge requirements in 99.2% of the water quality parameter samples collected in the period from August 1, 1998, through July 31, 1999, at sanitary and industrial outfalls. Concentrations of chemical, microbiology, and radioactive constituents in the drinking water system remained within federal and state drinking water standards.

The Laboratory continued an ongoing study of the hydrogeology and stratigraphy of the region through drilling as stated in the Hydrogeologic Workplan. Water samples from one well showed contamination previously unknown.

In 1999, the Laboratory sent 159 National Environmental Policy Act (NEPA) Environmental Review Forms to the Department of Energy (DOE) for review. A Site-Wide Environmental Impact Statement was completed under DOE's compliance strategy for NEPA. An Environmental Impact Statement assessing the conveyance and transfer of certain land tracts under the administrative control of DOE within Los Alamos and Santa Fe Counties was completed. DOE and LANL began planning and developing an Integrated Resources Management Plan in 1999 to integrate existing resource management plans and the development of other management plans with LANL site planning and mission activities. Laboratory archaeologists evaluated 749 proposed actions for possible effects on cultural resources and conducted 18 new field surveys to identify cultural resources. Laboratory biologists reviewed 409 proposed activities and projects for potential impact on biological resources including federally listed threatened and endangered species; of these, 52 projects required additional habitat evaluation surveys.

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

2. Compliance Summary

A. Introduction

Many activities and operations at Los Alamos National Laboratory (LANL or the Laboratory) use or produce liquids, solids, and gases that may contain nonradioactive hazardous and/or radioactive 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, and environmental impact analyses. 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 for control of radionuclides. Table 2-1 presents the environmental permits or approvals these organizations issued and the specific operations and/or sites affected.

B. Compliance Status

1. Resource Conservation and Recovery Act

a. Introduction. The Laboratory produces a variety of hazardous wastes, most 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. The applicable federal 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 regulate the storage, treatment, or disposal of hazardous waste and the hazardous component of radioactive mixed waste. A RCRA Part A permit application identifies (1) facility location, (2) owner and operator, (3) hazardous or mixed wastes to be managed, and (4) hazardous waste management methods and units (RCRA hazardous waste management areas). A facility that has submitted a RCRA Part A permit application for an existing unit manages 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 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 response, training, and inspection plans. The State of New Mexico issued LANL's current Hazardous Waste Facility Permit to DOE and the University of California (UC) in November 1989.

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

b. Resource Conservation and Recovery Act Permitting Activities. NMED signed the original RCRA Hazardous Waste Facility Permit for the waste management operations at Technical Areas (TAs) 50, 54, and 16 on November 8, 1989, authorizing Laboratory facilities and procedures for 10 years. In 1999, the permit was administratively continued beyond the expiration date until NMED issues a new permit (as allowed by the permit and by New Mexico Administration Code, Title 20, Chapter 4, Part 1, as revised January 1, 1997 [20 NMAC 4.1], Subpart IX, 270.51),

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 1999

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 Administratively continued	NMED
	RCRA General Part B renewal application	submitted January 15, 1999		
	RCRA mixed waste Revised Part A application	submitted April 1998	– – –	NMED
	TA-50/TA-54 permit renewal application	submitted January 15, 1999		
HSWA	RCRA Corrective Activities	March 1990	December 1999 Administratively continued	NMED
TSCA[a]	Disposal of PCBs at TA-54, Area G	June 25, 1996	June 25, 2001	EPA
CWA/NPDES[b], Los Alamos	Discharge of industrial and sanitary liquid effluents	August 1, 1994	October 31, 1998[c]	EPA
	Storm water associated with industrial activity	December 23, 1998	October 1, 2000	EPA
	DARHT Facility	October 2, 1998	July 7, 2003	EPA
	Guaje Well Field Improvements	October 2, 1998	July 7, 2003	EPA
	Fire Protection Improvements	October 2, 1998	July 7, 2003	EPA
	Strategic Computing Complex	May 21, 1999	July 7, 2003	EPA
	Norton Power Line Project	June 1, 1999	July 7, 2003	EPA
	TA-9-15 Gas Pipeline Replacement Project	August 22, 1999	July 7, 2003	EPA
CWA Sections 404/401 Permits	F.U. 4 Stream Crossing Restoration	July 24, 1997	July 24, 1999	COE[d]/NMED
	Guaje Canyon/Utility Line Discharges	September 9, 1997	September 9, 1999	COE/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/Fire Protection Improvement Project	November 14, 1997	November 14, 1999	COE/NMED
	Sandia Canyon/Survey Activities	March 4, 1998	March 4, 2000	COE/NMED
	Guaje Canyon/Bank Stabilization	March 2, 1998	March 2, 2000	COE/NMED
	Three Mile Canyon/Headwaters and Isolated Waters	July 14, 1998	January 28, 1999	COE/NMED
	Lab-wide Gaging Stations/Sci. Meas. Devices	August 28, 1998	August 28, 2000	COE/NMED

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 1999 (Cont.)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
CWA Sections 404/401 Permits (Cont.)	Norton Transmission Line Replacement	March 4, 1999	March 4, 2001	COE/NMED
	Wetland Characterization	May 25, 1999	May 25, 2001	COE/NMED
	Sewer Line Crossing, Upper Sandia Canyon	May 27, 1999	May 27, 2001	COE/NMED
	Lab-wide Gaging Stations/Sci. Meas. Devices Part 2	June 15, 1999	June 15, 2001	COE/NMED
	TA-9 to TA-15 Natural Gas Line Replacement	June 17, 1999	June 17, 2001	COE/NMED
	TA-48 Wetlands Improvement	July 9, 1999	July 9, 2001	COE/NMED
	TA-72 Firing Range Maintenance	July 13, 1999	July 13, 2001	COE/NMED
	Gas Line Leak Repair, LA Canyon	July 16, 1999	When repair completed	COE/NMED
Groundwater Discharge Plan, Fenton Hill	Discharge to groundwater	June 5, 1995	June 5, 2000	NMOCD[e]
Groundwater Discharge Plan, TA-46 SWS Facility[f]	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 (20 NMAC[g] 2.70)	LANL air emissions	not yet issued[h]		NMED
Air Quality (20 NMAC 2.72)	Portable Rock Crusher	June 16, 1999	None	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	October 30, 1998	None	NMED
	Beryllium machining at TA-35-213	December 26, 1985	None	NMED
	Beryllium machining at TA-55-4	March 11, 1998	None	NMED

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 1999 (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	December 31, 2002	NMED
Open Burning (20 NMAC 2.60) Prescribed Burning	Wood pile at TA-16	August 12, 1999	August 12, 2000	NMED
Open Burning (20 NMAC 2.60) Prescribed Burning	West Jemez Fuel Break Maintenance	February 26, 1999	December 31, 1999	NMED

[a]Toxic Substances Control Act.
[b]National Pollutant Discharge Elimination System.
[c]Administratively extended by EPA.
[d]Corps of Engineers.
[e]New Mexico Oil Conservation Division.
[f]Sanitary Wastewater Systems (SWS) Facility.
[g]New Mexico Administrative Code.
[h]Application submitted to NMED December 1995.
[i]National Emission Standards for Hazardous Air Pollutants.
[j]High-explosive.

subject to the timely submittal of permit renewal applications.

In 1998, the Laboratory received guidance from NMED on the permit renewal development strategy and the format for the permit renewal applications. NMED requested that the Laboratory submit (1) a General Part B permit application to serve as a general resource document and as the basis for Laboratory facility-wide portions of the final permit; (2) TA-specific permit applications to provide detail on specific waste management units, resulting in individual chapters of the final permit; and (3) revisions of previously submitted permit applications reflecting the new format.

The Laboratory submitted a General Part B and TA-50- and TA-54-specific permit renewal applications to NMED on January 15, 1999. The TA-16 incinerator, originally permitted in 1989, was shut down, and a closure plan was submitted in October. With these actions, the Laboratory met the submittal requirement for the waste management units active in 1989 or added to the permit later.

Several permit applications for waste management units being managed under the requirements of 20 NMAC 4.1, Subpart VI, were also developed or reformatted from previous applications and submitted to NMED in 1999, including units at TA-3, -14, -15, and -36. The Laboratory submitted a revised permit application for the expansion of the TA-54 West Outside Storage Area in support of mixed waste transportation in October. The Laboratory received approval of an upgrade to the TA-16-388 Open Burn Pad on May 12, 1999. A supplemental information package for TA-54 Storage Dome 375 was submitted in September. NMED approved the TA-54 Decontamination and Volume Reduction System on December 6, 1999.

NMED implemented the new permit fee regulations (20 NMAC 4, Part 2, Hazardous Waste Fees, December 31, 1998) in 1999. These regulations require identification of all active and inactive waste management sites at the Laboratory. The Laboratory submitted a negotiated Annual Unit Audit and the required fees to NMED in September.

The Laboratory closed one active waste management unit in 1999 and submitted the final report and certification for closure of the TA-21, Building 61, container storage area to NMED on February 26, 1999. NMED approved the closure on June 28, 1999.

The Laboratory also submitted closure plans for other waste management units in 1999:

- TA-54, Storage Shafts 145 and 146, on November 4, 1999, and
- TA-50, container storage buildings 137 and 138 and storage pads 139 and 140, on August 17, 1999.

c. Resource Conservation and Recovery Act Corrective Action Activities. Solid waste management units (SWMUs) can be 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. See previous LANL environmental reports (ESP 1999, ESP 1998, ESP 1997, ESP 1996) for the history of RCRA closures.

Implementation of clean closure of the TA-16 material disposal Area P landfill began in 1998. The first activity was digging test pits in the landfill to characterize waste types and volumes. Pieces of high-explosives (HE) materials that could be detonated were detected in some of the pits, requiring extensive modification of the Site-Specific Health and Safety Plan. Excavation of Area P began in February 1999. By the end of 1999, remote excavation of soil and debris from the West Lobe of Area P was complete. Approximately 24,320 yd^3 of soil and debris were excavated. Remote excavation of the East Lobe began in December 1999. Section 2.F.2 contains additional information about Area P.

The Environmental Restoration (ER) Project submitted the closure plan for the TA-16-387 flash pad in August 1999. The flash pad is an open burn structure within an area referred to as the Burning Ground at TA-16. The flash pad treated HE-contaminated waste by burning combustible wastes and “flashing” noncombustible wastes to remove the hazardous characteristic of reactivity and to ensure that the waste has no remaining associated safety hazards before disposal. TA-16-387 will be closed concurrently with Area P.

The closure plan for the TA-16-394 burn tray went to NMED in November 1999. The burn tray is also located within the Burning Ground at TA-16. The burn tray burned HE-contaminated oils, solvents, and water mixed with oils and solvents. It is no longer needed to treat hazardous waste.

d. Other Resource Conservation and Recovery Act Activities. The Hazardous and Solid Waste Group (ESH-19) began the self-assessment program in 1995 in cooperation with waste management coordinators to assess the Laboratory's performance in properly storing and handling hazardous and mixed waste to meet federal and state regulations, DOE orders, and Laboratory policy. ESH-19 communicates findings from individual self-assessments 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 1999, ESH-19 completed 1,358 quarterly self-assessments.

As part of the self-assessment program, ESH-19 performed independent hazardous waste management system evaluations for five divisions during 1999. These evaluations are similar to International Organization for Standardization (ISO) 14000 environmental management system audits. The management systems ESH-19 reviewed included organizational structure; environmental commitment; formality of program; internal and external communication; staff resources, training, and development; environmental planning and risk management; program evaluation, reporting, and corrective action; and hazardous chemical management and waste minimization. The program is voluntary; the driver for these evaluations is division management's desire to improve RCRA performance.

e. Resource Conservation and Recovery Act Compliance Inspection. NMED did not conduct an annual hazardous waste compliance inspection at the Laboratory in 1999.

f. Mixed Waste Federal Facility Compliance Order. The Laboratory met all 1999 Site Treatment Plan deadlines and milestones. In October 1995, the State of New Mexico issued a Federal Facility Compliance Order to both DOE and UC requiring compliance with the Site Treatment Plan. That plan documents the development of treatment capacities and technologies or use of off-site facilities for treating mixed waste generated at LANL stored beyond the one-year time frame (Section 3004[j] of RCRA and 40 CFR Section 268.50). The Laboratory treated and disposed of over 650 m^3 of mixed waste through FY99.

g. Underground Storage Tanks. The Laboratory had two underground storage tanks (USTs) (as defined by 40 CFR Part 280) in operation during 1999. The Laboratory closed (removed or permanently took out of service) all other USTs by December 22, 1998, the EPA upgrade/closure deadline. The two operating USTs are designated as TA-16-197 and TA-15-R312-DARHT.

TA-16-197 is a 10,000-gal. UST for unleaded gasoline at a single-pump fueling station for fueling Laboratory service vehicles located at and around TA-16. TA-15-R312-DARHT is a 10,000-gal. UST that captures and stores any accidental releases from an equipment room located at the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility. If a pipe breaks or a leak occurs in the equipment room, all fluids enter floor drains that discharge to the UST. This tank is normally empty and is only used as a secondary containment system during an accidental spill. Substances that could potentially enter the tank are mineral oil and glycol.

Both USTs are double-walled with double-wall piping. Both tanks have leak-detection systems. TA-16-197 has a cathodic corrosion protection system. TA-15-R312-DARHT is a fiberglass tank that does not require a corrosion protection system. NMED conducted its annual UST inspection on April 16, 1999 (see Table 2-2). USTs TA-16-197 and TA-15-R312-DARHT complied with all applicable UST regulations.

Former UST TA-2-1, a tank containing diesel fuel, was removed and permanently closed on October 29, 1998. During the removal, low levels of petroleum contamination (300 ppm total recoverable petroleum hydrocarbons [TRPH]) were found at a sample location below the tank fill line. On April 6, 1999, three additional samples were collected from a location under the former fill line. The TRPH result (440 ppm) from one of the samples was above the 100 ppm standard of the NM UST regulations. The Laboratory and NMED agreed to defer further investigation/cleanup activities at the TA-2-1 UST site until the LANL Decontamination & Decommissioning (D&D) investigation and remediation activities take place in 2006. The sampling results, the good condition of the removed UST, and the history of the site indicate that significant amounts of petroleum contamination are not present at the site.

h. Solid Waste Disposal. The Laboratory has a commercial/special-waste landfill located at TA-54, Area J, that is subject to NM Solid Waste Management Regulations (NMSWMR). In December 1998, the NMED Solid Waste Bureau requested a permit for the facility, which has been operating under a Notice of Intent since the NMSWMR were issued in 1995. Area J is closing in 2000 because the Laboratory decided not to retrofit Area J with a liner and other equipment needed to meet the regulations. The Laboratory submitted a closure plan to NMED in May

Table 2-2. Environmental Inspections and Audits Conducted at the Laboratory during 1999

Date	Purpose	Performing Agency
November 3, 1999	TA-54, Area J, Commercial/Special	NMED/SWQB[a]
July 12, 1999	NPDES Storm Water Program Inspection	EPA/NMED
April 16, 1999	Underground Storage Tank Inspection	NMED

[a]New Mexico Environment Department/Surface Water Quality Bureau.

1999. NMED has not yet approved the plan, and no closure activities took place during 1999. Generators of commercial/special waste will individually arrange to ship their wastes off-site to a New Mexico Special Waste landfill when Area J closes. The amount of soil and concrete needing disposal from Area P is expected to decrease significantly before Area J closes. After closure, soil will be landfilled at a facility in Rio Rancho, and concrete will be shipped to Santa Fe for recycling.

In 1999, the TA-54, Area J, landfill received and disposed of 5,236 yd^3 of solid waste in its pits and shafts. The increase in the amount of waste (up from 55.5 yd^3 in 1998) is due to a large volume of soil and concrete received from cleanup efforts at TA-16, Area P. The asbestos transfer station at Area J transferred 363 yd^3 of asbestos to both in- and out-of-state special-waste landfills. In 1999, LANL completed the required Solid Waste Facility annual report for 1998. Personnel from the NM Solid Waste Bureau inspected Area J on November 3, 1999, and found no violations of the NMSWMR.

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 and leases it 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. The Laboratory contributed 23% (11,799 tons) of the total volume of trash landfilled at this site during 1999, with the residents of Los Alamos County and the City of Española contributing the remaining 77%. Laboratory trash landfilled included 2,570 tons of trash, 8,331 tons of concrete/rubble, and 577 tons of construction and demolition debris. During 1999, the Laboratory also sent 256 tons of brush for composting and 65 tons of metal for recycling to the county landfill.

i. Waste Minimization and Pollution Prevention. To comply with the HSWA Module of the RCRA Hazard Waste Facility permit, RCRA Subtitle A, DOE Order 5400.1, Executive Order (EO) 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, and other regulations, the Laboratory must have a waste minimization and pollution prevention program. A copy of that Laboratory program, the *1999 Environmental Stewardship Roadmap*, is located at *http://eso.lanl.gov/info/publications/default.htm* on the World Wide Web.

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 Waste Disposal Act promotes process substitution; materials recovery, recycling, and reuse; and treatment as alternatives to land disposal of hazardous waste.

The *1999 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1* provides the amounts of routine, nonroutine, and total RCRA-hazardous, low-level, and mixed low-level wastes Laboratory operations generated during 1999. A copy of this report and additional information about waste minimization can be found at *http://twilight.saic.com/WasteMin* on the World Wide Web. DOE defines routine/normal waste generation at LANL as waste generated from any type of production, operation, analytical, and/or research and development (R&D) laboratory operations; treatment, storage, and disposal (TSD) operations; work for others; or any other periodic and recurring work that is considered ongoing in nature.

Nonroutine/off-normal waste generation is defined as one-time operations waste such as wastes produced from ER Project activities, including primary and secondary wastes associated with removal and remediation operations, and wastes associated with the legacy waste program cleanup and D&D operations.

In 1999, source reduction and recycling activities reduced the following amounts of waste:

Transuranic (TRU) waste	7.33 m^3
Low-level radioactive waste	1,236.96 m^3
Mixed low-level radioactive waste	30.54 m^3
Sanitary solid waste	1,993.98 metric tons
State-regulated waste	163.42 metric tons
Toxic Substances Control Act (TSCA) waste	0.45 metric tons
RCRA waste	146.57 metric tons

j. Greening of the Government Executive Order. The Laboratory purchases products made with recovered materials in support of EO 13101, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," signed by President Clinton on September 14, 1998, and to comply with RCRA. EPA designates the categories of these items, referred to as Affirmative Procurement. Based on past reports, the Laboratory purchases the largest number of items in three categories: paper, toner cartridges, and plastic desktop accessories whenever available. The Laboratory submits a summary report to DOE after each fiscal year end and is required to report quarterly to UC on the Affirmative Procurement Rate.

In January 2000, the Federal Register released the Recovered Materials Advisory Notice III (RMAN III). The RMAN III contains the EPA's recommendations for purchasing 18 new Affirmative Procurement items including furnishings and construction materials. The Laboratory is working to incorporate these items into the Just-in-Time online catalog purchasing database.

k. Resource Conservation and Recovery Act Training. The RCRA training program is a required component of and is described in the RCRA Hazardous Waste Facility Permit. The Laboratory training program is in compliance and, with the exception of refresher courses that undergo annual revisions, experienced only minor modifications and revisions in 1999 to reflect regulatory, organizational, and/or programmatic changes.

During 1999, 247 workers completed RCRA Personnel Training, 433 workers completed RCRA Refresher Training, and 616 workers completed Waste Generation Overview. Of the 433 workers who required RCRA Refresher Training during 1999, 332 met this requirement through completing hazardous waste operations (HAZWOPER) Refresher for Treatment, Storage, and Disposal Workers that includes the RCRA Refresher as part of the eight-hour requirement.

The Environment, Safety, and Health Training Group (ESH-13) completely revised the following RCRA courses during 1999.

RCRA Refresher Training

HAZWOPER: Refresher for Environmental Restoration Workers

HAZWOPER: Refresher for Treatment, Storage, and Disposal Workers

ESH-13 updated the following courses during 1999:

Waste Generator Overview

Waste Documentation Forms

Waste Management Coordinator Requirements

The following RCRA self-study courses were developed in 1999:

Environmental Issues for Managers

Waste Management Overview

Waste Characterization Overview

Waste Storage and Disposal Overview

Environmental Regulation Overview

l. Hazardous and Solid Waste Amendments Compliance Activities. In 1999, the ER Project remained in compliance with Module VIII of the RCRA permit. The Laboratory's ER Project originally involved approximately 2,100 potential release sites (PRSs), consisting of solid waste management units and areas of concern. The ER Project has recommended designating approximately 1,400 PRSs as no further action (NFA) because they meet one or more of the following criteria.

Criterion 1. The site does not exist, is a duplicate of another site, cannot be located, or is located within another site and has been or will be investigated as part of that site.

Criterion 2. The site,was never used for the management (i.e., generation, treatment, storage, or disposal) of RCRA solid or hazardous wastes and/or constituents.

Criterion 3. The site is not known to have released nor is it suspected of releasing or having released RCRA solid or hazardous wastes and/or constituents to the environment. The term “release” means any spilling, leaking, pouring, emitting, emptying, discharging, injecting, pumping, escaping, leaching, dumping, or disposing of hazardous wastes (including hazardous constituents) into the environment.

Criterion 4. The site is regulated under another state and/or federal authority. If the site is known to have released or is suspected of releasing or having released RCRA solid or hazardous wastes and/or constituents to the environment, it has been or will be investigated and/or remediated in accordance with applicable state and/or federal regulations.

Criterion 5. The site was characterized or remediated in accordance with current applicable state and/or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk, assuming current and projected future land use.

The ER Project continues to reevaluate many of these sites for ecological and other relevant and appropriate concerns. At the end of FY99, approximately 280 PRSs had been evaluated and found to comply with the criteria needed to justify the NFA classification, and 102 PRSs had been removed from the RCRA permit.

In 1999, the LANL ER Project HSWA compliance activities included remedial site assessments and site cleanups. The assessment portion of the ER Project included submission of eight RCRA facility investigation (RFI) reports to NMED and RFI fieldwork on numerous sites. Remedial activities cleaned seven sites including an inactive firing site, septic tanks, and areas with contaminated soil.

The ER Project anticipates that the corrective action process for all PRSs will be complete by 2013. Based on the new watershed approach (as described in Section 2.E.1), future work will focus on PRSs in the Los Alamos townsite at the head of Los Alamos, Pueblo, Guaje, Rendija, Barranca, Bayo, and DP Canyons and work down each canyon to the Rio Grande. Work will then continue southward, watershed by watershed, until work on PRSs in all eight watersheds is completed.

2. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, mandates actions for certain releases of hazardous substances into the environment. The Laboratory is not listed on the EPA’s National Priority List, but the ER Project follows some CERCLA guidelines for remediating Laboratory sites that contain certain hazardous substances not covered by RCRA and/or that may not be included in Module VIII of the Laboratory’s Hazardous Waste Facility Permit.

DOE fulfills its responsibilities as both a natural resource trustee and lead response agency for Project activities at the Laboratory. DOE’s policy is to consider CERCLA Natural Resource Damage Assessment (NRDA) issues and, when appropriate, resolve them with other natural resource trustees as part of the ER Project remedy selection process. ER Project cleanup considers integrated resource management activities (e.g., biological resource management, watershed management, and groundwater protection) at the Laboratory. As ER Project cleanup activities progress, natural resource trustees (i.e., Department of Interior, Department of Agriculture Forest Service, Cochiti Pueblo, Jemez Pueblo, San Ildefonso Pueblo, Santa Clara Pueblo, and the State of New Mexico) are invited to participate in the process. DOE initiated its dialogue with the natural resource trustees on ER Project activities in 1997. In 1999, the natural resource trustees conducted a preliminary assessment of potential natural resource impact indicators and service losses and conducted a field survey of best management practices for surface water protection at ER Project PRSs. Additionally, ER Project-related issues are discussed in the Pajarito Plateau Watershed Partnership and the East Jemez Resources Council meetings.

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 EO 12856.

b. Compliance Activities. In 1999, the Laboratory submitted three 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 requires the preparation of emergency plans for more than 360 extremely hazardous substances if stored in amounts above threshold limits. The Laboratory is required to notify state and local emergency planning committees of any changes at the Laboratory that might affect the local emergency plan or if the Laboratory's emergency planning coordinator changes. In July 1999, LANL sent notification to the state and local planning committees regarding the presence of nickel carbonyl, hydrogen fluoride, chlorine, sulfuric acid, and nitric acid at the facility. Officials were informed of the presence of these materials in excess of chemical specific threshold quantities.

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 over specified reporting quantities into the environment. Releases must be reported immediately to the state and local emergency planning committees and to the National Response Center. No leaks, spills, or other releases of specific chemicals into the environment that required EPCRA reporting occurred during 1999.

Material Safety Data Sheet/Chemical Inventory Reporting. Title III, Sections 311-312, of EPCRA requires facilities to provide an annual inventory of the quantity and location of hazardous chemicals present at the facility above specified thresholds; the inventory includes the material safety data sheet for each chemical. The Laboratory submitted a report to the state emergency response commission, the local emergency planning committee, and the Los Alamos County Fire Department listing 58 chemicals and explosives at the Laboratory during 1999 in quantities exceeding threshold limits.

Table 2-3. Compliance with Emergency Planning and Community Right-to-Know Act during 1999

Statute	Brief Description	Compliance
EPCRA Sections 302-303 Planning Notification	Requires emergency planning notification to state and local emergency planning committees.	LANL sent notification to appropriate agencies (July 30, 1999) informing officials of the presence of hazardous materials in excess of specific threshold planning quantities and of the current facility emergency coordinator.
EPCRA Section 304 Release Notification	Requires reporting of releases of certain hazardous substances over specified thresholds to state and local emergency planning committees and to the National Response Center.	There were no leaks, spills, or other releases of chemicals into the environment that required EPCRA Section 304 reporting during 1999.
EPCRA Sections 311-312 MSDSs and Chemical Inventories	Requires facilities to provide appropriate emergency response personnel with an annual inventory and other specific information for any hazardous materials present at the facility over specified thresholds.	The presence of 58 hazardous materials over specified quantities in 1999 required submittal of a hazardous chemical inventory to the state emergency response commission, the local emergency planning committee, and the Los Alamos County Fire Department.
EPCRA Section 313 Annual Releases	Requires all federal facilities to report total annual releases of listed toxic chemicals used in quantities above reportable thresholds.	Threshold quantities for nitric acid were exceeded in 1999 requiring submittal of a Toxic Chemical Release Inventory Reporting Form to the EPA.

Toxic Release Inventory Reporting. Title III, Section 313, of EPCRA, as modified by EO 12856, requires all federal facilities to report total annual releases of listed toxic chemicals. Nitric acid was the only Section 313-listed toxic chemical that was used in quantities above reportable thresholds in 1999. Approximately 13,000 lb of nitric acid were used for plutonium processing and an additional 2,518 lb were used in glassware cleaning and ion exchange. The 1999 Toxic Release Inventory reported air emissions between 10–100 lb of nitric acid resulting from these activities.

4. Emergency Planning under DOE Order 151.1

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 DOE Order 151.1, will be published in early 2000. 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 FY99, 1,162 employees received training as a result of Emergency Management Plan requirements and the Emergency Management and Response organization's internal training program.

5. Toxic Substances Control Act

Because the Laboratory's activities are research and development and do not involve making chemicals to sell, the polychlorinated biphenyls (PCB) regulations (40 CFR 761) have been the Laboratory's main concern under the TSCA. The PCB regulations govern substances including but 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 (SWS) Facility, and materials contaminated by spills.

In 1999, the Laboratory's Operations Working Group adopted a goal of having the Laboratory PCB-free, and efforts are continuing to reduce the Laboratory's inventory of PCB items. ESH-19 personnel are preparing an inventory of items containing PCB and looking for funding sources to replace existing serviceable items that contain PCB with new items that are PCB-free.

During 1999, the Laboratory had 15 off-site shipments of PCB waste. The quantities of waste disposed include 910 kg of capacitors; 550 kg of cleanup waste, 208 kg of laboratory waste; 500 kg of PCB-contaminated liquids; 282 kg of PCB oil; 101,420 kg of sludge, grit, and screening with PCB; 6,530 kg of fluorescent light ballasts; and 764 kg of PCB-contaminated soil.

The Laboratory manages all wastes in accordance with 40 CFR 761 manifesting, record keeping, and disposal requirements. PCB wastes are sent to EPA-permitted disposal and treatment facilities. Light ballasts are shipped off-site for recycling.

The Laboratory generated 0.46 m^3 of radioactively contaminated PCB solids in 1999. Nonliquid wastes containing PCB contaminated with radioactive constituents are disposed of at the Laboratory's EPA-authorized TSCA landfill located at TA-54, Area G. 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 Final Rule for the Disposal of PCB, dated August 28, 1998. No liquid radioactively contaminated PCB were disposed of on-site in 1999.

The primary compliance document related to 40 CFR 761.180 is the annual PCB report submitted to EPA, Region 6. EPA did not conduct an audit of the Laboratory's PCB management program during 1999.

6. 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 New Mexico Department of Agriculture (NMDA) has been granted the primary responsibility for pesticide enforcement under the FIFRA. The New Mexico Pesticide Control Act regulates private and public applicators, commercial and noncommercial applicators, pest management consultants, pesticide dealers, pesticide manufacturers, and all activities relating to the distribution and use of pesticides.

For the Laboratory, these regulations apply to the licensing and certification of pesticide applicators, record keeping, pesticide application, equipment inspection, pesticide storage, and disposal of pesticides.

NMDA did not conduct an inspection of the Laboratory's pesticide application program in 1999.

Amount of Pesticides Used during 1999.

TEMPO (insecticide)	1,600 grams
MAX FORCE (ant granules)	62 oz
FLOREL (growth retardant)	5 gal.
STINGER (wasp freeze)	50 oz
A2,4-D (herbicide)	4 gal.
TELAR (herbicide)	17 g
VELPAR L (herbicide)	11 gal.
MAKI (rodenticide)	46 oz
DICOT (fertilizer)	20 lb

7. Clean Air Act

NMED or the EPA regulates Laboratory operations and its air emissions. A complete description of air quality requirements applicable to the Laboratory is presented in the Air Quality Group's QA Project Plan for the Operating Permit Project, available at *http://www.esh.lanl.gov/~AirQuality/qa_airqual.htm*. A summary of the major aspects of the Laboratory's air quality compliance program is presented below.

a. New Mexico Air Quality Control Act. In December 1995, LANL submitted to NMED the Operating Permit application that Title V of the Clean Air Act (CAA) and Title 20 of the New Mexico Administrative Code, Chapter 2, Part 70–Operating Permits (20 NMAC 2.70) requires. NMED has not yet issued a permit. Meanwhile, LANL operates under the terms of its application. When issued, the permit will specify the operational terms and limitations imposed on LANL to continue to ensure that all federal and state air quality standards are being met. Because NMED is not scheduled to issue a permit for a couple of years, LANL began updating the application so that a current application will be available if NMED requests it. LANL updates the application as it adds new emission units and as the regulations change.

LANL is a major source under the Operating Permit program based on the potential to emit regulated air pollutants. Specifically, LANL is a major source of nitrogen oxides (NO_x), emitted primarily from the TA-3 steam plant boilers. However, LANL initiated a project to install flue gas recirculation equipment on the boilers to reduce the NO_x emissions by approximately 70%. Project implementation begins in 2000.

LANL reviews plans for new and modified projects, activities, and operations to identify all applicable air quality requirements including the need to revise the Operating Permit application, to apply for construction permits, or to submit notifications to NMED (20 NMAC 2.72). During 1999, over 300 air quality reviews were performed. One of these projects required a construction permit. However, six sources/activities (a new storage tank, relocation of generators, and new generators) were exempt from permitting but required written notification to NMED.

As part of the Operating Permit program, NMED collects fees (20 NMAC 2.71) from sources that are required to obtain an Operating Permit. For LANL, the fees are based on the allowable emissions from activities and operations as reported in the Operating Permit application. LANL's fees for 1999 were $13,017.50.

LANL reports regulated air pollutant emissions to NMED annually as required by 20 NMAC 2.73. Table 2-4 shows LANL's 1999 calculated air pollutant emissions reported to NMED for the annual emissions inventory based on actual production rates or fuel consumption rates. LANL reports for the following industrial-type sources: boilers, water pumps, and asphalt production. These industrial-type sources operated primarily on natural gas. However, the steam plant boilers at TA-3 and TA-21 use diesel as a backup. In addition, LANL reports emissions from a paper shredder, a degreaser, and a rock crusher and from beryllium-permitted activities. LANL calculates air emissions using emission factors from source tests, manufacturer data, and EPA documentation. Detailed analysis of chemical tracking and procurement records indicates that LANL procured approximately 20 tons of VOCs. For a conservative estimate of air emissions from R&D activities, we assumed that the total VOC quantity was emitted.

Combustion units were the primary source of criteria pollutants (NO_x, sulfur oxides [SO_x], particulate matter [PM], and carbon monoxide [CO] emissions) emitted at LANL. Of all combustion units, the TA-3 steam plant was the primary source of criteria pollutants. R&D activities were the primary source of VOC emissions. Additional information can be found in LA-13728-SR.

Table 2-4. Calculated Actual Emissions for Regulated Pollutants (Tons) Reported to NMED

Emission Units	Pollutants				
	PM	CO	NO_x	SO_x	VOC
Asphalt Plant	0.103	0.498	0.037	0.007	0.025
TA-3 Steam Plant	3.05	16.0	65.3	0.412	2.20
TA-16 Boilers	0.126	0.616	0.616	0.010	0.091
TA-21 Steam Plant	0.141	1.55	1.85	0.044	0.101
Water Pump	0.003	1.65	5.17	0.002	0.103
TA-48 Boilers	0.255	2.81	3.35	0.020	0.184
TA-53 Boilers	0.205	2.27	2.70	0.016	0.149
TA-55 Boilers	0.443	4.89	6.58	0.023	0.218
TA-59 Boilers	0.152	1.68	2.00	0.012	0.110
Degreaser	NA	NA	NA	NA	0.032
Paper Shredder	0.001	NA	NA	NA	NA
Rock Crusher	0	0	0	0	0
Total	4.48	32.0	87.6	0.546	3.21

NA = not applicable.

An assessment of the ambient impacts of air pollutant emissions, presented in the Site-Wide Environmental Impact Statement (SWEIS) for Los Alamos (DOE 1999), indicates that no adverse air quality impacts result from LANL's combustion and industrial-type sources. The actual amounts of air pollutant emissions generated in 1999 are less than the amounts for which the SWEIS analyzed impacts.

Figure 2-1 provides a comparison among recent emissions inventories reported to NMED with some noteworthy differences in the emissions from 1998 to 1999. Overall, LANL used more fuel in 1999. For example, the steam plant at TA-3 used 21% more natural gas and the steam plant at TA-21 used 27% more natural gas than in the previous year. In addition, emissions from diesel combustion at the two steam plants were reported for 1999 and not for 1998, because LANL used diesel as a Y2K preventative measure. Emission estimates, where appropriate, have been updated to reflect significant changes in EPA emission factors for natural gas combustion. The rock crusher was not operated in 1999. Therefore, there were no PM emissions from the crushing activities and no combustion products from the rock crusher diesel-fired engine.

The VOC emissions from R&D activities are 60% higher than in 1998. This evaluation does not necessarily indicate an increase in the amount of chemicals used. Other factors affecting this evaluation are the improved tools for chemical management and the availability of electronic data for the physical properties and chemical formulas. Air quality reports on the nonradionuclide air emissions are available at *http://www.esh.lanl.gov/~AirQuality/aqreports.htm* on the World Wide Web.

Smaller sources of air pollutant emissions, such as nonregulated boilers, emergency generators, space heaters, etc., are located throughout LANL. NMED considers them insignificant sources. These sources are not required to be and were not included in the annual emissions inventory.

An advantage of the Operating Permit will be the consolidation of all air quality requirements into one document for LANL. The following existing air quality programs/projects will be incorporated into the Operating Permit when it is issued.

Construction Permits. LANL currently operates under the air permits listed in Table 2-1. Table 2-5 summarizes allowable emissions from 20 NMAC 2.72 Construction Permits**.** In June, the Laboratory was issued a Construction Permit to operate an impact rock crusher to crush potentially radioactively contaminated concrete removed from buildings as part of the Laboratory's D&D efforts. However, the equipment was not operated in 1999.

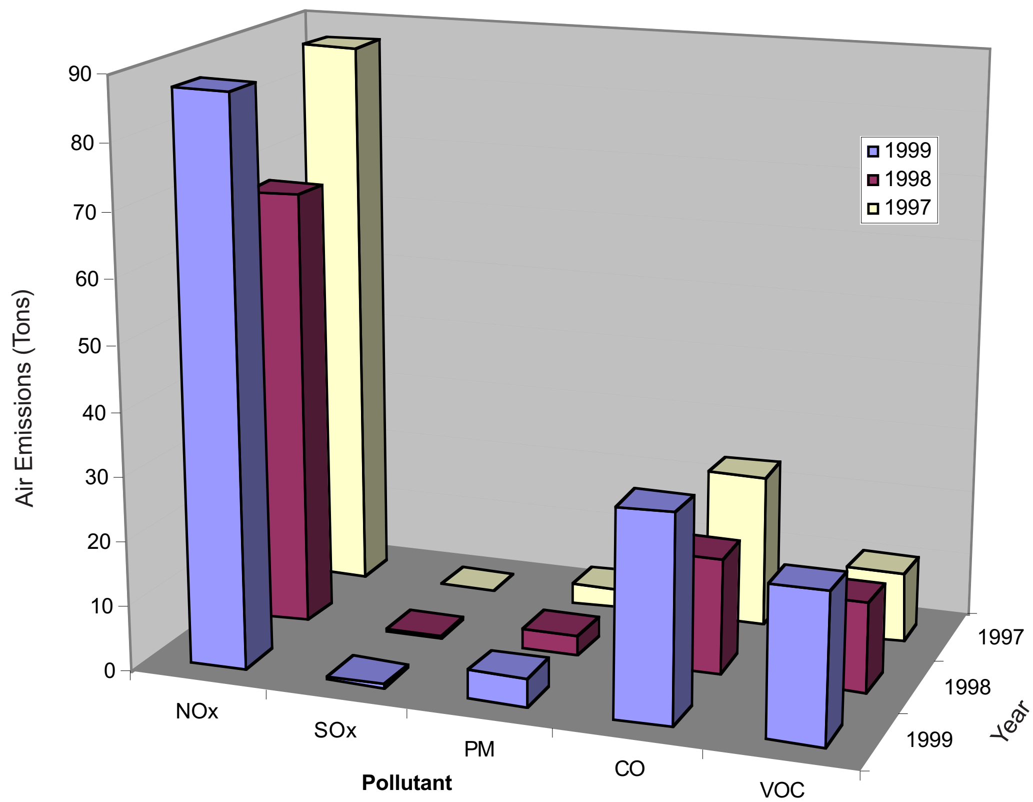

Figure 2-1. Emissions generated in 1997, 1998, and 1999.

Open Burning. LANL has an Open Burning permit (20 NMAC 2.60) for operational burns conducted for research projects. LANL also acquired two burn permits for prescribed burns as a preventive measure against wildfires. However, LANL conducted only one burn, which occurred in November 1999. Measured levels of suspended particulate matter in the size range of 10 microns or less (PM_{10}) met state and federal standards during the November burn.

Asbestos. The National Emission Standard for Hazardous Air Pollutants for Asbestos (Asbestos NESHAP) requires that LANL provide advance notice to NMED for large renovation jobs involving asbestos and of all demolition projects. The Asbestos NESHAP further requires that all activities involving asbestos be conducted in a manner that mitigates visible airborne emissions and that all asbestos-containing wastes be packaged and disposed of properly.

LANL continued to perform renovation and demolition projects in accordance with the requirements of the Asbestos NESHAP. These activities included four large renovation jobs and demolition projects for which NMED received advance notice. These larger projects and numerous smaller projects generated 76.6 m^3 of asbestos waste, which was not radioactively contaminated. All asbestos wastes were properly packaged and disposed at approved landfills.

To ensure compliance, the Laboratory conducted internal inspections of job sites and asbestos packaging approximately monthly. In addition, two inspections by NMED during the year identified no violations. The Air Quality Group's QA Project Plan for the Asbestos Report Project is available at *http://www.esh.lanl.gov/~AirQuality/qa_airqual.htm* on the World Wide Web.

b. Federal Clean Air Act. All of the federal air quality requirements, with a couple of exceptions, have been adopted by the State of New Mexico as part of its State Implementation Plan and have been summarized in the previous section. The exceptions are the Stratospheric Ozone Protection, the NESHAP for Radionuclides, and one newly mandated program under the CAA.

Ozone-Depleting Substances. Title VI of the CAA contains specific sections establishing regulations and requirements for ozone-depleting substances (ODS) such as halons and refrigerants. The sections

Table 2-5. Allowable Air Emissions (20 NMAC 2.72)

Source	Regulated Pollutant	Allowable Emissions
Beryllium Machining at TA-3-39	Beryllium	0.008 lb/yr
	Beryllium	4.0E-06 lb/hr
Beryllium Machining at TA-3-102	Beryllium	0.00014 lb/yr
	Beryllium	4.0E-07 lb/hr
Beryllium Machining at TA-3-141	Beryllium	0.0004 lb/yr
	Beryllium	3.0E-06 lb/hr
Beryllium Machining at TA-35-213	Beryllium	0.0008 lb/yr
	Beryllium	4.0E-07 lb/hr
Beryllium Cutting and Bead Dressing at TA-55-4	Beryllium	0.0041 lb/yr
	Beryllium	1.0E-05 lb/hr
	Aluminum	0.0042 lb/yr
	Aluminum	1.0E-05 lb/hr
Beryllium Metallography at TA-55-4	Beryllium	0.0030 lb/yr
	Beryllium	2.0E-06 lb/hr
Rock Crusher	Particulate Matter	Limited[a]
	Nitrogen Dioxide	6.4 tons/yr
	Nitrogen Dioxide	6.2 lb/hr
	Carbon Monoxide	1.4 tons/yr
	Carbon Monoxide	1.3 lb/hr
	Volatile Organic Compounds	0.5 tons/yr
	Volatile Organic Compounds	0.5 lb/hr
	Sulfur Dioxide	0.4 tons/yr
	Sulfur Dioxide	0.4 lb/hr

[a] Fugitive particulate matter emissions from transfer points, belt conveyors, screens, feed bins, and from stockpiles shall not exhibit greater than 10% opacity. Fugitive particulate matter emissions from the rock crusher shall not exhibit greater than 15% opacity. Opacity is the degree to which emissions reduce the transmission of light and obscure the view of a background object.

applicable to LANL include Section 608, National Recycling and Emission Reduction Program, and Section 609, Servicing of Motor Vehicle Air Conditioners. Section 608 prohibits individuals from knowingly venting ODS into the atmosphere during maintenance, repair, service, or disposal of halon fire-suppression systems and air conditioning or refrigeration equipment. It also requires technician certification and the use of certified recovery equipment. Section 609 includes standards and requirements for recycling equipment that services motor vehicle air conditioners and for training and certifying maintenance and repair technicians. LANL contracts with Johnson Controls Northern New Mexico (JCNNM) and other vendors to maintain, service, repair, and dispose of halon fire-suppression systems and air conditioning and refrigeration equipment. LANL contracts automotive repair work, including motor vehicle air-conditioning work, to qualified local automotive repair shops.

Radionuclides. Under the National Emission Standard for Hazardous Air Pollutants for Radionuclides (Rad NESHAP), EPA limits the effective dose equivalent (EDE) to any member of the public from radioactive airborne releases from a DOE facility, such as LANL, to 10 mrem/yr. The 1999 EDE (as calculated using EPA-approved methods) was 0.32 mrem. Because the Los Alamos Neutron Science Center did not operate in 1999, the dose was from a number of smaller sources. The Air Quality Group's QA Project Plan for the Rad/NESHAP Compliance Project is available at *http://www.esh.lanl.gov/~AirQuality/qa_airqual.htm* on the World Wide Web. In addition, air quality reports on the radionuclide air emissions are available at *http://www.esh.lanl.gov/~AirQuality/aqreports.htm* on the World Wide Web.

LANL reviews plans for new and modified projects, activities, and operations to identify the need for emissions monitoring or prior approval from EPA. During 1999, approximately 150 reviews involved the evaluation of air quality requirements associated with the use of radioactive materials. None of these projects required EPA prior approval.

In 1999, independent auditors completed a report of LANL's 1996 compliance status. The independent audit, which was initiated in 1997, found that the Laboratory was not in compliance with certain regulatory and technical requirements of the CAA in 1996. It is important to note, however, that the audit report recognized that it is very unlikely that LANL exceeded the 10 mrem/yr dose standard. Section 2.D., Consent Decree, provides more information.

Risk Management Program. In 1990, Congress amended the CAA by adding Section 112(r), Prevention of Accidental Releases. Section 112(r) required EPA to establish a risk management program (RMP) to prevent accidental releases of flammable and toxic substances to the environment and to minimize the consequences of a release. EPA established the requirements for the RMP in 40 CFR 68. Facilities that are subject to the RMP were required to register with EPA and submit a facility-specific risk management plan by June 21, 1999. The 112(r) program provides lists of toxic and flammable substances with their associated Threshold Quantities (TQs). Any process or storage facility that uses any listed substance in quantities exceeding its TQ is subject to EPA's RMP. Under the 112(r) program, the threshold determinations are based on the quantity of substance present at a particular location or in a particular process at any point in time (i.e., what is the potential for release during an accident) and not on cumulative usage.

LANL did not exceed any TQ between the effective date (June 21, 1999) and the end of the year and, therefore, was not subject to the RMP and was not required to register with EPA. LANL will continue to evaluate chemical procurements and new sources and to track known processes containing regulated substances to determine any change in the applicability status of the RMP.

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. 1251 *et seq.*) is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The act established the requirements for National Pollutant Discharge Elimination System (NPDES) permits for 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.

UC and DOE are co-permittees of the NPDES permit covering Laboratory operations. EPA Region 6 in Dallas, Texas, issues and enforces the permit. However, NMED certifies the EPA-issued permit and performs some compliance evaluation inspections and monitoring for EPA through a Section 106 water quality grant.

The current Laboratory NPDES Permit, No. NM0028355, expired October 31, 1998, but EPA has administratively continued it until a new permit is issued. As required by the NPDES regulations, on May 4, 1998, 180 days before permit expiration, the Laboratory submitted an application to EPA for renewal of the NPDES permit. Each year, the number of permitted outfalls at the Laboratory is decreasing in response to the success of the Waste Stream Characterization Program and Corrections Project and the NPDES Outfall Reduction Program. As of January 1, 1999, the Laboratory's NPDES permit had 36 outfalls, which included one sanitary outfall and 35 industrial outfalls. By December 31, 1999, 16 industrial outfalls had been eliminated, bringing the total number of NPDES-permitted outfalls to 20. The Laboratory achieved this reduction in outfalls by removing process flows for seven industrial outfalls and completing the lease transfer of the drinking water system, including nine associated outfalls, to Los Alamos County. Future activities are planned to further reduce the number of permitted outfalls at the Laboratory. Ten additional outfalls are currently targeted for elimination. These include NPDES Outfalls 051, 02A129, 03A024, 03A027, 03A047, 03A048, 03A130, 03A158, 031028, and 05A097. Completing equipment upgrades to treatment facilities, decontamination and decommissioning of nonessential facilities, combining of process flows, installation of closed loop cooling systems, containerization of wastewater, and removal of experimental processes will eliminate these outfalls. Additionally, long-term objectives of the NPDES Outfall Reduction Program will require that outfall owners evaluate outfalls for continued operation and that new construction designs and modifications to existing facilities provide for reduced or no-flow effluent discharge systems.

Under the Laboratory's NPDES outfall permit, samples for effluent quality limits are collected for analysis weekly, monthly, and quarterly depending on the outfall category. Water quality samples are collected for analysis annually at all outfalls. The Laboratory reports results to EPA and NMED at the end of the monitoring period for each respective outfall category. During 1999, 16 of the 1,250 samples collected from the industrial outfalls exceeded effluent limits (see Table 2-6). No effluent limit exceedances occurred in the 175 samples collected from the SWS Facility Outfall 13S. See Table A-4 for a summary of these outfalls and a listing of the permit's monitoring limits.

Table 2-6 presents the exceedances of the water quality parameters for sanitary and industrial outfalls during 1999. The following is a summary of the corrective actions the Laboratory took during 1999 to address the effluent-limit exceedances.

TA-53, Low-Energy Demonstration Accelerator (LEDA) Cooling Tower (NPDES Outfall 03A113). On January 22, 1999, the chlorine (Cl_2) concentrations exceeded the NPDES average and

Table 2-6. National Pollutant Discharge Elimination System Permit Monitoring of Effluent Quality and Water Quality Parameters at Industrial Outfalls: Exceedances during 1999[a]

EPA ID	Technical Area	Date	Parameter		Results/Limits	
January						
03A113	TA-53-952 (LEDA)	01/22/99	Cl_2[b]	(daily max.)	6.1/0.5	mg/l
03A113	TA-53-952 (LEDA)	11/01/98–11/31/99	Cl_2	(daily avg.)	3.1/0.2	mg/l
March						
051	TA-50-1	03/15/99	TSS[c]	(daily max.)	78.3/62.6	lbs/day
051	TA-50-1	03/29/99	TSS	(daily max.)	81.2/62.6	lbs/day
051	TA-50-1	03/1/99–03/31/99	TSS	(daily avg.)	33.0/18.8	lbs/day
May						
129	TA-21-357	05/14/99	P	(daily max.)	45/40	mg/l
129	TA-21-357	05/1/99–07/31/99	P	(daily avg.)	21/20	mg/l
June						
051	TA-50-1	06/01/99–06/30/99	Zn	(daily avg.)	0.66/0.62	lbs/day
173	Guaje Well #2	06/03/99	Al	(daily avg.) - *WQP	5.2/5.0	mg/l
173	Guaje Well #2	06/03/99	Al	(daily max.) - *WQP	5.2/5.0	mg/l
July						
051	TA-50-1	07/06/99	Zn	(daily max.)	3.43/1.83	lbs/day
051	TA-50-1	07/01/99–07/31/99	Zn	(daily avg.)	1.10/0.62	lbs/day
August						
051	TA-50-1	08/02/99	Zn	(daily max.)	2.10/1.83	lbs/day
051	TA-50-1	08/01/99–08/31/99	Zn	(daily avg.)	0.66/0.62	lbs/day
October						
051	TA-50-1	10/14/99	Zn	(daily max.)	2.28/1.83	lbs/day
051	TA-50-1	10/01/99–10/31/99	Zn	(daily avg.)	0.86/0.62	lbs/day

*Water Quality Parameter

Note: During February, April, September, November, and December, there were no NPDES exceedances.

[a] Effluent quality limits are presented in Table A-5; water quality parameters are presented in Table A-6.
[b] Chlorine.
[c] Total Suspended Solids.

maximum permit limits at NPDES Outfall 03A113 at the TA-53-LEDA cooling tower. On the day of the exceedance, craft workers were scheduled to perform work inside the new LEDA cooling tower at TA-53. A leaking solenoid valve deposited treated water into the empty basin where the work was to be performed. To avoid delays in the scheduled work, a TA-53 employee drained the water in the basin, which discharged directly through the outfall. Because the wastewater was discharged without going through the neutralization process, a chlorine exceedance occurred. The cooling tower maintenance crew was notified of the condition as soon as the elevated Cl_2 concentrations were discovered. The leaking solenoid was valved off, and site operators worked with the manufacturer to repair it. A repeat compliance sample collected on January 25, 1999, documented the Cl_2 level of 0.0 mg/l. As a result of this incident, and other site-wide safety concerns, operations at TA-53 were shut down. Operations restart procedures included a review of the Operation and Maintenance (O&M) Procedures and equipment for cooling towers. The review revealed that the equipment and O&M procedures were not consistent. Facility Management personnel updated the O&M procedures and along with craft workers, received training in the new procedure. Additionally, personnel at TA-53 now conduct routine inspections to detect mechanical deficiencies, and corrective actions are implemented when they discover any defects.

TA-50, Building 1 (NPDES Outfall 051). On March 15, 1999, and March 29, 1999, the total suspended solids (TSS) concentrations exceeded the NPDES average and maximum permit limits at the NPDES Outfall 051 at the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF). Radioactive Liquid Waste Group (FWO-RLW) personnel conducted an investigation into the occurrence. FWO-RLW reviewed the TA-50 RLWTF's operational sampling data and records for March 15, 1999, and March 29, 1999, but did not find any off-normal conditions. On April 6, 1999, the Occurrence Investigation Group (ESH-7), ESH-18, EM-FWO, and DOE/LAAO personnel discussed the findings of the investigations and corrective actions at an occurrence investigation meeting. The collection of operational samples for TSS and other NPDES analytes occurs after the gravity filters and before discharge into one of two effluent holding tanks. The pH adjustment that occurs in the effluent holding tank(s) may have caused calcium carbonate to precipitate out of solution. The calcium carbonate may have caused the TSS to exceed NPDES effluent limits. FWO-RLW personnel conducted additional bench studies to evaluate pH adjustment effects on TSS levels in the effluent tank(s). Operational samples collected at the facility were below effluent limits before discharge. Additionally, facility operators relocated the operational sampling point to the effluent tank.

TA-21-357 (NPDES Outfall 02A129). On May 14, 1999, the total phosphorus (P) concentration exceeded the average and maximum NPDES permit limits at Outfall 02A129 at TA-21-357. However, reanalysis of the sample resulted in a lower phosphorus concentration that was within permit limits. An investigation indicated that the original high analytical reading was most likely a result of spot contamination in the digestion tube during analyses. Because the first sample was the only one that met all NPDES quality assurance/quality control requirements, the first analytical result exceeding the average and maximum permit limit was reported.

Guaje Well #2 (NPDES Outfall 04A173). On June 3, 1999, the aluminum concentrations exceeded the NPDES average and maximum permit limits at NPDES Outfall 04A173, associated with Guaje Well #2. As of September 1998, the water supply system is operated by the County of Los Alamos and owned by DOE, under a lease agreement. The Laboratory deleted this outfall from its NPDES Permit on September 21, 1999. In addition, the County of Los Alamos demolished this outfall on August 6, 1999.

TA-50, Building 1 (NPDES Outfall 051). On June 21, 1999, July 6, 1999, August 2, 1999, and October 14, 1999, the TA-50 RLWTF exceeded the average and/or maximum permit loading limits at NPDES Outfall 051 for total zinc (Zn). These zinc exceedances were a result of the new chemical denitrification treatment process that TA-50 RLWTF implemented to make the treatment plant effluent meet DOE Derived Concentration Guidelines and New Mexico groundwater standards for nitrate. This treatment process uses zinc. The TA-50 RLWTF also uses tubular ultrafiltration (TUF) and reverse osmosis (R/O) treatment units to meet NPDES permit limits. The reject wastewater from the R/O units currently is blended back into the headworks of the TA-50 RLWTF. As a result, zinc is continually recirculated through the TA-50 RLWTF and concentrated in the R/O wastewater.

After the zinc exceedances on June 21, 1999, July 6, 1999, and August 2, 1999, the clarifiers at TA-50 RLWTF were put back online on August 10, 1999, to precipitate out the residual zinc. These clarifiers were taken offline when the membrane treatment train (TUF/centrifugal ultrafilter/reverse osmosis) went into service. This measure was not sufficient; therefore, the last discharge of chemical denitrification unit effluent to the headworks occurred during the first week of November 1999. No further zinc-laden wastes from this treatment unit will be introduced into the TA-50 RLWTF headworks until another corrective measure has been identified to handle the zinc. Additionally, on November 16, 1999, facility operators implemented operational sampling to test for zinc before discharge from the effluent tanks. In the future, routine treatment of radioactive liquid wastewater will include the membrane treatment train and the clariflocculator treatment process.

In addition to the corrective actions noted, additional measures implemented to prevent noncompliances include performing operational sampling before discharge at outfalls, developing wastewater disposal policy with Waste Acceptance Criteria for treatment facilities, refining waste characterization and profiling processes, and using alternative wastewater disposal practices such as land application for dust suppression or re-use in cooling tower systems.

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

During 1999, the SWS Facility generated approximately 31.6 dry tons (63,200 dry lb) of sewage sludge. All of this sludge was, or will be, disposed of as 50–499 ppm PCB-contaminated waste at a TSCA-permitted landfill.

c. National Pollutant Discharge Elimination System Permit Compliance Evaluation Inspection. The NMED did not conduct a NPDES Outfall Compliance Evaluation Inspection during 1999.

d. National Pollutant Discharge Elimination System Storm Water Program. The NPDES permit program also regulates storm water discharges from certain activities. During 1999, the Laboratory had seven NPDES permits for its storm water discharges (see Table 2-1). Under the EPA Region 6 NPDES Storm Water Construction permit six projects were permitted: DARHT, Guaje Well Improvements Project, the Fire Protection Improvements Project, the Strategic Computing Complex (SCC), the Norton Power Line Project, and the TA-9-15 Gas Pipeline Replacement Project.

UC and DOE are co-permittees under the NPDES Multi-Sector General Permit for the Laboratory. The Multi-Sector General Permit regulates storm water discharges from the following industrial activities: 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; steam and electric power generating facilities; asphalt batch plant operations and metal fabrication activities; vehicle maintenance activities; primary metal activities; and chemical manufacturing activities.

The Multi-Sector General Permit is the second general permit published by EPA that regulates storm water discharges from industrial activities. This permit expires in September of 2000, and EPA has proposed a third general permit for these activities.

As with the Baseline General Permit, the Multi-Sector General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan. During 1999, the Laboratory developed and implemented 22 Storm Water Pollution Prevention Plans for its industrial activities.

The Multi-Sector General Permit requires monitoring of the storm water discharges from all industrial activities. The Laboratory collected approximately 74 samples for the three monitoring quarters during 1999 and will submit this monitoring data to EPA in the form of a Discharge Monitoring Report (DMR) before March 31, 2000.

To meet the monitoring requirements of the Multi-Sector General Permit, the Laboratory is operating 54 stream monitoring and partial record storm water monitoring stations on the canyons entering and leaving the Laboratory, at the confluence of these major canyons, and in certain segments of these canyons and at a number of facilities. The discharge information for 1999 is reported in "Surface Water Data at Los Alamos National Laboratory: 1999 Water Year" (Shaull et al., 2000).

e. National Pollutant Discharge Elimination System Storm Water Program Inspection. On July 12, 1999, EPA Region 6 and NMED conducted a compliance inspection of the Laboratory's Storm Water Program. Deficiencies noted during the inspection are being corrected.

f. Spill Prevention Control and Countermeasures Program. The Laboratory's Spill Prevention Control and Countermeasures (SPCC) Plans, as required by the CWA in accordance with 40 CFR 112, are comprehensive plans developed to meet the EPA requirements that regulate water pollution from oil spills. The Laboratory has SPCC Plans for the 28 aboveground oil storage tanks that operated during 1999.

g. Dredge and Fill Permit Program. Section 404 of the CWA requires the Laboratory to obtain permits from the Army Corps of Engineers (the Corps) to perform work within perennial, intermittent, or ephemeral watercourses. Projects involving excavation or fill below the normal high-water mark must be conducted with attention to 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 to protect water quality. Section 401 of the CWA requires states to certify that 404 permits the Corps issued will not prevent attainment of state-mandated stream standards. NMED reviews Section 404/401 joint 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 had 19 nationwide permits under the Sections 404/401 program during 1999. Projects permitted include utility lines, road crossings, headwaters and isolated waters, and wetland/riparian areas.

9. Safe Drinking Water Act

a. Introduction. On September 8, 1998, DOE transferred operation of the Los Alamos Water Supply System from the Laboratory to Los Alamos County under a lease agreement. Under this agreement, the Laboratory retained responsibility for operating the distribution system within the Laboratory's boundaries, whereas the county assumed full responsibility for operating the water system including ensuring compliance with the requirements of the Safe Drinking Water Act (SDWA) (40 CFR 141) and the New Mexico Drinking Water Regulations (NMEIB 1995). Under the SDWA, Los Alamos County is required to collect samples from various points in the Laboratory's, Los Alamos County's, and Bandelier National Monument's water distribution systems and from the water supply wellheads to demonstrate compliance with SDWA maximum contaminant levels (MCLs). The EPA has established MCLs for microbiological organisms, organic and inorganic constituents, and radioactivity in drinking water. The state has adopted these standards and has included them in the NMEIB. The EPA has authorized NMED to administer and enforce federal drinking water regulations and standards in New Mexico.

During 1999, the Laboratory sampled all of the water supply wells in operation at the time of sampling for quality assurance purposes. The Laboratory's monitoring results are not for SDWA compliance purposes; Los Alamos County's SDWA sampling program determines SDWA compliance. This report presents the results from both the quality assurance monitoring the Laboratory conducted and the SDWA compliance monitoring Los Alamos County conducted.

In 1999, the monitoring network for Los Alamos County's SDWA compliance sampling program consisted of the following four location groups:

(1) wellhead sampling from the water supply wells in operation at the time of sampling (Guaje wells G1A, G2A, G3A, G4A, and G5A; Pajarito Mesa wells PM1, PM2, PM5; and Otowi well O4);

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

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

(4) the 29 residential lead and copper sampling sites located in White Rock and the Los Alamos townsite.

Staff from NMED's Drinking Water Bureau performed all chemical and radiological sampling for Los Alamos County with the exception of TTHM and lead/copper sample collection, which JCNNM and Los Alamos County staff conducted. The New Mexico Health Department's Scientific Laboratory Division in Albuquerque and the Soil and Water Testing Laboratory in Las Cruces received samples for analysis. The JCNNM Health and Environmental (HENV) laboratory performs microbiological sampling and analysis. NMED has certified the HENV laboratory for microbiological compliance analysis. Certification requirements include proficiency samples, maintenance of an approved quality assurance/quality control program, and periodic NMED audits.

In 1999, the Laboratory's monitoring network for quality assurance sampling consisted of the following location group: wellhead sampling from the eight water supply wells in operation at the time of sampling (Guaje wells G1A, G2A, G3A, G4A; Pajarito Mesa wells PM1, PM2, PM5; and Otowi well O4). The Laboratory's quality assurance drinking water program provides additional assurance during the transition period following transfer of the water system to Los Alamos County. Sampling locations, frequencies, preservation, handling, and analyses follow the requirements specified in federal and state regulations. Laboratory staff performed chemical and radiological sampling and submitted the samples for analysis to the New Mexico Health Department's Scientific Laboratory Division in Albuquerque. NMED has certified laboratory staff to perform drinking water sampling. ESH-18 maintains both electronic and hard copy files of all data collected from quality assurance testing.

b. Radiochemical Analytical Results. In 1999, Los Alamos County collected drinking water samples from four water supply wells to determine the radiological quality of the drinking water. As shown in Table 2-7, the concentrations of gross alpha and gross beta activity were less than the EPA screening levels. When gross alpha and beta activity measurements are below the screening levels, Los Alamos County does not need to perform further isotopic analyses or perform dose calculations under the SDWA program. However, it should be noted that ESH-18 also conducts comprehensive monitoring of the water supply wells for radiochemical constituents (see Table 5-16).

Radon is a naturally occurring radionuclide produced during the decay of geological sources of uranium. In 1999, Los Alamos County conducted radon sampling at the five water supply wells in the Guaje well field. As shown in Table 2-8, the concentrations ranged from 224 to 576 pCi of radon per liter of water. On August 6, 1996, EPA withdrew the proposed MCL of 300 pCi of radon per liter of water. In August 1999, the EPA issued a new proposed rule for radon that sets the following regulatory standards for radon: an MCL of 300 pCi/L and an Alternative Maximum Contaminant Level (AMCL) of 4,000 pCi/L. The AMCL applies to those states that implement an EPA-approved Multi-Media Mitigation

Table 2-7. Radioactivity in Drinking Water (pCi/L) during 1999 by LANL

	Gross Alpha			Gross Beta		
Sample Location	**Calibration Std.**	**Value**	**(Uncertainty)**	**Calibration Std.**	**Value**	**(Uncertainty)**
Wellheads:						
Pajarito Well-PM1	^{241}Am	1.0	(0.4)	^{137}Cs	3.6	(0.9)
	Natural U	1.3	(0.5)	^{90}Sr, ^{90}Y	3.4	(0.8)
Pajarito Well-PM2	^{241}Am	0.5	(0.3)	^{137}Cs	1.7	(0.8)
	Natural U	0.6	(0.4)	^{90}Sr, ^{90}Y	1.7	(0.8)
Pajarito Well-PM5	^{241}Am	0.8	(0.4)	^{137}Cs	2.7	(0.9)
	Natural U	1.0	(0.5)	^{90}Sr, ^{90}Y	2.6	(0.9)
Guaje Well-G1A	^{241}Am	0.2	(0.3)	^{137}Cs	3.3	(0.9)
	Natural U	0.3	(0.4)	^{90}Sr, ^{90}Y	3.2	(0.8)
Guaje Well-G2A	^{241}Am	0.2	(0.3)	^{137}Cs	2.5	(0.8)
	Natural U	0.3	(0.4)	^{90}Sr, ^{90}Y	2.4	(0.8)
Guaje Well-G3A	^{241}Am	0.7	(0.3)	^{137}Cs	1.0	(0.8)
	Natural U	0.9	(0.4)	^{90}Sr, ^{90}Y	0.9	(0.8)
Guaje Well-G4A	^{241}Am	1.0	(0.3)	^{137}Cs	1.2	(0.8)
	Natural U	1.2	(0.4)	^{90}Sr, ^{90}Y	1.1	(0.8)
Otowi Well-O4	^{241}Am	1.2	(0.5)	^{137}Cs	3.1	(1.0)
	Natural U	1.4	(0.7)	^{90}Sr, ^{90}Y	3.0	(1.0)
EPA Maximum Contaminant Level		15			NA	
EPA Screening Level		5			50	

Table 2-8. Compliance Radon in Drinking Water (pCi/L) during 1999 by LA County

Sample Location	Value	(Uncertainty)[a]
Wellheads:		
Guaje Well Field-G1A	301	(20)
Guaje Well Field-G2A	345	(22)
Guaje Well Field-G3A	224	(17)
Guaje Well Field-G4A	576	(33)
Guaje Well Field-G5A	352	(23)
Proposed EPA Maximum Contaminant Level	300	

[a]Uncertainties are expressed as one standard deviation.

(MMM) program for reducing radon levels in indoor air. The State of New Mexico has announced that it intends to develop an MMM program. The EPA plans to publish the final rule by August 2000.

In 1999, the Laboratory collected quality assurance drinking water samples at eight water supply wells to determine the radiological quality of the drinking water. As shown in Table 2-9, the concentrations of gross alpha and gross beta activity were less than the EPA screening levels.

c. Nonradiological Analytical Results. In 1999, Los Alamos County collected TTHM samples during each quarter from six locations in the Laboratory and Los Alamos County water distribution systems. As shown in Table 2-10, the annual average for samples in 1999 was 5.2 µg of TTHM per liter of water, less than the SDWA MCL of 100 µg of TTHM per liter of water. In 1999, Los Alamos County collected samples for inorganic constituents in drinking water at the nine water supply wells in operation at the time of sampling. As shown in Table 2-11, all inorganic constituents at all locations were less than the SDWA MCLs.

In 1999, Los Alamos County collected VOC samples from the nine water supply wells in operation at the time of sampling. As shown Table 2-12, no VOCs were detected at any of the sampling locations with the exception of chloroform in the following wells: G2A (0.20 µg/L), G3A (1.20 µg/L), and G5A (0.20 µg/L). The SDWA 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 the chloroform found in the samples was the chlorine used in disinfecting the wells. LANL's quality assurance sampling of wells G2A and G3A in November 1999 did not detect chloroform in the samples at concentrations greater than the analytical laboratory's sample detection limit.

In 1999, Los Alamos County collected lead and copper samples at residential drinking water taps. Under the SDWA, if more than 10% of the samples collected from selected residential sites exceed the action levels for lead or copper, then the water supplier must take prescribed actions to monitor and control the corrosivity of the water supplied to customers. Additionally, if 90% of the sample sites are below the action levels for lead and copper, then the water system is in compliance without the need to implement corrosion controls. As shown in Table 2-13, all 29 samples collected during 1999 were below EPA action levels for lead and copper. The Los Alamos Water Supply System was in compliance with the SDWA regulations for lead and copper in drinking water during 1999.

In 1999, Los Alamos County collected synthetic organic compound (SOC) samples from the following seven water supply wells in operation at the time of sampling: PM1, PM2, PM5, O4, G2A, G4A, and G5A. No SOCs were detected at any of the sampling locations at concentrations greater than the analytical laboratory's sample detection limit.

In 1999, LANL collected quality assurance samples for inorganic constituents in drinking water at the eight water supply wells in operation at the time of sampling. As shown in Table 2-14, all inorganic constituents at all locations were less than the SDWA MCLs.

In 1999, LANL collected quality assurance VOC samples from the eight water supply wells in opera-

Table 2-9. Compliance Radioactivity in Drinking Water (pCi/L) during 1999 by LA County

	Gross Alpha			Gross Beta		
Sample Location	**Calibration Std.**	**Value**	**(Uncertainty)[a]**	**Calibration Std.**	**Value**	**(Uncertainty)[a]**
Entry Points:						
Pajarito Well Field-PM2	^{241}Am	–0.20	(0.20)	^{137}Cs	2.50	(0.80)
	Natural U	–0.20	(0.30)	^{90}Sr, ^{90}Y	2.40	(0.80)
Pajarito Well Field-PM5	^{241}Am	–0.20	(0.30)	^{137}Cs	2.60	(0.80)
	Natural U	–0.20	(0.30)	^{90}Sr, ^{90}Y	2.50	(0.70)
Otowi Well Field-O4	^{241}Am	0.50	(0.40)	^{137}Cs	5.10	(0.80)
	Natural U	0.60	(0.50)	^{90}Sr, ^{90}Y	5.00	(0.80)
Guaje Well Field-G4A	^{241}Am	1.00	(0.60)	^{137}Cs	3.90	(0.80)
	Natural U	1.20	(0.80)	^{90}Sr, ^{90}Y	3.80	(0.80)
EPA Maximum Contaminant Level		15			NA	
EPA Screening Level		5			50	

[a]Uncertainties are expressed as one standard deviation.

Table 2-10. Compliance Total Trihalomethanes in Drinking Water (μg/L) during 1999 by LA County

	1999 Quarters			
Sample Location	**First**	**Second**	**Third**	**Fourth**
Distribution Sites:				
Los Alamos Airport	5.2	7.9	8.8	4.4
White Rock Fire Station	<0.5	1.3	<0.5	<0.5
North Community Fire Station	1.7	2.1	9.5	2.8
S-Site Fire Station	2.1	3.5	5.2	2.9
Barranca Mesa School	1.5	1.5	0.6	1.3
TA-39, Bldg. 02	13.2	13.5	19.5	15.2
1999 Average of 5.2 μg/L				
EPA Maximum Contaminant Level			100.0	
Sample Detection Limit			0.5	

Table 2-11. Compliance Inorganic Constituents in Drinking Water (mg/L) during 1999 by LA County

Sample Location	As	Ba	Be	Cd	Cr	F	CN	Hg	Ni	NO_3 (as N)	Se	Sb	Tl	SO_4
Wellheads:														
Pajarito Well Field-PM1	0.001	<0.1	<0.001	<0.001	0.003			<0.0002	<0.01	0.48	<0.005	<0.001	<0.001	
Pajarito Well Field-PM2	<0.001	<0.1	<0.001	<0.001	0.003			<0.0002	<0.01	0.33	<0.005	<0.001	<0.001	
Pajarito Well Field-PM5	0.001	<0.1	<0.001	<0.001	0.004			<0.0002	<0.01	0.30	<0.005	<0.001	<0.001	
Otowi Well Field-O4	0.002	<0.1	<0.001	<0.001	0.003			<0.0002	<0.01	0.38	<0.005	<0.001	<0.001	
Guaje Well Field-G1A	0.004	<0.1	<0.001	<0.001	<0.001	0.42	<0.1	<0.0002	<0.01	0.41	<0.005	<0.001	<0.001	<10
Guaje Well Field-G2A	0.010	<0.1	<0.001	<0.001	0.004	0.36	<0.1	<0.0002	<0.01	0.40	<0.005	<0.001	<0.001	<10
Guaje Well Field-G3A	0.005	<0.1	<0.001	<0.001	<0.001	0.32	<0.1	<0.0002	<0.01	0.52	<0.005	<0.001	<0.001	<10
Guaje Well Field-G4A	0.002	<0.1	<0.001	<0.001	0.002			<0.0002	<0.01		<0.005	<0.001	<0.001	
Guaje Well Field-G5A	0.003	<0.1	<0.001	<0.001	0.003	0.29	<0.1	<0.0002	<0.01	0.40	<0.005	<0.001	<0.001	<10
EPA MCLs	0.05	2.0	0.004	0.005	0.10	4.0	0.20	0.002	0.1	10.0	0.05	0.006	0.002	

Table 2-12. Compliance Volatile Organic Constituents in Drinking Water (µg/L) during 1999 by LA County

Sample Location	VOC Group I 62 Compounds
Entry Points:	
Pajarito Well Field-PM1	U
Pajarito Well Field-PM2	U
Pajarito Well Field-PM5	U
Otowi Well Field-O4	U
Guaje Well Field-G1A	U
Guaje Well Field-G2A	0.20 µg/L Chloroform
Guaje Well Field-G3A	1.20 µg/L Chloroform
Guaje Well Field-G4A	U
Guaje Well Field-G5A	0.20 µg/L Chloroform

U = None detected above the Sample Detection Limit (SDL).

tion at the time of sampling. No VOCs were detected at any of the sampling locations at concentrations greater than the analytical laboratory's sample detection limit.

d. Microbiological Analyses of Drinking Water. Each month during 1999, Los Alamos County collected an average of 46 samples from the Laboratory's, Los Alamos County's, 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 555 samples analyzed during 1999, none indicated the presence of total or fecal coliforms. Noncoliform bacteria were present in 38 of the microbiological samples. Noncoliform bacteria are not regulated, but their repeated presence in samples may serve as an indicator of stagnation and biofilm growth in water pipes. Table 2-15 presents a summary of the monthly analytical data.

e. Long-Term Trends. The Los Alamos water system has never incurred a violation for an SDWA-regulated chemical or radiological contaminant. The water supply wells have, on occasion, exceeded the proposed SDWA MCL for radon because of its natural occurrence in the main aquifer.

f. Drinking Water Inspection. The NMED did not conduct an inspection of the drinking water system during 1999.

10. Groundwater

a. Groundwater Protection Compliance Issues. Groundwater monitoring and protection efforts at the Laboratory have evolved from programs initiated by the US Geological Survey in the 1940s 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 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.

Task III of Module VIII of the RCRA Hazardous Waste Facility Permit, the HSWA Module, requires the Laboratory to collect information regarding the environmental setting at the facility and to collect data on groundwater contamination. Task III, Section A.1, requires the Laboratory to conduct a program to evaluate hydrogeologic conditions. Task III, Section C.1, requires the Laboratory to conduct a groundwater investigation to characterize any contamination at the facility.

Table 2-13. Compliance Lead and Copper in Drinking Water at Residential Taps during 1999 by LA County

Values	Lead	Copper
Values less than or equal to Detection Limit	29 samples	29 samples
Values Detectable but less than Action Level	0 samples	0 samples
Values greater than Action Level	0 samples	0 samples
Total	29 samples	29 samples
Sample Detection Limit (SDL)	5 µg/L	50 µg/L
90th Percentile Value	<5 µg/L	<50 µg/L
EPA Action Level	15 µg/L	1300 µg/L

Table 2-14. Inorganic Constituents in Drinking Water (μg/L) during 1999 by LANL

Sample Location	As	Ba	Be	Cd	Cr	F	CN	Hg	Ni	NO_3 (as N)	Se	Sb	Tl
Wellheads:													
Pajarito Well-PM1	0.003	<0.1	<0.001	<0.001	0.006	0.26	<0.005	<0.0002	<0.01	0.47	<0.005	<0.001	<0.001
Pajarito Well-PM2	0.001	<0.1	<0.001	<0.001	0.006	0.27	<0.005	<0.0002	<0.01	0.32	<0.005	<0.001	<0.001
Pajarito Well-PM5	0.001	<0.1	<0.001	<0.001	0.003	0.27	<0.005	<0.0002	<0.01	0.29	<0.005	<0.001	<0.001
Guaje Well-G1A	0.014	<0.1	<0.001	<0.001	0.008	0.53	<0.005	<0.0002	<0.01	0.43	<0.005	<0.001	<0.001
Guaje Well-G2A	0.009	<0.1	<0.001	<0.001	0.003	0.38	<0.005	<0.0002	<0.01	0.4	<0.005	<0.001	<0.001
Guaje Well-G3A	0.002	<0.1	<0.001	<0.001	0.006	0.30	<0.005	<0.0002	<0.01	0.60	<0.005	<0.001	<0.001
Guaje Well-G4A	0.002	<0.1	<0.001	<0.001	0.002	0.28	<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	0.002	0.30	<0.005	<0.0002	<0.01	0.38	<0.005	<0.001	<0.001
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.

Table 2-15. Compliance Bacteria in Drinking Water at Distribution System Taps during 1999 by LA County

		No. of Positive Tests		
Month	**No. of Samples Collected**	**Coliform**	**Fecal Coliform**	**Noncoliform**
January	47	0	0	3
February	48	0	0	4
March	47	0	0	3
April	45	0	0	3
May	46	0	0	2
June	45	0	0	3
July	46	0	0	6
August	47	0	0	4
September	47	0	0	4
October	45	0	0	1
November	47	0	0	1
December	45	0	0	4
Total 1999	555	0	0	38
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.

In March 1998, NMED approved a comprehensive hydrogeologic characterization work plan for the Laboratory. The Hydrogeologic Workplan (LANL 1998) was developed partially in response to NMED's denial of the Laboratory's RCRA groundwater monitoring waiver demonstrations. The plan proposes a multiyear drilling and hydrogeologic analysis program to characterize the Pajarito Plateau and to assess the potential for groundwater contamination from waste disposal operations. The goal of the project is to develop greater understanding of the geology, groundwater flow, and geochemistry beneath the 43-square-mile Laboratory area and to assess any impacts that Laboratory activities may have had on groundwater quality. The Hydrogeologic Workplan will result in an enhanced understanding of the Laboratory's groundwater setting and an improved ability to ensure adequate groundwater monitoring. Completion of the Hydrogeologic Workplan is anticipated in 2005.

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 NMED, a facility must submit a groundwater discharge plan and have NMED (or the Oil Conservation Division for energy/mineral extraction activities) approval. 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 SWS Facility; and one for the land application of dried sanitary sewage sludge from the SWS Facility. On August 20, 1996, the Laboratory submitted a groundwater discharge plan application for the RLWTF at TA-50. As of December 31, 1999, NMED approval of the plan was still pending.

b. Compliance Activities. The Laboratory continued an ongoing study of the hydrogeology and stratigraphy of the region, as required by the HSWA Module of the RCRA Hazardous Waste Facility Permit, DOE Order 5400.1, and the Hydrogeologic Workplan (LANL 1998). The Groundwater Protection Management Program Plan that ESH-18 administers integrates studies by several Laboratory programs. The Laboratory's Groundwater Annual Status Summary Report (Nylander et al., 2000) provides more detailed information on newly collected groundwater data. Drilling progress for the Hydrogeologic Workplan (LANL 1998) during 1999 included work on the following wells. Some key findings for 1999 are noted.

- R-9 is located at the Laboratory's eastern boundary in Los Alamos Canyon. A temporary casing was removed, and well construction was completed in October.
- R-12 is located at the Laboratory's eastern boundary in Sandia Canyon. Well construction was in progress at the end of 1999.
- R-15 is located on the floor of Mortandad Canyon, approximately one mile upstream of the eastern Laboratory boundary. The well is downstream of the TA-50 RLWTF effluent discharge point. During drilling, we found tritium levels of approximately 4,000 pCi/L in a perched groundwater zone at 646 feet, indicating Laboratory impacts. However, tritium levels of < 3 pCi/L in the regional aquifer at 964 ft indicated no contamination. R-15 has been cased and developed.
- R-25 is located near the Laboratory's western boundary, south of Cañon de Valle within TA-16. During drilling in 1998, groundwater samples from a perched zone below 750 ft and from the regional aquifer showed high explosives and chemicals associated with their breakdown. In 1999, drilling was completed, and the well was partially constructed before complications with screen #3 delayed completion.
- R-31 is located in Ancho Canyon west of State Road 4. The first phase of drilling was completed in 1999.

The EPA issued findings from a 1998 groundwater sampling inspection of the Laboratory (EPA 1999). During the inspection, approximately 40 water samples were collected from wells, effluent sources, and springs located on DOE and San Ildefonso Pueblo lands. The findings are consistent with previous Laboratory studies and refer to water in the alluvium just below the canyon floor: "…three of the canyons sampled (DP, Mortandad, and Los Alamos) had groundwater exceeding EPA's Drinking Water MCLs for radionuclides and/or nitrate. All contamination detected within these canyons were within the LANL boundary, and no off-site contamination was detected. None of the contaminated aquifers (sic) are currently being used as a drinking water source." The EPA recommended additional characterization and groundwater monitoring of intermediate and deep groundwater underlying these canyons. In December 1999, the EPA returned to the Laboratory to conduct additional groundwater sampling of the water supply production wells and in Mortandad Canyon.

During the 1998 sampling inspection, the Laboratory and the NMED collected split samples at many of the sampling sites for comparison with the EPA results. A statistical analysis showed good overall agreement between EPA, NMED, and LANL results (Gallaher et al., 2000). In some 95% of the laboratory measurements, the three organizations agreed on whether contaminant levels exceeded regulatory limits.

11. National Environmental Policy Act

a. Introduction. The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4331 *et seq.*) requires federal agencies to consider the environmental impacts of proposed actions before making decisions. NEPA also requires a decision-making process open to public scrutiny. All activities DOE or the Laboratory proposes are subject to NEPA review. DOE is the sponsoring agency for most LANL activities. 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 is categorically excluded from the need to prepare further NEPA documentation based on previous agency experience and analysis or whether to prepare one of 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, or
- 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, 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 that requires an EIS, the LANL Site-Wide EIS, or a programmatic EIS done at the nationwide level, the LANL project may be included in the larger EIS. The LANL project is then analyzed in 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. These documents create the basis of a DOE NEPA Environmental Review Form, formerly known as a DOE Environmental Checklist. The LANL Ecology Group (ESH-20) prepares these documents using the streamlined format as specified by DOE/LAAO.

b. Compliance Activities. In 1999, LANL sent 159 NEPA Environmental Review Forms to DOE for review. DOE categorically excluded 70 actions and amended the categorical exclusion for 75 actions. DOE made other determinations on six actions. Two EA determinations resulted in FONSIs. Six actions were unresolved in 1999. LANL applied DOE "umbrella" categorical exclusion determinations for 161 actions.

c. Environmental Impact Statements.

Site-Wide Environmental Impact Statement. Under DOE's compliance strategy for NEPA, a SWEIS is prepared to examine the environmental impacts of operations at a multiprogram site. An earlier SWEIS for LANL operations was prepared in 1979; that document and subsequent NEPA reviews for specific project or program activities have served as the NEPA basis for operations at LANL until now. DOE completed a new SWEIS (DOE 1999) in January 1999; the associated ROD was signed on September 13, 1999. NEPA documents at LANL will be tiered from or reference this SWEIS until the DOE determines that a new SWEIS is needed. An annual report that identifies how LANL's operations track against the projections made in the SWEIS, the *SWEIS 1998 Yearbook,* is available at *http://lib-www.lanl.gov/la-pubs/00460172.pdf*, and an overview of the Yearbook is available at *http://lib-www.lanl.gov/la-pubs/00460173.pdf* on the World Wide Web. The yearbook will be published annually.

Conveyance and Transfer of Certain Land Tracts Located within Los Alamos and Santa Fe Counties and Los Alamos National Laboratory. DOE completed this EIS (DOE/EIS-0293) to assess the environmental impacts of conveying or transferring certain land tracts under the administrative control of DOE within Los Alamos and Santa Fe Counties in October 1999. Its ROD is anticipated in early 2000. The EIS evaluates the congressionally mandated action required under PL 105-119 to convey or transfer certain land tracts to the County of Los Alamos and to the Secretary of the Interior in trust for San Ildefonso Pueblo.

d. Environmental Assessments Completed during 1999. The status of the Laboratory's EA-level NEPA documentation and project descriptions follows.

Decontamination and Volume Reduction System for Transuranic Waste at Los Alamos National Laboratory (DOE-EA-1269). This EA addressed a decontamination and compaction process for reducing the volume of oversized metallic TRU wastes at LANL that require disposal at the Waste Isolation Pilot Plant (WIPP). The process, called the decontamination and volume reduction system (DVRS), will be implemented at TA-55 Dome 226. The DVRS will have the capability to produce and dispose of approximately 3,120 $yd^3$of oversized metallic TRU waste that is currently in storage at TA-55, within a substantially reduced operating period. The majority of this oversized TRU waste will be sorted, segregated, and decontaminated to meet low-level waste (LLW) criteria and then compacted and disposed of on-site as LLW. The remainder of oversized metallic TRU waste that cannot be decontaminated to meet LLW criteria will be cut up and compacted to fit into WIPP-approved waste containers, packaged, and shipped as TRU waste to WIPP. The DVRS is expected to process an estimated 7,020 yd^3 of oversized metallic TRU waste in about six years. DOE determined that the proposed action would not significantly affect the quality of the human environment, completed the EA, and issued a FONSI on June 25, 1999. This EA is available at *http://lib-www.lanl.gov/la-pubs/00326873.pdf* on the World Wide Web.

Nonproliferation and International Security Center (DOE-EA-1238). This EA analyzed construction and operation of a Nonproliferation and International Security Center at TA-3. The facility will increase the efficiency and effectiveness of support to DOE's Office of Nonproliferation and National Security through consolidation of personnel at a central location at LANL. The approximate 164,000-ft^2 building will contain offices and an instrumentation and calibration laboratory and will house approximately 465 employees relocated from other LANL facilities. LANL was the only site under consideration for the facility. The analysis indicated that potential adverse affects are only associated with severe and extremely unlikely accident conditions involving LANL's Chemistry and Metallurgy Research building. DOE determined that the proposed action would not significantly affect the quality of the human environment, completed the EA, and issued a FONSI on July 22, 1999. This EA is available at *http://nepa.eh.doe.gov/ea/ea1238/ea1238.html* on the World Wide Web.

Parallex Project Fuel Manufacture and Shipment (DOE-EA-1216). Activities necessary to analyze and manufacture 59.2 lb of mixed oxide (MOX) fuel at TA-55 and ship it to the US-Canada border were analyzed in this EA. The EA discusses a limited-scale test to provide DOE information necessary to assess and demonstrate the feasibility of using MOX fuel in Canadian Deuterium Uranium (CANDU) reactors as a potential disposition option for surplus weapons-usable plutonium. The ROD for *The Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS* (DOE/EIS-0229) requires that DOE retain the option of dispositioning some weapons-usable plutonium as MOX fuel in heavy water reactors, such as CANDU reactors, if Russia, Canada, and the U.S. sign a multilateral agreement. DOE determined that the proposed action would not significantly affect the quality of the human environment, completed the EA, and issued a FONSI on August 13, 1999. This EA is available at *http://nepa.eh.doe.gov/ea/ea1216/ea1216.pdf* on the World Wide Web.

e. Environmental Assessments in Progress during 1999.

Electric Power System Upgrade. The proposed action consists of constructing and operating a 19.5-mi electric power transmission line from the Norton Station west across the Rio Grande to locations within TA-3 and TA-5. The project includes the construction of associated electric substations at the Laboratory, as well as the construction of two short line segments that would uncross a portion of two existing power lines. Additionally, a fiber optics communications line is included as part of the required grounding conductor for the power line. Work on the EA continued through 1999.

Leasing Land to a Commercial AM Radio Station. The proposed action is to lease approximately three acres of land at TA-54 to construct and operate a commercial (KRSN) radio broadcasting antenna. Work on this EA began in late December 1999.

f. Mitigation Action Plans. As part of the implementation requirements under NEPA, DOE prepares and is responsible for implementing Mitigation Action Plans (MAPs) (10 CFR 1021, Section 331 [a] July 9, 1996). MAPs are generally project specific and are designed to (1) document potentially adverse environmental impacts of a proposed action, (2) identify impact mitigation commitments made in the final NEPA documents (FONSIs or RODs), and (3) establish action plans to carry out each commitment. The MAP Annual Report (MAPAR) reports the implementation status of each MAP to the public. ESH-20 coordinates the implementation of the following DOE MAPs at the Laboratory.

Site-Wide Environmental Impact Statement. DOE issued this MAP in September 1999. The MAP provides details about the mitigation actions found in the ROD and tasks LANL with preparation of a project plan to implement them. Mitigations include specific measures to further minimize the impacts identified in the SWEIS as a result of operations (e.g. electrical power and water supply, waste management, and wildfire) and measures to enhance existing programs to improve operational efficiency and minimize future potential impacts from LANL operations (e.g., cultural resources, traditional cultural properties, and natural resources management). Specific measures should be completed by FY2006, and the enhancement of existing programs should be implemented by FY2003. A MAPAR will be prepared in 2000.

Dual Axis Radiographic Hydrodynamic Test Facility Mitigation Action Plan. DOE issued this MAP in 1995. On January 14, 1999, the DARHT MAPAR for 1998 was released to the public for review and comment.

During 1999, all DARHT construction-related mitigation measures were completed. ESH-20 issued a memorandum through DOE/LAAO providing a status and closure on all DARHT construction-related mitigation commitments and action plans on June 24, 1999. The memorandum was required as part of attaining authorization to begin operations for the DARHT project and provides documentation of DOE concurrence with ESH-20 that all applicable DARHT MAP construction mitigation measures have been appropriately addressed and are now complete. All operational mitigation action commitments for protecting workers, soils, water, biotic resources, and cultural resources in and around the DARHT facility are being implemented and are on schedule.

Low-Energy Demonstration Accelerator Mitigation Action Plan. DOE issued this MAP in 1996. On January 14, 1999, the LEDA MAPAR for

1998 was released to the public for review and comment. All MAP commitments for preventing soil erosion and monitoring industrial NPDES outfalls and potential wetlands formation in and around the LEDA facility are being implemented and are on schedule.

Lease of Land for the Development of a Research Park at LANL Mitigation Action Plan. DOE issued this MAP in October 1997. Implementation of the MAP was contingent on the completion and approval of the formal lease agreement between DOE and the lessee. The lease agreement is complete, and Congress approved it in February 1999. A MAPAR will be prepared in 2000.

12. Integrated Resources Management

DOE and LANL began planning and developing an Integrated Resources Management Plan (IRMP) in 1999. The Record of Decision for the LANL SWEIS includes a DOE commitment to prepare a site-wide IRMP over the next three years under the implementation of the SWEIS MAP.

The IRMP involves DOE and multiple LANL organizations and is being developed as a mission-oriented tool for integrating facility and land use planning activities with the management of natural and cultural resources. In 1999, DOE and LANL established an IRMP Project Management Team (PMT) to direct the preparation of the plan. The PMT completed a work plan to prepare the IRMP in November 1999. In addition, the Site-Wide Issues Project Office established a LANL steering committee to facilitate the development of the IRMP. The plan will integrate existing resource management plans and the development of other management plans with LANL site planning and mission activities.

As part of the IRMP effort in 1999, LANL began developing a Cultural Resources Management Plan (CRMP) and Biological Resources Management Plan (BRMP).

Cultural Resources Management Plan. As part of the MAP in the ROD for the Laboratory SWEIS, the Cultural Resources Team is assisting DOE/LAAO in developing a CRMP to provide an institutional approach for managing prehistoric and historic properties. Work on the CRMP began in 1999 and will continue through 2002. The CRMP will include an archaeological research design; historic contexts for evaluating buildings and structures of the Manhattan Project and the Cold War; the process the Laboratory uses for reviewing undertakings and determining effects; and the standards, procedures, and professional qualifications for managing cultural resources. In association with the CRMP, we will develop a policy-based approach to managing traditional cultural properties that are sacred to traditional Native American cultures. Additionally, the CRMP will contain a set of management goals and a five-year plan for attaining them that includes inventory and assessment targets for prehistoric and historic properties. Implementation of the CRMP will begin in 2003.

Biological Resources Management Plan. The BRMP is being developed to respond to an institutional need for an integrated and comprehensive approach to site-wide management of the following biological resources: threatened and endangered and other sensitive species; sensitive habitats (floodplains, wetlands, and Native American resource collection areas); large game and other wildlife species; and forests. The BRMP will address such issues as wildfire risk, vehicle accidents with elk and deer, and water quality issues like soil erosion and the movement of contaminants.

13. Cultural Resources

a. Introduction. The ESH-20 Cultural Resources Team is responsible for developing the CRMP (see Section 12), building and maintaining a database of all cultural resources found on DOE land, supporting DOE’s compliance with the requirements applicable to cultural resource legislation as listed below, and providing appropriate information to the public on cultural resource management issues. Cultural resources are defined as archaeological materials and sites dating to the prehistoric, historic, or European contact period that are currently located on or beneath the ground; standing structures that are over 50 years old or are important because they represent a major historical theme or era; cultural and natural places, select natural resources, sacred objects and sites that have importance to American Indians; and American folklife traditions and arts.

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. Federal agencies must also consult with the State Historic Preservation Officer (SHPO) and/or National Advisory Council on Historic Preservation about possible effects on identified resources.

During 1999, Laboratory archaeologists evaluated 749 Laboratory proposed actions and conducted 18 new field surveys to identify cultural resources. DOE sent 18 survey results to the SHPO for concurrence in findings of effects and determinations of eligibility for National Register inclusion of cultural resources located during the survey. The Governors of San Ildefonso, Santa Clara, Cochiti, and Jemez Pueblos and the President of the Mescalero Apache Tribe received copies for comment and identification of any traditional cultural properties that may be affected by a proposed action. ESH-20 identified no adverse effects to prehistoric cultural resources in 1999.

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. Tribal groups must receive notification 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 descendant must be consulted for disposition of the remains. No discoveries of burials or cultural objects occurred in 1999.

The Archaeological Resources Protection Act (ARPA) of 1979 (Public Law 96-95) provides protection of cultural resources and sets penalties for their damage or removal from federal land without a permit. No ARPA violations were recorded on DOE land in 1999.

c. Compliance Activities.

Nake'muu. As part of the DARHT MAP, the Cultural Resource Team is conducting a long-term monitoring program at the ancestral pueblo of Nake'muu. The team is implementing the program to assess the impact of LANL mission projects on cultural resources. Nake'muu is the only pueblo at the Laboratory that still contains its original standing walls. It dates from circa 1200–1325 AD and contains 55 rooms with walls standing up to 6 feet high. As such, it represents one of the best-preserved ruins on the Pajarito Plateau. In 1999, the site was mapped and photographed and detailed drawings were made of all the standing masonry architecture. The team will update this baseline database on an annual basis and make continual assessments of site condition, deterioration rate, and possible sources of impact. The site is ancestral to the people from San Ildefonso Pueblo who refer to it in their oral histories and songs. They are invited for annual visits to Nake'muu to personally view the ruins and consult on the long-term status of the site.

Traditional Cultural Properties Consultation Comprehensive Plan. In 1999, the Cultural Resources Team assisted DOE/LAAO in developing a Traditional Cultural Properties Consultation Comprehensive Plan. This plan will provide the framework to open government-to-government consultations between DOE/LAAO and interested Native American tribal organizations on identifying, protecting, and gaining access to traditional cultural properties and sacred places. The development of the comprehensive plan is part of the mitigation actions described in the ROD for the SWEIS for the Continued Operation of the Los Alamos National Laboratory. The plan provides the legislative basis for traditional cultural properties protection and access agreements with participating tribal organizations. It also describes methods and procedures for maintaining confidentiality of sensitive information. The comprehensive plan will be available for tribal comment in the summer of 2000.

Land Conveyance and Transfer. Public Law 105-119, November 1997, directs the Department of Energy to convey and transfer parcels of DOE land in the vicinity of the Laboratory to the County of Los Alamos, New Mexico, and to the Secretary of the Interior, in trust for the San Ildefonso Pueblo. In support of this effort, the Cultural Resources Team conducted historic property inventories and evaluations as required under Section 106 of the National Historic Preservation Act, in preparation for the eventual transfer of lands out of federal ownership. This effort has included the archaeological survey of 4,700 acres of Laboratory lands and the inventory and evaluation of 47 buildings and structures located on the transfer parcels. Final cultural resources reports are scheduled to go to the New Mexico SHPO in the spring of 2000.

14. Biological Resources including Floodplain and Wetland Protection

a. Introduction. The DOE and the Laboratory comply with the Endangered Species Act; the Migratory Bird Treaty Act; the Bald Eagle Protection Act; Presidential Executive Order 11988, Floodplain Management; Presidential Executive Order 11990, Protection of Wetlands (Corps 1989); and Section 404 of the Clean Water Act. The Laboratory also protects plant and animal species listed by the New Mexico Conservation Act and the New Mexico Endangered Species Act.

b. Compliance Activities. During 1999, the ESH-20 Biology Team reviewed 409 proposed Laboratory activities and projects for potential impact on biological resources, including federally listed threatened and endangered species. These reviews evaluate the amount of previous development or disturbance at the site, determine the presence of wetlands or floodplains in the project area, and determine whether habitat evaluations or species-specific surveys are needed. Of the 409 reviews, the Biology Team identified 52 projects that required habitat evaluation surveys to assess whether the appropriate habitat types and parameters were present to support any threatened or endangered species. As part of the standard surveys associated with the Threatened and Endangered Species Habitat Management Plan, the Biology Team conducted approximately 30 species-specific surveys to determine the presence or absence of a threatened or endangered species at LANL. The Laboratory adhered to protocols set by the US Fish and Wildlife Service and to permit requirements of the New Mexico State Game and Fish Department.

c. Biological Resource Compliance Documents. In 1999, the Biology Team prepared several biological resource documents, such as biological assessments, biological evaluations, and other compliance documents. These documents included, among others, a biological assessment of the electrical power systems upgrade (Balice and Haarmann 1999) and the Isotope Production Facility (Loftin and Haarmann 1999). DOE determined that these projects may affect but are not likely to adversely affect individuals of threatened and endangered species or their critical habitat; the US Fish and Wildlife Service concurred with these determinations.

The Biology Team contributed to the continued implementation of the Threatened And Endangered Species Habitat Management Plan (HMP) (LANL 1998b). Site plans were successfully used to further evaluate and manage the threatened and endangered species occupying DOE/Laboratory property (see Sections 2.E.4 and 6.C.20). Members of both the Biology and Natural Resources Management Teams began developing the BRMP as described in Section 12.

C. Current Issues and Actions

1. Compliance Agreements

a. New Mexico Hazardous Waste Management Regulations Compliance Orders. The Laboratory received Compliance Order (CO) 98-01 on June 8, 1998, which alleged noncompliance with the NM Hazardous Waste Management Regulations at the DP Tank Farm, PRS 21-029. As part of the ordered actions, the Laboratory submitted a Sampling and Analysis Plan to NMED to address the alleged deficiencies in October 1998. NMED accepted the plan in 1999, and the CO has been resolved.

On June 25, 1998, the Laboratory received CO-98-02 that alleged two violations of the NM Hazardous Waste Management Regulations at TA-21 concerning the storage of gas cylinders. NMED proposed civil penalties of over $950,000. The Laboratory filed its answer to the CO on August 10, 1998, meeting the compliance schedule by demonstrating that all gas cylinders had been disposed of properly. Efforts to resolve this CO continued during 1999.

On December 21, 1999, the Laboratory received CO-99-03. It covered the alleged deficiencies the NMED Hazardous and Radioactive Materials Bureau discovered during a five-month inspection that took place in 1997. The inspection was called “wall-to-wall” because NMED personnel walked every space at the Laboratory—storage areas, laboratories, hallways, stairwells, and the areas around buildings—looking for improperly stored hazardous chemicals. In past inspections, only designated storage areas were included. A large number of violations were alleged with over $1 million in proposed penalties.

Twenty-nine deficiencies were alleged, including the following:

- inoperable eyewash decontamination unit (1),
- no accumulation start date on a container label (1),
- an open container (1),
- illegal storage past 90 days (1),
- no hazardous waste code on Land Disposal Restriction (LDR) notices (2),
- no annual RCRA refresher training (2),
- improperly labeled wastes (3),
- inadequately controlling hazardous wastes (6), and
- no hazardous waste determination (12).

The Laboratory will prepare its response to the CO during 2000. Because of the long time between the inspection and the issuance of the CO, the Laboratory has corrected most of the alleged violations.

The Laboratory received CO-99-01 on December 28, 1999, in response to the NMED inspection conducted between August 10 and September 18,

1998. The inspection team visited approximately 544 sites at the Laboratory. Total penalties proposed were almost $850,000.

The following 30 violations were alleged in the Compliance Order:

illegal storage past 90 days (4),

no hazardous waste determination (5),

no weekly inspections of storage areas (2),

no accumulation state date on a container label (1),

improperly labeling hazardous waste (4),

no hazardous waste code on the LDR notice (1),

not certifying an LDR notice (1),

no decontamination equipment (2),

no emergency communication devices (2),

no emergency fire equipment (1),

no annual RCRA review training (2),

inadequate operating records (4), and

inadequately controlling hazardous waste (1).

The Laboratory is in the process of preparing its answer to the Compliance Order. The full text of the COs received during 1999, as well as status updates, is available at *www.drambuie.lanl.gov/~esh19/* on the World Wide Web.

2. Environmental Oversight and Monitoring Agreement

The Agreement-in-Principle between the Department of Energy and the State of New Mexico for Environmental Oversight and Monitoring provides technical and financial support for state activities in environmental oversight and monitoring. The requirements of the agreement are carried out by the DOE Oversight Bureau of the New Mexico Environment Department. The bureau holds public meetings and publishes reports on its assessments of Laboratory activities. Highlights of the Oversight Bureau's activities are presented below.

Gamma radiation and air particulate monitoring. The bureau monitored gamma radiation at 11 stations near the Laboratory's perimeter and one station in Santa Fe. Airborne radionuclides were measured at four air monitoring stations surrounding the Laboratory. The levels of gamma radiation and airborne radionuclides were consistent with the levels LANL measured and were in the range of background.

Soil, sediment, and biota. Soil and sediment samples were collected at 21 locations. Except at a few locations known to be influenced by historical Laboratory releases, the levels of radionuclides and metals were consistent with regional background. A technical report, *NMED/LANL 1996 Soil Results: Data Evaluation and Statistical Comparison*, was issued. The report compares the bureau's results to LANL's for samples collected at 16 soil sampling stations. The results were similar to LANL's.

The bureau collected 11 fish samples from Cochiti and Abiquiu Reservoirs. Results for mercury were consistent with LANL's and within the range of historical data. Because the standard method for analyzing biological material for PCB compounds gave results at or below the method quantitation limit, the bureau analyzed some of its samples using a high-resolution method that quantifies low levels of PCB. Data resulting from the low-level measurements may be useful in evaluating potential toxicity of the compounds.

In 1999 NMED issued, *Flora and Fauna Sampling Results at Los Alamos National Laboratory, New Mexico during 1995 and 1996* (NMED 1999). In this report, results for all constituents, with the exception of lead, were similar to the results obtained by the Laboratory. For lead, the bureau measured concentrations lower than those LANL reported. The report also described results from Cochiti Reservoir fish samples that were analyzed for mercury and PCB compounds. The mercury concentrations were similar to those found in fish from other reservoirs in the state and were similar to those LANL reported. PCB were either not detected or were found at or below the method quantitation limit.

Surface Water and Groundwater. Bureau staff collected 60 samples from on-site and off-site wells, springs, and surface water stations. Storm water was collected from five of the Laboratory's eight major drainages. The bureau followed the hydrogeologic investigations, particularly the drilling of deep aquifer wells in Mortandad Canyon and at TA-16, and collected samples from some of the wells.

Environmental Restoration. The Oversight Bureau continued to participate in the work of the LANL Environmental Restoration Project. The bureau reviewed investigation and cleanup work associated with townsites, material disposal areas, and canyons. The bureau collected samples at two sites near Acid Canyon: below the former radioactive liquid waste treatment plant and in a drainage channel below the Old Catholic church.

The bureau helped to develop guidance for the assessment of ecological risk, reviewed and participated in the development of the Watershed Management Plan, and participated in the development of the watershed approach. Issues relating to surface water quality and contaminant transport were identified. Staff participated in developing and implementing a process to evaluate sites for the potential for erosion caused by surface water.

D. Consent Decree

1. Clean Air Act Consent Decree/Settlement Agreement

During 1997, DOE and the Laboratory Director entered into a Consent Decree and a Settlement Agreement to resolve a lawsuit that the Concerned Citizens for Nuclear Safety filed. The lawsuit, filed in 1994, alleged that LANL was not in full compliance with the CAA Radionuclide NESHAP, 40 CFR 61, Subpart H. The decree and agreement require actions that will continue through 2002 and, depending upon the results of the independent audits, may continue through 2004. All of the provisions of the decree and the agreement were met during 1999 and are described in detail at *http://drambuie.LANL.gov/~AirQuality/CD_Agreement.htm* on the World Wide Web.

Risk Assessment Corporation (RAC) completed the first independent technical audit of the Laboratory's Radionuclide NESHAP program during 1999. The final report indicates that the Laboratory did not meet certain regulatory and technical requirements and was not in compliance with 40 CFR 61, Subpart H for 1996. The audit also concluded that the Laboratory did not exceed the 10-mrem-per-year dose standard prescribed in the regulation. Although the Laboratory agreed that technical recommendations the RAC final report made would enhance the quality of the radionuclide NESHAP program, LANL did not agree that these findings demonstrate noncompliance with the NESHAP regulation during 1996 and did not modify its certification of compliance sent to EPA for that year. The Laboratory implemented most of the technical recommendations contained in the final audit report. The Laboratory submitted RAC's final audit report to DOE, and DOE has provided copies to EPA Region 6, NMED, and to the Laboratory's Community Reading Room. The second audit of the radionuclide NESHAP will begin in June 2000.

An independent contractor completed monitoring of thermoluminescent dosimeters during 1999. The Laboratory made the final payment to the University of New Mexico School of Medicine to fund development of a curriculum in the Masters of Public Health degree program on environmental health issues, called for by the 1997 Consent Decree, during 1999.

E. Significant Accomplishments

1. Environmental Restoration Project—The Watershed Approach

The ER Project reorganized its activities during 1999 according to the natural watersheds across the Laboratory in which the various PRSs are located. Each watershed consists of one or more components called aggregates; each aggregate contains several PRSs that will be investigated, assessed, and remediated (if necessary) as a group. The ER Project reevaluated over 2,100 individual PRSs to determine which were related by contaminant source, geographic location, and potential cumulative risk to group sites into eight watersheds.

A single watershed comprises one or more mesas and a common canyon drainage. The mesas draining into a common canyon may contain multiple contaminated sites. Each major canyon in the Los Alamos area was identified as an aggregate; eight canyon aggregates drain into the Rio Grande. Six of the eight watersheds contain multiple canyons and drainage systems with several hundred PRSs. As noted, these watersheds are subdivided into aggregates; additionally, potentially contaminated sites located on mesa tops and slopes were grouped into 27 site aggregates. Table 2-16 presents, by watershed, the canyon and site aggregates. The specific location of each canyon is shown on Figure 1-3.

The objective of the ER Project is to complete corrective actions at every site under its purview. Corrective actions are considered complete at a site when

- the ER Project has demonstrated and documented that the site either poses no risk to humans and ecological receptors or that the risk is acceptable—or a final remedy is evaluated, selected, and implemented to reduce or eliminate risk—and

- the administrative authority has concurred.

The ER Project Installation Work Plan fully documents the watershed approach; the plan is updated annually as part of the requirements of the RCRA Hazardous Waste Facility Permit, (LANL 2000).

In addition to a reengineered approach, the ER Project also revised its risk assessment methodology to add ecological risk assessments to the human health risk assessment if warranted by the risk-screening assessment. The current and future land use of the site determines human health exposure scenarios. Those scenarios include residential, industrial, recreational, and resource user categories (Mirenda and Soholt 1999). The ER Project has defined general risk endpoints for the Laboratory and has developed screening methods for assessing potential ecological risks (Ryti et al., 1999). The Installation Work Plan explains this process in more detail.

Readers can view the DOE's Paths to Closure for a review of the project schedule. Readers can keep current on the ER Project by reviewing *http://erproject.lanl.gov* on the World Wide Web.

2. TA-21 Nontraditional In Situ Vitrification Cold Demonstration

In April 1999, members of the ER Project, in conjunction with the DOE/LAAO; the DOE's Environmental Management Office of Science and Technology; MSE Technology Applications, Inc.; and Geosafe Corporation executed a demonstration of a nontraditional *in situ* vitrification (NTISV) technology on an area north of Area V in TA-21. The NTISV technology uses heat from electricity to convert earth into an inert, glass-like monolith. The conversion occurs below the ground surface. It is called a "cold" demonstration because it involves no radioactive constituents; the simulated bed contained low levels of petroleum hydrocarbons and nonhazardous chemicals chosen because they would behave like actual contaminants during the process. Analysis of the resultant materials is still in progress.

3. Pollution Prevention

In 1999, the Laboratory applied for nine NMED-sponsored Green Zia Pollution Prevention Environmental Excellence awards. The Laboratory has also encouraged subcontractors to apply and utilize these tools, resulting in two contractor applications.

The following are specific Laboratory projects completed in 1999:

- In September, the Laboratory opened a Materials Recovery Facility to capture recyclable materials and hazardous waste before they are shipped to the county landfill.
- The Laboratory initiated a procurement to have industry present technologies to increase the efficiency of the cooling towers, the largest source of water consumption at LANL. The cooling towers are currently only about 50% efficient, measured by the ratio of evaporated water to make-up water, and this project is expected to increase that efficiency to at least 75%.
- The Laboratory purchased a mobile unit to treat photochemicals, chiller cleaner, rinsewater, and other hazardous liquid wastes to meet the waste acceptance criteria for the sanitary waste plant.
- Replacing mercury thermometers with digital or alcohol-based thermometers has minimized the amount of mercury in Radiological Controlled Areas.

The Laboratory is currently using the Green Zia tools on the Transition Manufacturing & Safety Equipment (TMSE) Project. The TMSE Project is the primary project to ready LANL for nuclear pit production. This $72 million construction project includes significant facility upgrades in the TA-55 area. The Environmental Stewardship Office is working with the Nuclear Materials Technology Division to utilize the Green Zia tools to evaluate, avoid, reduce, and/or recycle TMSE radioactive and nonradioactive waste.

4. New Mexico Water Quality Control Commission 1998 Triennial Review

The Laboratory provided testimony as an interested party in a hearing NMWQCC conducted as part of the 1998 Triennial Review of water quality standards for the State of New Mexico. The amendments that resulted from this hearing may affect the effluent limitations that apply to Laboratory discharges regulated by the NPDES industrial outfall permit. Representatives from ESH-18, Laboratory Counsel, an independent law firm, water resource experts, and an aquatic biologist prepared and presented the Laboratory's testimony.

Table 2-16. Canyon Aggregates and Site Aggregates within Watersheds

Watershed	Canyon Aggregate	Site Aggregate
Los Alamos/Pueblo	Los Alamos/Pueblo	Middle Los Alamos/DP
		Pueblo
		Upper Los Alamos
		Bayo
		Rendija/Barranca/Guaje
		Lower Los Alamos
Sandia	Sandia	Upper Sandia
		Lower Sandia
Mortandad	Mortandad	Middle Mortandad/Ten-site
		Upper Mortandad
		Middle Cañada del Buey
		Upper Cañada del Buey
		Lower Mortandad/Cañada del Buey
		Lower Mortandad/Cedro
Pajarito	Pajarito	Lower Pajarito
		Threemile
		Starmer/Upper Pajarito
		Twomile
Water/Cañon de Valle	Water/Cañon de Valle	Cañon de Valle
		S-Site
		Potrillo/Fence
		Upper Water
		Lower Water/Indio
Ancho	Ancho	North Ancho
		South Ancho
Chaquehui	Chaquehui	Chaquehui
Frijoles	Frijoles	Frijoles

On December 7 and 8, 1999, the NMWQCC approved the final *State of New Mexico Standards for Interstate and Intrastate Surface Waters.* The new water quality standards were filed with the New Mexico State Records Center on January 24, 2000, and were effective February 23, 2000. EPA may consider the new water quality standards in establishing effluent discharge limits in the Laboratory's new NPDES industrial outfall permit.

5. SWEIS Yearbook

During production of the SWEIS, the SWEIS Project Office recognized the opportunity to make the SWEIS a "living" document that would provide both LANL and DOE with a tool to minimize additional NEPA analysis for ongoing projects. The idea was formulated for producing an annual "yearbook" for the SWEIS, which would minimize the need to update the SWEIS itself and would thereby result in substantial cost savings to DOE and the Laboratory. This yearbook provides comparisons of actual operations data to projections made in the SWEIS based on DOE's ROD for continued operation of the Laboratory. Not only does the yearbook enable DOE to make a decision on when and if a new SWEIS is needed, but it also serves as a guide to facilities and managers at LANL in determining whether activities are within the SWEIS operating envelope. Having this information available can streamline the NEPA process for new activities and avoid project delays. The first annual yearbook was published in December 1999.

6. Wildlife Reserve

SWIPO was the point-of-contact for LANL in the creation of the White Rock Canyon Wildlife Reserve that Secretary of Energy Bill Richardson dedicated on

October 30, 1999. This reserve of approximately 1,000 acres on the southeast perimeter of the Laboratory will be managed for its significant biological attributes, ecological and cultural resources, and research potential. The DOE and the Department of the Interior, National Park Service will co-manage the reserve with programmatic and technical assistance from UC/LANL.

7. V Site

In May 1998, DOE/LAAO received a Save America's Treasures matching grant to restore the V Site Manhattan Project buildings at Los Alamos National Laboratory. The Save America's Treasures grant was part of the Millennium Grant program sponsored by the White House and administered by the Department of Interior. The grant requires the Department of Energy to raise nonfederal matching funds to implement the award. In 1999, to facilitate the fund-raising activities, DOE has entered into a Memorandum of Understanding with the National Trust for Historic Preservation, a nonprofit historic preservation organization located in Washington, D.C., to assist the department in raising the necessary matching funds. The grant will help restore the V Site, which contains the most important remaining Manhattan Project buildings at Los Alamos. The high-explosive components of the “plutonium gadget” were assembled at V Site and detonated at Trinity Site in southern New Mexico on July 16, 1945. The restored buildings will house a Manhattan Project museum that will present interpretive displays and artifacts from the Manhattan Project at Los Alamos. The museum will be an annex of the Bradbury Science Museum in Los Alamos. This federal grant of $700,000 is contingent on obtaining matching funds.

8. Clean Water Act

During 1999, the Laboratory installed and/or instrumented an additional 22 stream monitoring stations, with eight additional stations proposed for FY00. The stations are located on the major canyons entering and leaving the Laboratory. In addition, stations were installed at the confluence of the major canyons within the Laboratory boundary and within certain segments of the larger canyons. The Laboratory is currently operating 54 monitoring stations.

F. Significant Events

1. Plutonium-239, -240 in Acid Canyon

Acid Canyon is a tributary to upper Pueblo Canyon, part of the Los Alamos/Pueblo watershed. Former TA-45 was located at the top of Acid Canyon; a wastewater treatment plant for radioactive liquid wastes and a vehicle decontamination facility were located there during the 1950s and early 60s. Decontamination and decommissioning of the main structures, associated waste lines, and wastewater outfalls began in October 1966.

In 1967, Los Alamos County assumed title to the property and used the site for storing and staging equipment and supplies for the Utility Department. After the Utility Department moved to its current site on Trinity Drive, the county built a skate park on the site in 1997. Investigation and cleanup activities have continued at former TA-45 and in Acid Canyon since 1945. The cleanups met the cleanup standards in place at the time.

In 1999, environmental personnel took sediment samples to confirm the results of previous studies. The sampling used a geomorphic approach (based on land forms) to identify and locate potentially contaminated sediment deposits. The sampling was designed to find the areas that might contain the highest contamination levels and involved detailed mapping of sediment deposits and intensive radiation surveys with field instruments.

Results of the investigation showed plutonium-239, -240 levels from 2 to 1,880 piC/g in sediment. The 1,880 piC/g value is three times higher than any previous sample analyzed from Acid Canyon. The Laboratory performed additional field studies, collecting 35 new sediment samples in November 1999 to further characterize plutonium concentrations and evaluate risks associated with these concentrations. The risk assessment will take place in 2000 when the sampling results are received and a more complete characterization of contaminants in Acid Canyon is available.

2. Detonable High Explosives at Material Disposal Area P

The Laboratory's ER Project has been working at Area P at TA-16 for several years implementing the cleanup of this site under a closure plan approved by NMED (see Section 2.B.1.c). Area P received burn pad debris and other wastes from the early 1950s until

1984. By December 1997, the Laboratory had excavated test pits, and workers began removing surface debris in October 1998. In February 1999, workers began excavating the landfill itself. In addition to removing equipment contaminated with HE from the World War II-era buildings, workers expected to remove HE residues, barium, and empty drums, bottles, and debris. They also found detonable pieces of HE. After revising the safety plan for the site, Laboratory workers began using a remote-handled machine to excavate the landfill. Explosives ordnance disposal experts sorted through the excavated materials. By the end of 1999, over 120 pounds of HE had been removed from the site and burned. ER Project managers expect cleanup work at the site to be completed during 2001.

3. Contamination in Wells in 1999

Data from the Hydrogeologic Workplan has shown that Laboratory operations have affected the deepest groundwater zone in some areas. Low levels of nitrate, tritium, and high explosives have been found in the deepest zone but have not impacted the present municipal drinking water supply wells. Well R-25 in TA-16 is located in an area where operations include high-explosives research, development, testing, and manufacturing. Discharges from past manufacturing activities appear to be the source of high-explosives constituents discovered in groundwater samples from this well.

G. Awards

1. Water Quality

Members of the ESH-18 NPDES Outfall and Storm Water/SPCC Teams received awards during 1999: the 1999 Pollution Prevention Success Award from the LANL Environmental Stewardship Office for NPDES Permit Reapplication Project, R-25 Monitoring Well Land Application, and the Surface Water Site Assessment Process. A member of the ESH-18 Storm Water/SPCC Team also received the LANL Achievement Award for his support of the TA-54 Storm Water Pollution Prevention Program.

2. Air Quality

A member of ESH-17 received a Los Alamos Achievement Award for outstanding research and development and was recognized by the ESH Division Review Committee for improved protection of the public. This research and development lead to improvements in atmospheric tritium measurements that provide for more accurate estimates of public health impacts from Laboratory operations.

3. Solid and Hazardous Waste

Three members of ESH-19 received Los Alamos Distinguished Performance Awards in 1999. One award was made for work on the Legacy Materials Cleanup project that resulted in significant time and dollar savings to the Laboratory. Members of teams that played essential roles in getting the first shipment of waste sent to the WIPP also received Distinguished Performance Awards.

ESH-19 staff participated on two Ship-to-WIPP projects and received several Laboratory division awards and letters of commendation from DOE Headquarters and the Albuquerque Area Office Manager’s Performance Excellence Award. Many years of effort went into getting the WIPP site open to receive waste and then demonstrating to the NMED that the Laboratory was ready to ship its waste.

A member of ESH-19 received two Pollution Prevention Awards during 1999. The first was for efforts to recycle 5,500 pounds of mercury rather than disposing of it. The second was for establishing recycling areas for solid wastes such as circuit boards, scrap metal, and cardboard that JCNNM maintenance and construction generated.

4. Ecology

Several ESH-20 employees received Los Alamos Achievement Awards for their work on the Threatened and Endangered Species Habitat Management Plan.

The DOE Los Alamos Area Office presented ESH-20 with Personal Peer Awards for work on specific projects. These included recognition for

- continued support of regulatory compliance programs and various interagency teams, including the Interagency Wildfire Management Team;
- continued support to the National Historic Preservation Act Compliance Program;
- continued support to the National Environmental Policy Act Compliance Program; and
- continued support to the Endangered Species Act Compliance Program.

ESH-20 received a Performance Excellence Award for the Land Conveyance and Transfer Project in recognition of significant contribution to the achievement of DOE Albuquerque Area Office's vision, mission, goals, and objectives.

One member of the ESH-20 technical staff was a distinguished nominee at the national conference for the Society of Mexican American Engineers and Scientists. He received an award from that Society in recognition of his professional contributions in the field of environmental research. The Spring/Summer 1999 magazine *Mexican American Engineers and Scientists* profiled his biography.

An ESH-20 graduate student received outstanding recognition and was presented with the Best Student Presentation Award at the annual meeting of the Society of Environmental Toxicology and Chemistry.

One member of the ESH-20 technical staff received a Performance Excellence Award from the DOE Albuquerque Operations Office for the Stockpile Stewardship Management Programmatic Environmental Impact Statement.

5. Environmental Restoration Project

The ER Project Program Manager and other project leaders and personnel received Los Alamos Achievement Awards for their efforts in directing and supporting the project reengineering. Members of the Communication and Outreach Team of the ER Project received Los Alamos Achievement Awards and DOE Environmental Excellence Awards for their work on preparing and presenting the *Land Conveyance and Transfer at Los Alamos National Laboratory under Public Law 105-119* document. ER Project personnel participated in the Team Award for Pollution Prevention Success with members of ESH-18 for their work on the R-25 Monitoring Well Land Application Project.

6. Waste Management Program

The Laboratory received three Green Zia awards in 1999. The Transuranic Waste Inspectable Storage Project received an achievement level award, and the Environmental Science and Waste Technology Division and Hydrodynamic Operations Group (DX-3) received commitment level Green Zia awards.

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3. Environmental Radiological Dose Assessment

3. Environmental Radiological Dose Assessment

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Abstract

We calculate potential radiological doses to members of the public who may be exposed to Los Alamos National Laboratory (LANL or the Laboratory) operations. To fully understand potential radiological impacts, we calculate the doses to the population nearby, to potentially maximally exposed individuals on- and off-site, and to "average" residents of Los Alamos and White Rock. The population and individual doses include consideration of all potential exposure pathways (primarily inhalation, ingestion, and direct exposure). Our calculations indicate the population within 80 km of LANL received a dose of 0.3 person-rem, smaller than last year's 0.8 person-rem (person-rem is the quantity used to describe population dose). The calculated maximum off-site radiation dose to a member of the public from Laboratory sources is near the Shell Station on Trinity Drive and was 0.7 mrem, which is less than 1% of the Department of Energy (DOE) dose limit of 100 mrem and also well below the level at which health affects would occur. This dose is calculated using all exposure pathways to satisfy DOE requirements and is different from the dose presented in Chapter 2, which is calculated for compliance with National Emission Standards for Hazardous Air Pollutants and considers only the dose from the air pathway. The calculated maximum on-site individual exposure to a member of the public is 3 mrem, which compares with 6 mrem in 1998. This member of the public is a hypothetical individual who passes along Pajarito Road near the Technical Area 18 Criticality Facility. Most of this dose would be from direct radiation for which the applicable dose limit is 100 mrem, the allowed dose from all pathways. No health effects would be expected from an exposure of this magnitude. Ingestion doses were calculated for produce, fish, eggs, deer, elk, and other locally grown or gathered foods. Among these, we saw net doses where the number is larger than its uncertainty for ingestion of deer collected in Los Alamos and cattle at San Ildefonso.

Health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem. We conclude that the doses calculated here, which are in the mrem (one one-thousandth of a rem) range, would cause no human health effects. They are also much smaller than typical variations in the background radiation dose. The total dose from background radiation, greater than 99% of which is from natural sources, is about 360 mrem in this area and can vary by 10 mrem from year to year.

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

A. Overview of Radiological Dose Equivalents

Radiological dose equivalents presented here 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 how radiation causes 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 different degrees of effectiveness, but we need to report the "effective" dose the whole body has received. 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. To calculate this dose we sum the doses to individual organs or tissues.

Long-lived radionuclides that a body inhales or ingests continue to deposit energy in the body and give doses for a long time after their intake. To account for this extended dose period, we also calculated a "committed effective dose equivalent" (CEDE), also referred to in this report as "dose." The CEDE gives the total dose, integrated over 50 years, that would result from radionuclides taken into the body from short-term exposures. In this report, we calculate CEDEs for radionuclides taken into the body during 1999. The doses we report below include the contributions from internally deposited radionuclides (CEDE) and from radiation exposures received from sources outside the body (EDE) all under the general term "dose."

Federal government standards limit the dose that the public may receive from Laboratory operations. The Department of Energy (DOE 1990) public dose limit to any individual 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 dose standard of the Environmental Protection Agency (EPA) of 10 mrem per year, which is codified in the Code of Federal Regulations (40 CFR 61); see Appendix A. These doses are in addition to exposures from normal background, consumer products, and medical sources. Chapter 2 presents dose calculations performed to comply with 40 CFR 61 (EPA 1986) that are based on different pathways and use different modeling programs than those performed for DOE requirements, which are presented here in Chapter 3.

This chapter reports calculations of potential radiological doses to members of the public. Therefore, we don't present worker doses in this report. Information on LANL worker radiation doses is published quarterly in the report "Los Alamos National Laboratory, Radiological Protection Program, Performance Indicators for Radiation Protection," which can be found in the Community Reading Room (505-665-4400).

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. We calculate doses that the population as a whole within 80 km may have received and also doses to specific hypothetical individuals within that population as shown below.

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

(2) *The maximally exposed individual (MEI) who is not on LANL/DOE property (referred to as the off-site MEI).* For this calculation, we use the definition of location in 40 CFR 61, which defines the receptor as someone who 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 we perform here is more comprehensive than the one required for compliance with 40 CFR 61 (as presented in Chapter 2). The calculated dose to the off-site MEI we present here is an "all-pathway" assessment, which includes contributions from air emissions from stack and diffuse sources at LANL, ingestion of food gathered locally, drinking water from local supply wells, exposure to soils in the Los Alamos/White Rock area, and any other significant exposure route.

(3) *The on-site MEI is defined as someone who is in transit through LANL/DOE property but not necessarily employed by LANL.* DOE-owned roads are generally open to public travel. We calculate this dose for a hypothetical member of the public who is exposed while on LANL/DOE property.

(4) *An "average" resident of Los Alamos and White Rock.* We used average air concentrations from LANL's Air Monitoring Network (AIRNET) in Los Alamos and White Rock to calculate these doses. To these calculated doses, we add the contributions from other potentially significant sources, which may include the Los Alamos Neutron Science Center (LANSCE) and Technical Area (TA) 18 (LANSCE and TA-18

emissions are not measurable 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 harvested (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

- drinking radioactive effluent from the TA-50 Outfall and
- exposure of a member of the public in Acid Canyon.

Other scenarios, which we analyzed and reported in previous reports (ESP 1996, 1997, and 1998), have not changed since that time, and, therefore, we did not reanalyze them. For example, in previous reports (ESP 1996, 1997), we modeled potential doses from contaminated sediments in Mortandad Canyon. Sediment sampling from 1999 indicates no significant changes from past years, so we did not perform new dose calculations for this exposure pathway. For the best estimate of potential doses from exposure to contaminated sediments in Mortandad or Los Alamos Canyon, see last year's report (ESP 1998). Finally, because wild fruits and vegetables were collected in Mortandad Canyon during 1997 but not 1998 or 1999, the best assessment of the dose from ingestion of fruits and vegetables is in Chapter 3 of the 1998 report (ESP 1998).

2. General Methodology

Our radiological 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 appropriate methods described below. The general process for calculating doses from ingestion or inhalation is to multiply the concentration of each radionuclide in the food product, water, or air by the amount of food or water ingested or air inhaled to calculate the amount of radioactivity taken into the body. Then, we multiply this amount by factors specific to each radionuclide (DOE 1988b) to calculate the dose from each radionuclide. We sum these amounts to give the total dose from each pathway, such as ingestion and inhalation, throughout the year. Where local concentrations are not known but source amounts (amounts released from stacks or from diffuse emission sources) are known, we can calculate the doses at receptor locations using a model. The model combines source-term information with meteorological data to estimate where the radioactive material 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 radioactive material finds its way into nearby vegetation and animal material. Direct doses from radiation sources external to the body are calculated by multiplying the concentration of the radionuclide by the appropriate exposure factors (DOE 1988a). We use the Generation II (GENII) model for all dispersion evaluations (Napier et al., 1988) because this is the model DOE has accepted for dose calculation. The following sections provide some of the specifics of the modeling.

C. Dose Calculations and Results

Explanation of Reported Negative Doses: 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 analyses. This result 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 Environmental Surveillance at Los Alamos reports before 1997, we carried these negative concentrations through all calculations, but then, if the calculated dose was less than zero, we reported it as zero. Starting in 1997, and continuing with this report, we report doses 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 evaluate doses to individuals more accurately.

Many of the doses reported also include a number in parentheses. This number is one standard deviation of the dose. It means that approximately 67% of the dose values lie within the dose plus or minus one standard deviation. A large standard deviation means there is much uncertainty in the reported dose.

1. Dose to the Population within 80 km

We used the local population distribution to calculate the dose from 1999 Laboratory operations to the population within 80 km (50 miles) of LANL (Figure 3-1). Approximately 264,000 persons live within an 80-km radius of the Laboratory. We used county population estimates for 1999 provided by the University of New Mexico Bureau of Business and Economic Research (BBER). These statistics are available at *http://www.unm.edu/~bber/*.

The collective EDE (or dose) from Laboratory operations is the sum of the estimated dose each member of the population within an 80-km radius of LANL received. The 80-km ring is assumed to center on TA-3, the main technical area for Los Alamos National Laboratory. The dose calculation does not include those working on-site. It is intended to calculate doses to residents at their homes. Because this dose results from airborne radioactive emissions, we estimated the collective dose by modeling the transport of radioactive air emissions.

We calculated the collective dose with the GENII collection of computer programs (Napier et al., 1988). The analysis included airborne radioactive emissions from all types of releases. Stack emissions were modeled from all monitored stack sources. We also included diffuse emissions from LANSCE and Area G in the modeling. We used air concentration data from the nine AIRNET stations at Area G to calculate the diffuse emission source term from Area G. 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.

We calculated the 1999 collective population dose attributable to Laboratory operations to persons living within 80 km of the Laboratory to be 0.3 person-rem (person-rem is the quantity used to describe population dose), which compares with the population dose of 0.8 person-rem reported for 1998 (ESP 1999). Figure 3-2 shows the different contributors to the population dose. Short-lived air activation products such as carbon-11, nitrogen-13, and oxygen-15 that the accelerator at LANSCE creates contribute about 6% to the calculated population dose. This amount was much less than previous years because LANSCE operated very little during 1999. Diffuse emissions of uranium, plutonium, and tritium from Area G are about 9% of the dose, and tritium from stack sources is about 83% of the dose. Plutonium, uranium, and americium from stack sources contribute about 3% 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, the hypothetical highest exposure to a member of the public for the off-site MEI, has traditionally been at East Gate along State Road 502 entering the east side of Los Alamos County. East Gate is normally the location of greatest exposure 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. During 1999, however, LANSCE operated much less than in previous years, and the dose from LANSCE was very small.

To determine the location of the off-site MEI for 1999 (in the absence of a significant dose contribution from LANSCE), we used AIRNET results to find where the highest concentrations of radionuclides of potential LANL origin coincided with a residential area. To the dose calculated from AIRNET results, we added modeled doses from LANSCE and TA-18, whose emissions cannot be measured by AIRNET. We also added 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).

We found that the highest calculated dose from ambient air concentration of plutonium, americium, and tritium was at the apartments just south of the

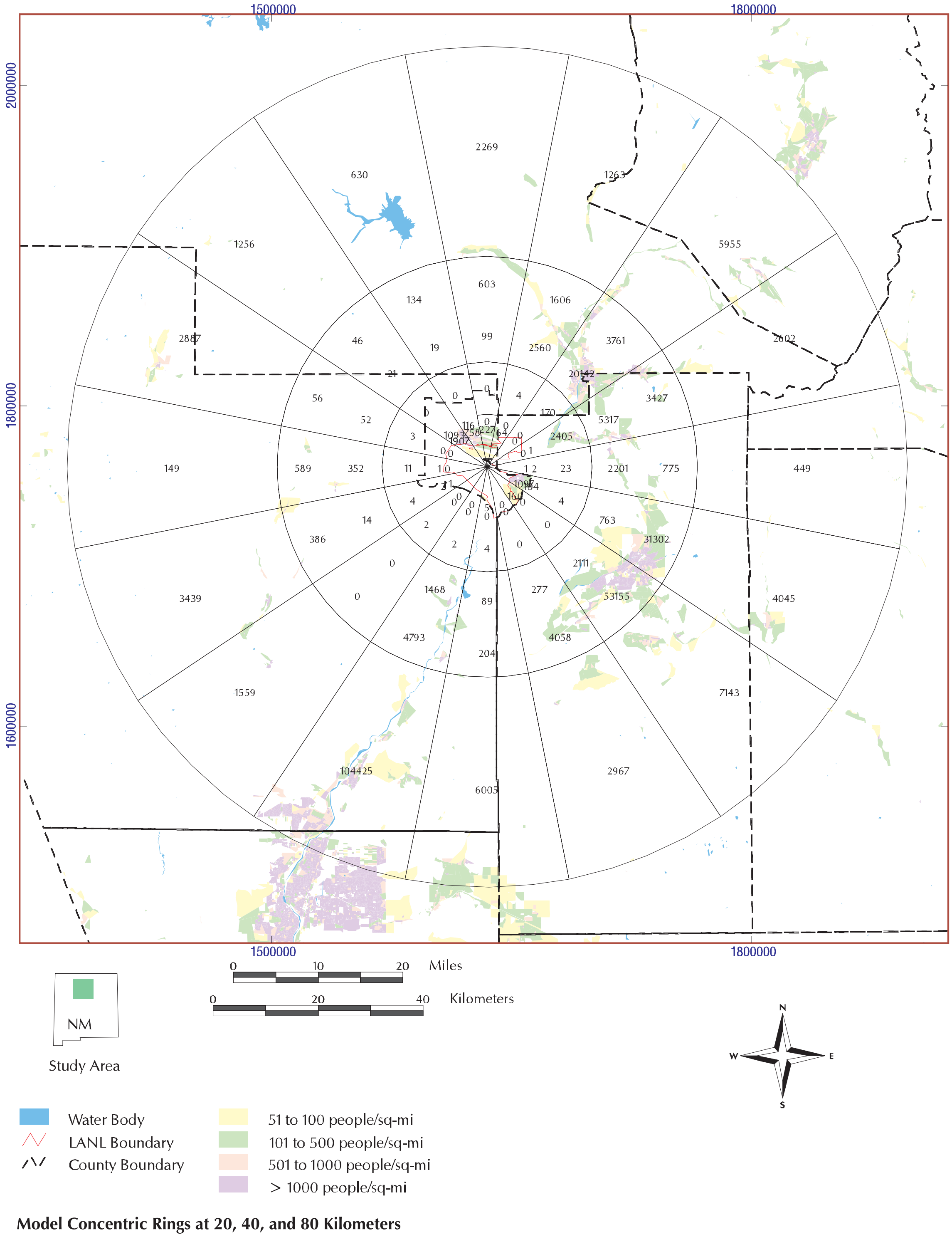

Figure 3-1. Estimated population around Los Alamos National Laboratory.

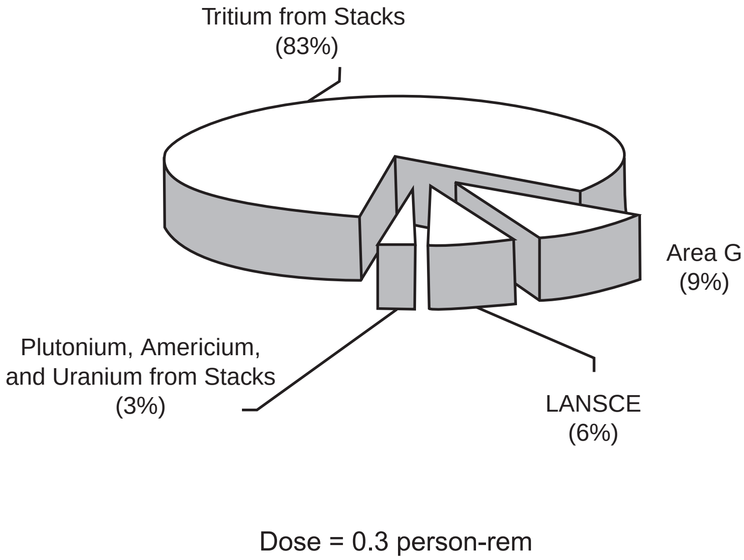

Figure 3-2. LANL contributions to population air pathway dose.

Shell Station on Trinity Drive in Los Alamos. The calculated net inhalation dose there was 0.04 mrem. To this inhalation dose, we added modeled doses from releases from LANSCE and TA-18 using the GENII computer code, which DOE developed for use in modeling doses from its facilities. The LANSCE contribution to the dose near the Shell Station was 0.0006 mrem, and the TA-18 contribution was 0.000003 mrem (Table 3-1). This calculated dose does not include the contribution from tritium from LANSCE because that tritium is included in the 0.04 mrem inhalation dose reported above.

Where references providing ingestion quantities were not available for locally grown or gathered food products, we attempted to quantify how much each food type contributed to the average person's ingestion dose. We interviewed residents of Los Alamos and White Rock to evaluate their ingestion habits. Based on these interviews, we concluded that average residents of Los Alamos/White Rock don't consume some of the food products gathered and analyzed this year. However, individuals who do consume products such as goat's milk and Navajo tea can calculate their individual doses by multiplying the amount they consume (in appropriate units) by the unit dose amounts provided in Table 3-2. We also concluded that the amounts of deer, elk, honey, and steer were less than the rates assumed in past environmental surveillance reports (ESP 1992–1999) and scaled these amounts to reflect local habits. The individual doses by food type for Los Alamos, White Rock, and San Ildefonso residents are discussed below. Table 3-2 shows these doses from consumption of various food types. However, the "average" doses shown in that table are based on national or regional averages (where these are known) and are not, in some cases, reflective of local consumption rates and habits. The total calculated food ingestion dose for an average resident of Los Alamos based on these calculations is 0.037 mrem.

LANL samples water supply wells each year, and the dose from drinking water from these wells is usually reported in these annual reports. Because of complications following the Cerro Grande fire, the subject matter experts determined that the sampling results for water supply wells for Los Alamos and White Rock were unreliable this year; please see more the detailed discussion in Chapter 5. The only two radionuclides (besides uranium, which is naturally occurring) that had concentrations above their detection limits were strontium-90 and americium-241. However, because of analytical problems, the strontium data were considered unreliable. The reported americium concentration was approximately the same as the concentration reported for a "blank." Blanks are sent to the lab and analyzed even though they are known to contain no radioactive material. They allow an assessment of the radioanalytical

Table 3-1. Summary of Doses to Various Receptors in the Los Alamos Area for 1999

	Receptors			
Sources	**Off-Site MEI Shell Station (mrem)**	**On-Site MEI Pajarito Road (mrem)**	**LA Average Resident (mrem)**	**WR Average Resident (mrem)**
LANSCE[a]	0.00060	0.00045	0.00045	0.00097
TA-18	0.0000025	2.6	0.0000053	0.000042
Ambient Air[b]	0.035	–0.039	–0.039	–0.043
Food Stuffs Ingestion[c]	0.037	0.037	0.037	0.038
Well Water Ingestion[d]	0.25	0.25	0.25	0.25
Soils Exposure[e]	0.33	0.33	0.33	0.33
Total	0.7	3	0.6	0.6

[a] These doses are modeled using GENII.
[b] 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.
[c] Calculated from ingestion of foods grown or gathered locally.
[d] Calculated based on average of doses from 1995–1998.
[e] These doses are modeled with the RESRAD Code 5.70 using radionuclide data from local soil concentrations.

process. In this case, because the blank showed about the same amount of americium-241 as the sample from one of the wells, the subject matter experts concluded that we should not report americium-241 as present in that well. Instead of using the current year samples, we used an average of the past four years' data. Because concentrations within large aquifers are unlikely to change rapidly, averaging results from recent years should give a reasonable estimate of current concentrations. Uranium, which was detected in the samples, is presumably natural in origin and is not included in the dose assessment, which is intended to calculate potential LANL impacts. The dose calculated based on the average of four years' data is 0.3 (0.3) mrem.

We also calculated the net dose received from soils in the Los Alamos/White Rock area. Analyses from all soil samples from the entire area in or near Los Alamos and White Rock were combined to estimate average soil concentrations in this area. These average soil concentrations (Table 6-1) were the RESRAD input concentrations used to calculate the dose from gross (no background subtraction) soil concentrations. We calculated the net dose by subtracting the dose from background soil concentrations from the dose from gross concentrations. We used a simplified version of the residential scenario originally developed by Fresquez and others (1996) in a computer model, RESRAD Version 5.82, to estimate the EDE from external radiation and the CEDE from internally deposited radiation (Yu et al., 1993). The primary simplification was that the modeling performed here did not consider horizons other than the surface zone from which the soil samples were taken (Table 3-3). The rationale behind the decision to not include the plant or drinking water ingestion or soil inhalation pathways here is that they are evaluated through direct measurement of these media. We have included direct exposure to, and ingestion of, contaminated soil in this assessment.

Our intent with these calculations is to evaluate the potential exposure contribution from past or present LANL operations. Because uranium-238 is the source for atmospheric radon-222, uranium from LANL could be a source for atmospheric radon gas. However, uranium-238 has a half-life of several billion years and must decay through several, long-lived radionuclides before radon is produced. Therefore, any Laboratory-produced uranium that was deposited in the soil will be producing negligible amounts of radon. For this reason, we do not include the radon pathway. We compared the doses calculated with those

Table 3-2. Ingestion Doses from Foods Gathered or Grown in the Area during 1999

	Dose per Unit Consumed in 1999 (mrem)	Average Consumption[a] Dose[b] (mrem)		Maximum Consumption[a] Dose[b] (mrem)	
Produce					
Regional Background (see text)	1.2×10^{-6}/lb	**0.00036**	**(0.00028)**	**0.0013**	**(0.0010)**
LANL On-Site Stations	-8.6×10^{-7}/lb[c]	–0.00025	(0.00028)	–0.00093	(0.0010)
Los Alamos Townsite	-1.0×10^{-6}/lb	–0.00029	(0.00029)	–0.0011	(0.0011)
White Rock & Pajarito Acres	-3.4×10^{-7}/lb	–0.00010	(0.00032)	–0.00037	(0.0012)
San Ildefonso Pueblo	-8.7×10^{-7}/lb	–0.00026	(0.00029)	–0.00094	(0.0011)
Cochiti Pueblo	-7.9×10^{-7}/lb	–0.00023	(0.00028)	–0.00085	(0.0010)
Piñon					
Regional Background (see text)	1.3×10^{-2}/lb	**0.038**	**(0.0043)**	**0.13**	**(0.014)**
Los Alamos	–0.0021/lb	–0.0063	(0.0087)	–0.021	(0.029)
White Rock	–0.0013/lb	–0.0038	(0.0057)	–0.013	(0.019)
San Ildefonso Pueblo	–0.0045/lb	–0.014	(0.0053)	–0.045	(0.018)
Goat's Milk					
Regional Background (Albuquerque)	0.0001/gal				
Los Alamos	–0.0009/gal				
White Rock	0.0083/gal				
Honey					
Regional Background	0.00012/lb	0.0004	0.0051	0.0013	0.017
Los Alamos	–2.5 E-10/lb	–9.2 E-10	8.70 E-09	–2.70 E-09	2.90 E-08
White Rock	–0.00011/lb	–0.00037	0.0052	0.0012	0.017
Navajo Tea (Cota)					
Regional Background (Española)	0.00012/L				
Los Alamos	0.00036/L				
White Rock	–0.00052/L				
San Ildefonso Pueblo	0.00075/L				
Egg					
Regional Background (Española)	0.00022/2 eggs	**0.040**	**(0.017)**	**0.060**	**(0.025)**
Los Alamos	–0.000063/2 eggs	–0.012	(0.021)	–0.017	(0.032)
White Rock/Pajarito Acres	0.000021/2 eggs	0.0039	(0.018)	0.0058	(0.027)
San Ildefonso Pueblo	–0.000074/2 eggs	–0.014	(0.024)	–0.020	(0.036)
Spinach					
Regional Background	0.0048/lb	**0.0013**	**0.00021**		
Los Alamos	–0.0025/lb	–0.00067	0.00036		
White Rock	–0.0015/lb	–0.00041	0.00029		
San Ildefonso Pueblo	–0.0037/lb	–0.001	0.0005		
Steer					
Regional Background	2.7×10^{-5}/lb muscle 0.14/lb bone	**7.3**	**1.1**	**8.5**	**1.2**
San Ildefonso Pueblo	0.0013/lb muscle 0.0032/lb bone	0.44	1.3	0.51	1.5

Table 3-2. Ingestion Doses from Foods Gathered or Grown in the Area during 1999 (Cont.)

	Dose per Unit Consumed in 1999 (mrem)	Average Consumption[a] Dose[b] (mrem)	Maximum Consumption[a] Dose[b] (mrem)
Deer			
Regional Background (Dulce, NM)	0.00015/lb muscle		
	0.038/lb bone		
Los Alamos Area Roads	0.00015/lb muscle		
	0.040/lb bone		
Elk			
Regional Background (Coyote, NM)	0.00060/lb muscle		
	0.062/lb bone		
Los Alamos Area Roads	–0.00035/lb muscle		
	0.039/lb bone		
Game Fish			
Regional Background (upstream)	0.00052/lb		
Cochiti (downstream)	0.00040/lb		
Nongame Fish			
Regional Background (upstream)	0.0012/lb		
Cochiti (downstream)	0.00023/lb		

[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.
Note—doses presented in this table are based on foodstuffs and biota data included in Chapter 6.
Note—Background doses (indicated in the table as “Regional Background”) are calculated based on food products from areas distant from LANL. Net doses are calculated by subtracting background doses from those at a sampled location near LANL.

Table 3-3. RESRAD Input Parameters for Soils Exposure Evaluation for 1999

Parameter	Value	Comments
Area of contaminated zone	10,000 m^2	RESRAD default value; a large 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 et al., 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 topmost unit being sand (Purtyman et al., 1983) and Table 13.1 in the data handbook (Yu et al., 1993)
Humidity in air	4.8 g/m^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)
Wind Speed	2 m/s	RESRAD default value
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	8,400 m^3/yr	RESRAD default value
Mass loading for inhalation	9×10^{-5} g/m^3	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 in study area each year	0.5	RESRAD default value
Fraction of time spent outdoors in study area	0.25	RESRAD default value
Shape factor	1	Corresponds to a contaminated area larger than a circular area of 1,200 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)

from exposure to background soils from the Embudo, Cochiti, and Jemez areas.

The net dose and one standard deviation for Los Alamos/White Rock area were found to be 0.3 (0.6) mrem. The background dose was 0.6 (0.2) mrem. The dose summary table (Table 3-1) includes the Los Alamos/White Rock doses. They are also added to the dose to an average member of Los Alamos or White Rock from other pathways or sources as described below. These doses are similar to the doses reported last year (within the range of uncertainty), as would be expected in the absence of any large-scale ground-contaminating event.

Figure 3-3 shows that the combination of the AIRNET calculated dose of 0.04 mrem, the GENII modeled doses of 0.0006 and 0.000003 mrem (from LANSCE and TA-18, respectively), the food ingestion dose of 0.037 mrem (Table 3-4), the water ingestion dose of 0.3 mrem, and the soils dose of 0.3 mrem gives a total off-site MEI dose of 0.7 mrem (Table 3-1). This level is far below the applicable 100 mrem standard, and we conclude these doses would cause no human health effects.

This dose is not comparable directly with the doses reported in Chapter 2, which are calculated for compliance with 40 CFR 61. The Chapter 2 dose includes only the air pathway and is modeled using a different computer model, CAP88, as required by 40 CFR 61. The dose presented here is for all pathways and uses the DOE GENII computer code.

3. Dose to Maximally Exposed Individual on Los Alamos National Laboratory/Department of Energy Property (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 LANL/DOE-owned local road that is open to the public most of the time. During experiments that have the potential to produce a dose of several mrem per operation, public access is restricted by closing Pajarito Road between White Rock and TA-51. Exposure to a member of the public would be negligible during road closures. However, we evaluated doses to an individual who passed by the facility frequently and received very small exposures from operations that took place while the road remained open. The exposure scenario likely to give the largest cumulative dose to a member of the public is a slow jogger who passes the facility frequently. Experimentation at TA-18 did not result in any road closures during 1999, so the total measured exposure was used in the dose calculation. We divided the total measured dose by 16 to account for the amount of time a member of the public might realistically have been in the area.

The dose we calculated by this method for 1999 operations of TA-18 is 2.6 mrem. Assuming that the

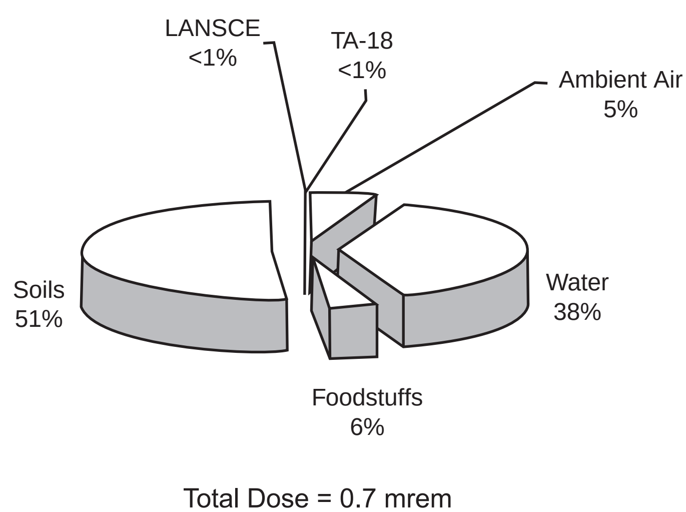

Figure 3-3. LANL contributions to maximally exposed off-site hypothetical individual during 1999.

Table 3-4. Compilation of Calculated Ingestion Doses for Los Alamos and White Rock

	Los Alamos (mrem)	1s (mrem)	White Rock (mrem)	1s (mrem)
Deer	**0.018**	**0.0044**	**0.018**	**0.0044**
Eggs	NC[a]	0	NC	0
Elk	0.021	0.025	0.021	0.025
Game Fish	NC	0	NC	0
Goat's Milk	NC	0	NC	0
Honey	NC	0	NC	0
Nongame Fish	NC	0	NC	0
Navajo Tea	NC	0	NC	0
Pinon	NC	NC	NC	NC
Produce	–0.000292	0.000289	–0.000101	0.000321
Spinach	–0.0007	0.0004	–0.0004	0.0003
Steer	NC	NC	NC	0
Total	0.037	0.025	0.038	0.025

[a] NC—not calculated. We did not calculate values for these foods because we determined that they were not a significant part of the average resident's diet.
Note—Bold indicates where value is larger than its uncertainty.

jogger was a resident of Los Alamos during 1999, the 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 appear in Table 3-1 and in Figure 3-4. The total calculated dose to this hypothetical resident of Los Alamos would be 3.2 mrem. This dose is about 3% of the DOE public dose limit of 100 mrem.

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

We calculated doses to the average residents of Los Alamos and White Rock based on average air concentrations (as determined from AIRNET data) in these areas. To these calculated doses, we added the contributions from LANSCE and TA-18 (some radionuclides emitted from LANSCE and TA-18 are not measurable by AIRNET), from ingestion of local food products and water, and from exposure to radionuclides in soil. In years before 1997, the Laboratory's annual environmental surveillance report did not include 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 here are not directly comparable with those earlier estimates of average doses in Los Alamos and White Rock.

a. Los Alamos Dose. The total LANL contribution to the dose to an average resident of Los Alamos during 1999 was 0.6 mrem from all pathways (Table 3-1). Figure 3-5 shows the various Laboratory contributions to this dose. The remainder of this section explains what contributed to this calculated 0.6 mrem dose.

We compiled air concentration data for uranium, plutonium, americium, and tritium from stations #4 (Barranca School), #5 (Urban Park), #6 (48th Street), #7 (Shell Station), #8 (McDonalds), #9 (Los Alamos Airport), #10 (East Gate), #12 (Royal Crest Trailer Court), #60 (Los Alamos Canyon), #61 (Los Alamos Hospital), and #62 (Trinity Bible Church). The inhalation dose calculated from the Los Alamos AIRNET data is –0.04 mrem and includes a subtraction for background air concentrations. The dose does not include a contribution from uranium isotopes because, based on evaluation of the ratio of uranium isotopes 234 and 238, only natural uranium was measured in the ambient air. Because no significant LANL-derived uranium was measured, we saw no reason to add uranium into the dose. Discussion of negative doses appears earlier in this chapter.

Because most of the radioactive emissions from LANSCE and TA-18 are not measurable by AIRNET, we modeled the dose from these emissions to a central

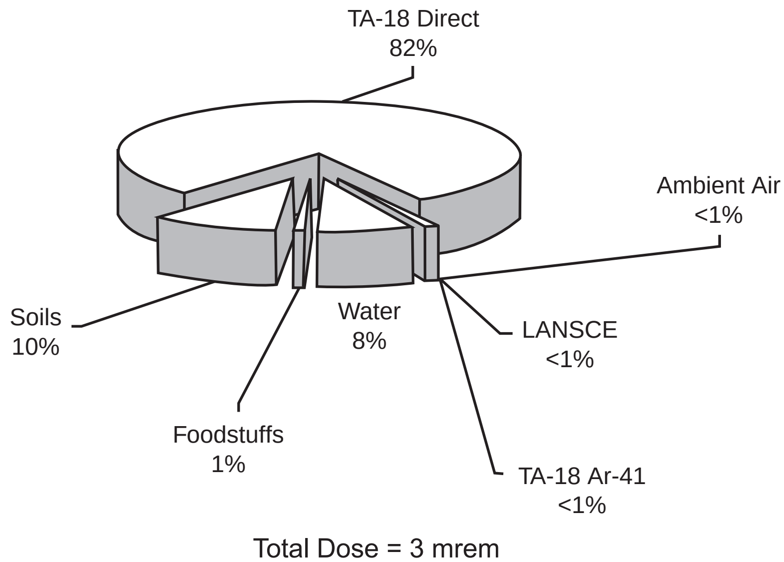

Figure 3-4. LANL contributions to maximally exposed on-site hypothetical individual during 1999.

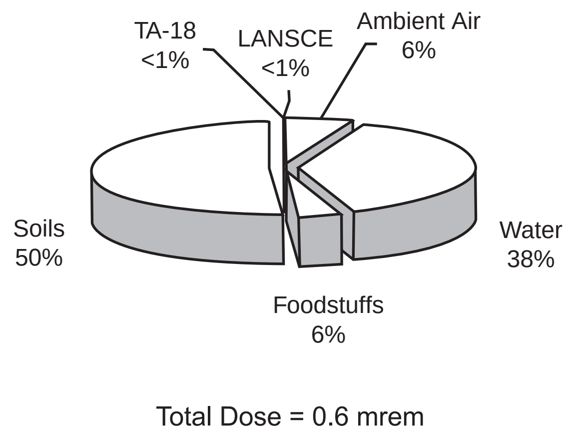

Figure 3-5. LANL contributions to an average Los Alamos resident's radiological dose in 1999.

point in Los Alamos using the GENII computer code. Exposure to the radioactive plume as it passes was the only significant pathway. We calculated the dose to a typical Los Alamos resident to be 0.0005 mrem from LANSCE and 0.000005 mrem from TA-18 (Table 3-1).

As discussed earlier, the dose calculated from exposure to contaminated soil in Los Alamos is 0.3 mrem. Because the one-standard-deviation value associated with this dose is 0.6 mrem, the net dose most likely lies within a range that includes zero.

Ingestion of locally grown or gathered food could provide additional dose. We calculated the dose from ingestion of food gathered or grown in the Los Alamos area and consumed by locals to be 0.037 mrem (Table 3-1).

As described above, we calculated the water ingestion dose from the Los Alamos/White Rock water supply by averaging the previous four years' data. The calculated dose is 0.3 (0.3) mrem with the uncertainty of one standard deviation in parentheses.

Summing all the possible contributors results in a total dose to an average Los Alamos resident of 0.6 mrem. This calculated dose derives mainly from water consumption and soil exposure. The uncertainties in these numbers indicate that this calculated dose is statistically indistinguishable from zero.

b. White Rock Dose. The total dose from all pathways to an average resident of White Rock from Laboratory operations was 0.6 mrem in 1999. The methodology for calculating the White Rock dose was identical to that used for Los Alamos. We used the following AIRNET stations to calculate average White Rock air concentrations: #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 net air inhalation dose calculated from these data is –0.04 mrem. The dose contribution from LANSCE operations in 1999 was 0.001 mrem, and the contribution from TA-18 was 0.00004 mrem (Table 3-1).

The potential dose from the water supply is the same as calculated for Los Alamos and was 0.3 (0.3) mrem based on an average of water sampling results for 1995–1998. Living on local soils provides the same dose potential as to a member of Los Alamos (because all sites in the Los Alamos/White Rock area were grouped together for the soil exposure evaluation); the dose would be 0.3 mrem (0.6 mrem) from exposure to soils. Ingestion of locally grown or gathered food products would provide a dose of 0.037 mrem (Table 3-1).

Summing all the possible contributors results in a total dose to an average White Rock resident of 0.6 mrem. This calculated dose derives mainly from water consumption and soil exposure. The uncertainties in these numbers indicate that the actual dose most likely lies within a range that includes zero.

5. Ingestion Doses for Various Locations in Northern New Mexico

We collected and analyzed many different types of food products for their radionuclide content. The following section presents the details of calculating food ingestion doses for various locations and food types 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 if the foods were gathered from those areas and are part of the "average" diet. These doses are tabulated in Table 3-2.

The following sections describe the doses calculated for each type of food. Doses are calculated (Table 3-2) for regional background concentrations (foods that were grown or gathered distant from LANL and that are presumed to reflect concentrations not affected by LANL operations) and for net concentrations at all other locations. We calculated net concentrations by subtracting background concentrations from those at the location of interest. The general process for calculating ingestion doses is to multiply the amount of each radionuclide ingested in a food product by a dose conversion factor for that radionuclide (DOE 1988b) to obtain the dose contribution for each radionuclide. We sum these contributions to calculate the total dose from each food type.

We performed three calculations for foodstuffs whose average and maximum consumption values are documented: one assuming average consumption rates, one assuming maximum hypothetical consumption rates, and one for dose-per-unit of food consumed. We have been reviewing the consumption rates used in our ingestion calculations and have begun updating these rates to be consistent with more recent studies compiled in the Environmental Protection Agency's Exposure Factors Handbook (EPA 1989), where appropriate. Therefore, the average and maximum doses calculated here may not be comparable with earlier reports. Unit doses are, however, directly comparable. From the Exposure Factors

Handbook, we use the mean and 95% values for average and maximum intake, respectively, for households that garden in the western United States. The consumption rates we 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. Consumption doses are calculated for all foodstuffs for which we had acceptable data. The uncertainty of one standard deviation is reported in parentheses.

a. Ingestion of Produce (Fruits and Vegetables). We collected fruits and vegetables at a number of locations throughout northern New Mexico. Because the plant types collected differed according to site, it was not possible to compare produce ingestion doses from location to location. Although the specific food types differed at various locations, Table 6-3 shows the values for the category of fruits and vegetables collected. For this report, we assume an average consumption rate of 294 lb per year and a maximum rate of 1,071 lb per year of homegrown fruits and vegetables (EPA 1997). These calculated ingestion amounts are based on Tables 13-12 and 13-17 (EPA 1989), which apply to intake of homegrown fruits and vegetables among western households that garden. This calculation assumes a body weight of 78.1 kg (Table 7-2, EPA 1989), which is the average body weight for adult males aged 18 to 75. The highest doses calculated occurred from ingestion of food products in regional background locations. The average consumption net annual dose at LANL on-site locations was –0.0003 (0.0003) mrem.

b. Ingestion of Piñon. Doses for ingestion of piñon tree nuts or tree shoot tips are calculated because of the importance of piñon in the local diet. The piñon trees produce piñon nuts irregularly in non-annual cycles about every seven to 10 years. Nuts were only available in 1998 at regional locations and sites on LANL property. The analytical results from the nuts are included in Chapter 6, but we did not perform dose calculations because nuts were not collected from local, non-LANL areas. Because results from piñon nuts were not available, we collected and analyzed piñon tree shoot tips, and Table 6-14 reports those results. Most literature suggests that the inedible portions of plants tend to have higher concentrations of radionuclides than the edible portions of plants (Fresquez et al., 1998a). Therefore, using piñon tree foliage to estimate doses for the ingestion of pine nuts probably overestimates risk. We included all radionuclides shown in Table 6-14 in the dose calculation. The highest (and only positive) unit dose of 0.013 (0.0014) mrem per pound of piñon shoots was calculated for the background station average. We assumed that the average annual consumption was about 3 lb and that the maximum annual consumption was 10 lb. We calculated the dose from average consumption of piñon shoots at San Ildefonso Pueblo for 1999 to be –0.014 (0.005) mrem.

c. Ingestion of Goat's Milk. Goat's milk was collected from Los Alamos, White Rock/Pajarito Acres, and Albuquerque (the background location) and analyzed (Table 6-7). "Average" consumption doses are not reported because few people drink goat's milk (Table 3-2). We report dose per gallon consumed so that those people who do drink goat's milk may calculate their dose. Some doses for White Rock/ Pajarito Acres and for the Albuquerque (background) milk were positive. The net dose in Los Alamos was negative but smaller than its associated uncertainty. The positive doses were also smaller than their uncertainties.

d. Ingestion of Navajo Tea. We collected Navajo tea (Cota) stems from Los Alamos, White Rock/Pajarito Acres, San Ildefonso Pueblo, and background locations. All calculated doses were smaller than their associated uncertainties. We calculated positive, very small doses for Los Alamos, San Ildefonso, and Española (background) area. The largest dose we calculated was for San Ildefonso and was 0.0008 (0.006) mrem per liter of tea consumed (Table 3-2).

e. Ingestion of Chicken Eggs. We collected and analyzed chicken eggs from Los Alamos, White Rock/ Pajarito Acres, San Ildefonso Pueblo, and from Española (the background location). All of the doses we calculated from egg consumption were extremely small; only the background dose was statistically different from zero. We calculated positive doses for the background location in Española and for White Rock (Table 3-2). An annual dose from an average consumption of one egg per day from the background location would be 0.04 (0.02) mrem.

f. Ingestion of Steer Meat and Bone. We collected free-range cattle from San Ildefonso Pueblo lands, and we compared the results of the analyses with regional background averages (Table 6-12). Table 3-2 presents the doses for consumption of meat and bone from the average background steer and for consumption of the steer from San Ildefonso Pueblo.

(Note: Pieces of bone sometimes end up in foodstuffs.) Consuming muscle and bone from San Ildefonso Pueblo would give doses of 0.001 and 0.003 mrem per pound, respectively.

g. Ingestion of Deer Meat and Bone. We collected deer killed along roadways within and around Los Alamos, analyzed their meat and bone tissue, and compared the results with regional background samples. We calculated the dose from the background deer to be 0.0002 mrem per pound of muscle consumed and 0.04 mrem per pound of bone consumed. The deer killed in the Los Alamos area would give net doses of 0.0002 and 0.04 mrem per pound consumed of muscle and bone, respectively.

h. Ingestion of Elk Meat and Bone. We collected elk around Los Alamos, analyzed their meat and bone tissues, and compared the results to regional background elk samples. We calculated the dose from the background elk to be 0.0006 mrem per pound of muscle consumed and 0.06 mrem per pound of bone consumed. Calculated net dose for consumption of the Los Alamos elk was –0.0004 mrem per pound of muscle and 0.04 mrem per pound of bone consumed (Table 3-2).

Note on Deer and Elk Analyses:

A two-year elk tracking study concluded that elk that spent an average of 50% of their time on LANL lands contained radionuclide concentrations in muscle and bone similar to those in elk collected as roadkill for the Laboratory's environmental surveillance program (Fresquez et al., 1998b). Therefore, it is our conclusion that these roadkill deer and elk provide a reasonable representation of the contamination levels in deer and elk populations that frequent LANL properties.

i. Ingestion of Fish. We compared surface- and non-bottom-feeding fish (referred to as game fish), including trout, walleye, and bass, collected from reservoirs upstream of LANL (Abiquiu, Heron, and El Vado) with game fish collected from Cochiti Reservoir, downstream of LANL. The calculated dose per pound from ingesting downstream game fish [0.0004 (0.0006) mrem] was slightly lower than the 0.0005 (0.0004) mrem per pound dose for upstream fish although the uncertainties indicate the doses are not statistically different from each other (Table 3-2).

We collected bottom-feeding fish (referred to as nongame fish), including carp, catfish, and sucker, 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 3-2). The assumed average and maximum consumption rates were the same for nongame fish as for game fish.

j. Ingestion Doses for San Ildefonso Pueblo. Residents of San Ildefonso Pueblo 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 we used these analyses to calculate doses from ingestion. Table 3-2 contains the doses from ingestion of all foods grown or gathered locally. Samples from wells in and around San Ildefonso Pueblo were not available for this report.

k. Summary of Food Product Ingestion Doses. Statistically significant doses were seen for consumption of several food types from background locations. However, the only statistically significant *net* dose we calculated was for consumption of deer from areas around Los Alamos. By significant, we mean that the uncertainty in the measurements (which is shown in parentheses) is smaller than the measured number and that the measured number is positive. 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 different from zero in a statistically significant sense.

6. Special Scenarios

a. Potential Radiological Dose to a Member of the Public Visiting Acid Canyon, Los Alamos. Acid Canyon is a tributary of upper Pueblo Canyon and received discharges of radioactive waste during the 1940s, 1950s, and 1960s from former TA-1 and TA-45. Since that time, the upper reaches of Acid Canyon have undergone a series of investigations. During 1999, detailed sampling by ER, NMED, and EPA was based on geomorphic assessment of where contaminants are most likely to be found (Reneau et al., 2000). The sampling revealed that some sediments along the several hundred meters of the South Fork of Acid Canyon contain relatively high concentrations of radionuclides. This area is open to the public. In fact, a maintained trail crosses this part of Acid Canyon in two places, and sections of the trail parallel the canyon for much of its length. Residential areas nearby make this a popular area for walking, running, biking, and general recreation.

We calculated the radiological dose that a frequent adult visitor to this area could receive. To develop this dose calculation, we evaluated all the sediment sampling results to determine how much radioactive material could be contributed to ambient air. We summed the contributions to calculate the total amount of radioactive material we would conservatively expect to be suspended in the local air. We assumed that this air was not mixing with air outside the immediate area. In other words, all the air was derived from suspension of the soils along the stream sides and within about 25 meters of the stream on both sides of the canyon.

An individual was assumed to breathe the local air for an hour per day, every day of the year. This individual was assumed to be breathing very heavily for 10 minutes and breathing lightly for the rest of the time. A possible scenario is as follows:

Someone has been running hard for a few minutes and runs up the trail into the upper Acid Canyon area. When the individual reaches the area (the area is too small for someone to jog in for any length of time), he or she sits down on the banks of the stream to relax and recover and remains there for 50 minutes. We also assume that the individual ingests 100 mg of dust derived locally per visit (EPA 1989).

The dose calculated, based on the assumptions described above, is 1.6 mrem for a year. About 1.2 mrem of this would come from ingestion, and most of the remaining dose would be from inhalation. It is unlikely that a casual adult user would receive more than this dose although scenarios can certainly be postulated that involve larger ingestion and therefore larger dose. This dose is less than 2% of the applicable all-pathway limit of 100 mrem. At such low doses, we conclude there would be no human health effects.

b. Ingestion of Radioactive Effluent from the Technical Area 50 Outfall. TA-50 discharges residual radioactive effluent to Mortandad Canyon. During 1999, the effluent included tritium, 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 no physical barriers prevent public access to this canyon, it is possible, though unlikely, 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, we present the dose-per-liter consumed here so that others may draw conclusions about the radiological dose and relative hazard that this effluent represents. We calculated the dose from effluent consumed to be 1.0 mrem per liter, essentially the same as last year's reported dose of 0.99 mrem per liter (ESP 1999). The plutonium isotopes (-238 and -239, -240) and americium-241 contribute the majority of this calculated 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 naturally in the environment. Estimates of dose rates from natural radiation come from 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 1975).

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. We assume the dose from radon-222 decay products to local residents 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. The NCRP (NCRP 1984, 1987a) has recommended a national survey.

Another naturally occurring source of radiological dose to the body is from naturally occurring 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. Doses from the global fallout associated with aboveground nuclear testing, the accident at Chernobyl, venting of belowground nuclear tests, and burn-up of satellites are a small fraction of total environmental doses (<0.3% [NCRP 1987a]).

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 appear graphically in Figure 3-6. 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 414 mrem.

E. Risk to an Individual from Laboratory Operations

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 are generally delivered at low dose rates—gradually, throughout the year. Our conclusion is that these doses would cause no adverse health effects, including cancer. Therefore, we have not calculated risks associated with the low doses presented in this report. A reader may calculate risk by multiplying the doses reported here by a cancer risk factor. The factor should be in units of excess cancer death risk per mrem or be converted to these units. For example, the Environmental Protection Agency (EPA 1994) has published such a factor in units of risk per Sievert. A Sievert (Sv) is 100 rem or 100,000 mrem.

The doses calculated from natural background radiation and medical and dental radiation can be compared with the incremental dose caused by radiation from Laboratory operations. The average doses to residents of Los Alamos and White Rock from Laboratory activities were 0.6 mrem in each community. The exposure to average 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 1975).

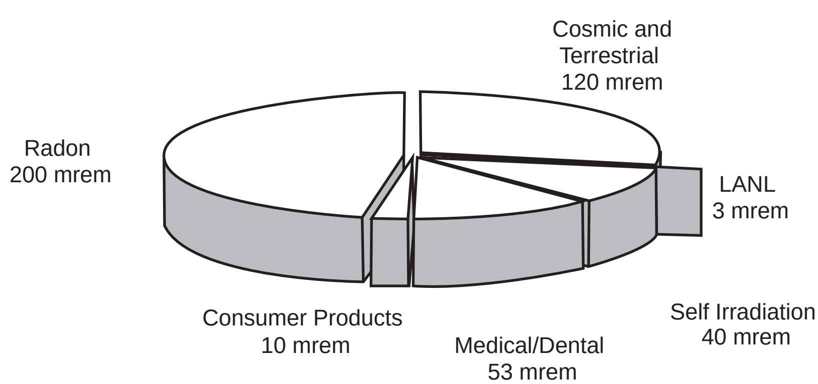

Figure 3-6. All contributions to the 1999 dose for the Laboratory's maximally exposed individual.

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4. Air Surveillance

4. Air Surveillance

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Abstract

Los Alamos National Laboratory (LANL or the Laboratory) operations emit radioactive and nonradioactive air pollutants and direct penetrating radiation into the atmosphere. Air surveillance at Los Alamos includes monitoring emissions, ambient air quality, direct penetrating radiation, and meteorological parameters to determine the air quality impacts of Laboratory operations.

The ambient air quality in and around the Laboratory meets all Environmental Protection Agency (EPA) and Department of Energy (DOE) standards for protecting the public and workers.

During 1999, a greatly reduced run cycle at Los Alamos Neutron Science Center (LANSCE) resulted in radioactive air emissions that were less than one-fourth of 1998 emissions. Tritium emissions doubled over 1998 emissions; this increase is primarily due to tritium facility deactivation work. Plutonium emissions from the Chemistry and Metallurgy Research (CMR) building were higher in 1999 because of increased plutonium powder operations. No radioactive air emissions required reporting under EPA or the New Mexico Environment Department (NMED) requirements for unplanned releases. Criteria pollutant emissions for 1999 were larger than 1998 emissions because of a 20% increase in natural gas usage at the steam plants.

Radioactive ambient air quality off-site was similar to 1998. Highest air concentrations caused by Laboratory operations were measured at on-site locations: Technical Area (TA) 54, Area G; TA-21; and TA-16. Tritium concentrations increased and plutonium concentrations decreased at TA-21, reflecting changing operations. Several instances of elevated air concentrations were investigated in 1999. These elevated air concentrations were the result of routine Laboratory operations, and in one case, construction activity in the Los Alamos townsite, resuspending contaminants from the original Laboratory TA-1. None of these elevated air concentrations exceeded DOE or EPA protection standards for workers or the public.

During 1999, measurements of direct penetrating radiation were similar to 1998 values. Highest doses were measured at locations on-site at Mortandad Canyon, the LANSCE lagoons, and Area A at LANSCE. An evaluation of alternate direct penetrating radiation measurement systems supports the conclusion that our thermoluminescent dosimeters (TLDs) overrespond by about 50% to low-energy gamma radiation; therefore, actual doses at many TA-54, Area G, locations are smaller than reported here. We report one full year of albedo dosimeter (neutron) measurements, taken on-site in the vicinity of TA-18. For 1999, the neutron correction factor we used in determining neutron doses was revised, resulting in higher measured doses. The highest dose, 36.5 mrem, was measured in the parking lot directly east of TA-18.

Temperatures were somewhat above normal for 1999. Total precipitation for the year was 87% of normal; however, annual snowfall was only 49% of normal 30-year average values.

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

4. Air Surveillance

A. Ambient Air Sampling *(Craig Eberhart and Jean Dewart)*

1. Introduction

The radiological air sampling network, referred to as AIRNET, at Los Alamos National Laboratory (LANL or the Laboratory) measures environmental levels of airborne radionuclides that may be released from Laboratory operations. Laboratory emissions include plutonium, americium, uranium, tritium, and activation products. Each AIRNET 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 in particulate matter such as uranium and thorium, terrestrial radon diffusing out of the earth and its subsequent decay products, and materials resulting from interactions with cosmic radiation (for example, natural tritiated water vapor produced by interactions of cosmic radiation and stable water). Table 4-1 summarizes regional levels of radioactivity in the atmosphere, which are useful in interpreting air sampling data.

Particulate matter in the atmosphere is primarily caused by aerosolized soil, which is dependent on meteorological conditions. Windy, dry days can increase the soil entrainment, 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.

Ambient air concentrations, as calculated from the AIRNET sample measurements, are compared with environmental compliance standards or workplace exposure standards depending on the location of the sampler. Concentrations in areas accessible to the public are usually compared with the 10 mrem concentration the Environmental Protection Agency (EPA) published in 40 CFR Part 61 Appendix E Table 2—"Concentration Levels for Environmental Compliance." Concentrations in controlled access areas are usually compared with Department of Energy (DOE) Derived Air Concentrations (DAC) for workplace exposure because access to these areas is generally limited to workers with a need to be in the controlled area. Finally, any doses in this section have been calculated by converting the individual isotopic concentrations using the EPA's 10 mrem concentrations. These doses are not necessarily comparable to the ones presented in Chapter 3 because additional data, such as water, food, and soil analyses, are used for estimating the Chapter 3 doses.

2. Air Monitoring Network

During 1999, the Laboratory operated more than 50 environmental air samplers to sample radionuclides by collecting water vapor and particulate matter. AIRNET sampling locations (Figures 4-1 through 4-4) are categorized as regional, pueblo, perimeter, quality assurance (QA), Technical Area (TA) 21, TA-15 and TA-36, TA-54 (Area G), or other on-site locations. Four regional sampling stations determine regional background and fallout levels of atmospheric radioactivity. These regional stations are located in Española and El Rancho and at two locations in Santa Fe. The pueblo monitoring stations are located at San Ildefonso and Jemez Pueblos. In 1999, more than 20 perimeter stations were within 4 km of the Laboratory boundary.

Because maximum concentrations of airborne releases of radionuclides would most likely occur on-site, more than 20 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, a backup station is located at East Gate. Stations can also be classified as being inside or outside a controlled area. A controlled area is a posted area that potentially has radioactive materials or elevated radiation fields (DOE 1988a). 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. Generally, each AIRNET sampler continuously collects particulate matter and water vapor samples for approximately two weeks per sample. Particulate matter is collected on 47-mm polypropylene filters at an airflow rate of about 0.11 m^3 per minute. The vertically mounted canisters each contain about 135 grams of silica gel with an airflow rate of about 0.0002 m^3 per minute; the gel collects the water vapor samples. This silica gel is dried in a drying oven before use in the field to remove most residual water. The gel is a desiccant that removes moisture from the sampled air; the moisture is then distilled, condensed, collected as a liquid, and shipped to the analytical laboratory. The AIRNET project plan (ESH-17 1999) and the numerous procedures through which the plan is implemented provide details about the sample collection, sample management, chemical analysis, and data management activities.

b. Data Management. Using a palm-top microcomputer, we recorded the 1999 field data, including timer readings, volumetric airflow rates at the start and stop of the sampling period, and comments pertaining to these data, electronically in the field. We later transferred these data to an electronic table format within the Air Quality Group (ESH-17) AIRNET Microsoft Access database. We also received the analytical data described in the next section in electronic form and loaded them into the database.

c. Analytical Chemistry. A commercial laboratory analyzed each 1999 particulate matter filter for gross alpha and gross beta activities. These filters were also grouped across sites, designated "clumps," and analyzed for gamma-emitting radionuclides. For 1999, clumps ranged from six to nine filters. Gamma-emitting radionuclides were also measured at each Federal Facilities Compliance Agreement station by grouping the filters collected each quarter. We combined half filters from the six or seven sampling periods at each site during the quarter to prepare a quarterly composite for isotopic analyses for each AIRNET station. These composites were dissolved, separated chemically, and then analyzed for isotopes of americium, plutonium, and uranium using alpha spectroscopy. Every two weeks, ESH-17 staff distilled the water from the silica gel cartridges and submitted the distillate to a commercial laboratory for tritium determination by liquid scintillation spectrometry. All analytical procedures meet the requirements of 40 Code of Federal Regulations (CFR) 61, Appendix B, Method 114. The AIRNET project plan provides a summary of the target minimum detectable amounts (MDA) for the biweekly and quarterly samples.

d. Laboratory Quality Control Samples. For 1999, ESH-17 and the contractor analytical laboratories maintained a program of blank, spike, duplicate, and replicate analyses. This program provided information on the quality of the data received from analytical chemistry laboratories. The chemistry met the QA requirements for the AIRNET program.

4. Ambient Air Concentrations

a. Explanation of Reported Concentrations Including Negative Values. Tables 4-1 through 4-12 summarize the ambient air concentrations calculated from the field and analytical data. Table 4-1 summarizes the average background concentrations of airborne radioactivity. Tables 4-2 through 4-12 summarize ambient air concentrations by the type of radioactivity or by specific radionuclides. The summaries include the number of results; the number of these results less than the uncertainty; the maximum, minimum, and average concentrations; the sample standard deviation; and, for the group summaries, the 95% confidence intervals. The number of results are normally equal to the number of samples analyzed, whereas the number less than the uncertainty is the number of analyses that do not have a measurable amount of the material of interest. The MDA used in Tables 4-11 and 4-12 are the levels that the instrumentation could detect under ideal conditions. Finally, all AIRNET concentrations and doses are total measurements without any type of regional background subtractions or corrections unless otherwise stated.

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 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 air concentration standard deviations in the tables represent one standard deviation as calculated from the sample data. All ambient concentrations are activity concentrations per actual cubic meter of sampled air.

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, which can be negative or positive and overwhelm the true value. Arbitrarily discarding negative values when the true value is near zero will result in overestimated ambient concentrations.

b. Gross Alpha and Beta Radioactivity. We use gross alpha and gross beta analyses 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 a potential problem, such as an unplanned release. Gross alpha and beta activity in air exhibits considerable environmental variability and, for alpha measurements, analytical variability. These naturally occurring 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.

In 1999, we collected and analyzed more than 1,000 air samples for gross alpha and gross beta activity. As shown in Table 4-2, the annual mean for all of the stations is less than the NCRP's estimated average (2 fCi per cubic meter) for gross alpha concentrations. Two factors probably contribute to these seemingly lower concentrations: the use of actual sampled air volumes instead of converting to standard temperature and pressure volumes and the burial of alpha emitters in the filter that are not measured by front-face counting. 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, atmospheric mixing, temperature, soil moisture, and the "age" of the radon. The differences among the groups may be 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 concentrations. All of the annual averages are below 20 fCi per cubic meter, the NCRP estimated national average for beta concentrations, but the gross beta measurements include little if any lead-210 because of its low-energy beta emission. In addition, the gross beta measurements are also calculated on the actual sampled air volumes.

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 1999, Laboratory operations released approximately 1,600 curies of tritium. Tritium is released from Laboratory operations as hydrogen (HT or T_2) and as an oxide (HTO or T_2O). We measure the tritium as an oxide because the dose impact is about 14 thousand times higher than if it were hydrogen (DOE 1988b).

Estimating ambient levels of tritium as an oxide (water) requires two factors: 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 (see 1998 ESR 4.A.4.c) (Eberhart 1999). 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 we used this water 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 EPA approved use of this method for compliance calculations of atmospheric tritium concentrations in March 1999 (EPA 1999).

Table 4-4 presents the sampling results for tritiated water concentrations. The annual concentrations for 1999 at all of the on-site and perimeter stations were higher than all of the regional and pueblo stations. In addition, 15 of the 16 on-site stations in technical areas with tritium sources (TA-16, TA-21, and TA- 54) had higher annual concentrations than all of the perimeter stations. These data indicate that the Laboratory is a measurable source of tritium based on ambient concentrations. All annual mean concentrations at all sampling sites were well below the applicable EPA and the DOE guidelines.

The highest off-site annual concentration, 4.4 pCi per cubic meter, was at station 17 near the Bandelier fire lookout. This concentration is equivalent to about 0.3% of the EPA public dose limit. We calculated elevated concentrations at a number of on-site stations, with the highest maximum and annual mean concentrations at station 35 within TA-54, Area G. This sampler is located in a radiological control area, near shafts containing tritium-contaminated waste. The annual mean concentration, 768 pCi per cubic meter, is only 0.004% of the DOE DAC for worker exposure.

We also saw elevated annual air concentrations at other Area G stations, at TA-21 stations, and station 25 located at TA-16. Station 25 is located near a tritium facility, but the source of the higher tritium levels appears to be off-gassing from some used tritium processing equipment that is stored nearby. The TA-21 stations are located near operations that use tritium.

d. Plutonium. While plutonium occurs naturally at extremely low concentrations from cosmic radiation and spontaneous fission (Eisenbud and Gesell 1997), it is not naturally present in measurable quantities in the ambient air. All measurable sources are from plutonium research and development activities, nuclear weapons production and testing, 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 in ambient air. Four isotopes of concern can be present in the atmosphere: plutonium-238, plutonium-239, plutonium-240, and plutonium-241. Plutonium-241 is not measured because it is a low-energy beta emitter that decays to americium-241, which we do measure. This beta decay is not only hard to measure, but the dose is small when compared to americium-241. Plutonium-239 and plutonium-240 are indistinguishable by alpha spectroscopy and are grouped together for analytical purposes. Therefore, any ambient air concentrations or analyses listed as plutonium-239 actually represent both plutonium-239 and plutonium-240.

Table 4-5 presents sampling results for plutonium-238. Most of the analytical results, including the on-site stations, were below the uncertainty level. The highest group summary mean was for the TA-54, Area G, stations, with an annual mean of 1.3 aCi/m^3. This result is less than 0.1% of the EPA public dose limit. The highest annual mean for an individual station was for station 34 at TA-54 with an annual mean activity of 5.9 aCi/m^3, which corresponds to 0.3% of the EPA public dose limit, or 0.03 mrem. Only two quarterly concentrations were above their uncertainties, and both were at station 34, which indicates that measurements at this site are quantitative and above background levels.

Sampling results for plutonium-239, -240 appear in Table 4-6. As with the plutonium-238 analyses, most of the analytical results were below their estimated uncertainties. The highest annual mean at any off-site station, and the only one with concentrations above the uncertainties, occurred at a perimeter sampler in the Los Alamos townsite (07) with an annual concentration of 7.4 aCi/m^3 of plutonium-239, -240. This concentration is equivalent to a dose of 0.04 millirems or 0.4% of the EPA public dose limit. This quantitative measurement appeared to be caused by soil disturbances associated with nearby construction activity in a former Laboratory technical site with contaminated soil that had been remediated. Undoubtedly trace amounts of contamination remained after cleanup, and the recent construction activity resuspended the contamination.

The TA-54, Area G, stations clearly had elevated ambient concentrations with an annual average of about 24 aCi/m^3. The annual average for station 27, which had been the highest concentration for the last two years, dropped from 73 aCi/m^3 in 1998 to 51 aCi/m^3 in 1999 apparently because the nearby gravel road was paved in early 1999. The source of these elevated levels, resuspension of contaminated particulate matter from material unearthed during a trenching operation, was originally mitigated in 1997 (Kraig and Conrad 2000, ESP 1998).

We recorded the highest annual concentration at station 34 in Area G. The concentration was 105 aCi/m^3, an increase of more than 27 times the 1998 concentrations for this site. This concentration is equivalent to a dose of 0.5 mrem, but it is only 0.005% of the DOE DAC for workplace exposure. See Section 4.A.5 for additional information.

e. Americium-241. Americium-241, a decay product of plutonium-241, is the primary source of radiation from this plutonium isotope. Nuclear explosions, the nuclear fuel cycle, and other processing of plutonium release plutonium-241 to the environment.

Table 4-7 presents the americium results. As with the plutonium isotopes, americium is present in very low concentrations in the environment as the low annual mean concentrations seen at the regional, pueblo, and perimeter station summaries show. One quarterly off-site measurement at station 32, the county landfill, was above its uncertainty level. The annual concentration at this site was 8.0 aCi/m^3, which is equivalent to a dose of 0.04 mrem or 0.4% of the EPA public dose limit. The cause(s) of this higher concentration were not identified.

The only other sites with measurements above the uncertainties were at Area G. The overall concentration at Area G was the highest for any group of samplers with an average of 16.5 aCi/m^3. The highest annual concentration was at station 34 at 89.7 aCi/m^3, which was nearly 6 times higher than the second highest annual concentration. The estimated dose from this concentration is 0.47 mrem or 0.004% of the DOE DAC for worker exposure. See Section 4.A.5 for additional information on the increase of plutonium and americium at station 34.

Station 27 concentrations dropped again this year. In 1997, the concentrations at station 27 had peaked at 469 aCi/m^3. By 1998, mitigation efforts had caused the concentrations to drop an order of magnitude to 48 aCi/m^3. The most recent mitigation, paving the nearby gravel road, reduced the 1999 concentrations to 15 aCi/m^3. The concentration at this Area G site, which is a controlled-access area, is equivalent to a dose of 0.08 mrem or only 0.0008% of the applicable DOE DAC.

f. Uranium. Three isotopes of uranium are normally found in nature: uranium-234, uranium-235, and uranium-238. The natural sources of uranium are crustal rocks and soils. Therefore, the ambient concentrations depend 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 above this range (Eisenbud and Gesell 1997). Relative isotopic abundances are constant and well characterized. Uranium-238 and uranium-234 are essentially in radioactive equilibrium, with a measured uranium-238 to uranium-234 isotopic activity ratio of 0.993 (as calculated from Walker et al., 1989). Thus, activity concentrations of these two isotopes are effectively the same in particulate matter derived from natural sources. Because known LANL uranium emissions are enriched (excess uranium-234 and -235) or depleted (excess uranium-238), we can use comparisons of isotopic concentrations to estimate LANL contributions. Using excess uranium-234 to detect the presence of enriched uranium may not seem suitable because the enrichment process is normally designed to increase uranium-235 concentrations. However, the enrichment process normally increases uranium-234 at a faster rate than uranium-235, and the dose from natural uranium is about an order of magnitude higher for uranium-234 than for uranium-235. Tables 4-8 through 4-10 give uranium results by isotope. The quarterly uranium-234 and -238 measurements that are above their uncertainties for both isotopes are plotted in Figure 4-5 along with a line representing the natural abundance of the two isotopes.

All annual mean concentrations of the three uranium isotopes were well below the applicable EPA and DOE guidelines. We measured all the maximum annual uranium concentrations in Area G. The maximum annual uranium-234 concentration was 116 aCi/m^3 at stations 27 and 50 in Area G, which is equivalent to a dose of about 0.15 mrem. The maximum annual uranium-235 concentration was 7.2 aCi/m^3 at station 27, which is equivalent to a dose of 0.01 mrem, but three of the four quarterly concentrations were below their uncertainties. The maximum annual uranium-238 concentration was 119 aCi/m^3, which is equivalent to a dose of about 0.14 mrem. Most of the uranium-235 measurements (93%), both on- and off-site, were below the uncertainties, whereas less than 7% of the uranium-234 and uranium-238 concentrations were below the MDA. Consequently, the uranium-235 data should not be considered quantitative measurements and will not be evaluated as such.

Both the regional and pueblo groupings had higher average concentrations of uranium-234 and uranium-238 than all of the other groupings except for the TA-54, Area G, stations. The higher concentrations for the regional and pueblo groups result from increased particulate matter concentrations associated with unpaved roads, unpaved parking lots, and other soil disturbances such as construction activities and even grazing but not any known “man-made” sources of uranium. Dry weather or a drier climate can also increase ambient concentrations of particulate matter and therefore uranium. Annual mean concentrations for both uranium-234 and uranium-238 were above 50 aCi/m^3 at five sites for 1999. Four of these stations are located at Area G (27, 38, 45, and 50), and one is located at the Los Alamos County Landfill (station 32).

We measured most of the quarterly uranium measurements above 50 aCi/m^3 at Area G or at the Los Alamos County Landfill. As noted earlier, the Area G sites also typically have plutonium and americium concentrations that are above background levels. However, comparable concentrations of uranium-238 and uranium-234 indicate that the higher uranium concentrations at the Area G sites and at the county landfill are attributable to natural uranium associated with higher levels of resuspended particulate matter from unpaved roads and the surface soil disturbances.

Station 77 at TA-36, which is located in an area where depleted uranium is still present as surface contamination from explosive tests, had uranium-238 concentrations that were more than double the uranium-234 concentrations. It has been previously identified as a location with excess ambient concentrations of uranium-238 (Eberhart et. al., 1999, and ESP 1999). The 1999 uranium-238 and uranium-234 concentrations at this site were 30 and 13 aCi/m^3 respectively. If we presume that all of the measured uranium-234 at this site is natural, then about 44% or 13 aCi/m^3 of the uranium-238 would also be natural. Therefore, the estimated LANL contribution is 17 aCi/m^3 of uranium-238, which is equivalent to an on-site dose of about 0.02 mrem or 0.0001% of the DOE DAC for workplace exposure. The National Emission Standards for Hazardous Pollutants (NESHAP) standard is 10 mrem for all radionuclides, so the maximum measured dose from LANL uranium emissions would be about 0.2% of the standard if it were a public exposure. The other AIRNET samplers in this area do not show similar patterns, an indication that the excess uranium-238 is small, localized, and not caused by current explosive tests.

g. Gamma Spectroscopy Measurements. In 1999, gamma spectroscopy measurements were made on groups of filters including analyses of "clumps" (biweekly filters grouped across sites for a single sampling period) and quarterly composites (biweekly filters grouped across time for a single site). Even though these gamma emitters have no action levels *per se*, we would investigate any measurement above the MDA, other than beryllium-7 and lead-210, because the existing data indicate that such a measurement is highly unlikely except after an accidental release. Instead of action levels, the AIRNET Sampling and Analysis Plan (ESH-17 1999) lists the minimum detection levels for 16 gamma emitters that could either be released from Laboratory operations or that occur naturally in measurable amounts (beryllium-7 and lead-210). The minimum levels are equivalent to a dose of 0.5 mrem. The beryllium-7 and lead-210 measurements were the only isotopes above their minimum detectable activities.

Table 4-11 summarizes the "less than" concentrations. The average annual MDA for every radionuclide in this table meets the required minimum detection levels. Because every value used to calculate the average annual MDA was a "less than" value for the 14 radionuclides listed in the table, it is likely that the actual concentrations are 3 or more standard deviations away from the average MDA. As such, the ambient concentrations, which were calculated from the MDA values, are expressed as "much less" (<<) values.

Table 4-12 summarizes the beryllium-7 and lead-210 data. Both beryllium-7 and lead-210 occur naturally in the atmosphere. Beryllium-7 is cosmogenically produced, whereas lead-210 is a decay product of radon-222. Some lead-210 is related to suspension of terrestrial particulate matter, but the primary source is atmospheric decay of radon-222. Even though the beryllium-7 and lead-210 are derived from gases, both become elements that are present as solids or particulate matter. These radionuclides will quickly coalesce into fine particles and also deposit on the surfaces of other suspended particles. The effective source is cosmic for beryllium-7 and terrestrial for lead-210, so the ratio of the two concentrations will vary, but they should be relatively constant for a given sampling period. Because all of the other radionuclides measured by gamma spectroscopy are "less than" values, measurements of these two radionuclides provide verification that the sample analysis process is working properly.

5. Investigation of Elevated Air Concentrations

Upon receiving the analytical chemistry data for biweekly and quarterly data, ESH-17 personnel calculated air concentrations and reviewed them to determine if any values indicated an unplanned release. Two action levels have been established: investigation and alert. Investigation levels are based on historical measurements and are designed to indicate that an air concentration is higher than expected. Alert levels are based on dose and require a more thorough, immediate follow-up. During 1999, ESH-17 reviewed the effectiveness of existing action levels and decided to recalculate them to provide more useful information. We calculated new action levels for plutonium, americium, and tritium, based on a more robust statistical treatment of outliers and an evaluation of seasonal fluctuations of tritium from Area G. We developed new methods for determining action levels for gross alpha, gross beta, and uranium and will implement them in 2000. See the discussion of how we determined action levels on the Air Quality Group Web site: *http://www.air-quality.LANL.gov*.

In 1999, a number of air sampling values exceeded ESH-17 investigation levels. 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.

Numerous tritium measurements continued to exceed action levels because tritium concentrations are now calculated using absolute humidity from meteorological measurements (see ESP 1999, 4.A.4.c). We based the revised (August 1999) investigation levels on tritium concentrations calculated using absolute humidity, which eliminated this problem.

A number of uranium measurements exceeded action levels during 1999. In each case, the follow-up investigation demonstrated that natural uranium associated with higher levels of suspended particulate matter produced the elevated uranium concentrations. We reached this conclusion by comparing the ratio of measured uranium-234 and uranium-238 air concentrations with the ratio in naturally occurring uranium. Therefore, no Laboratory source of increased uranium emissions was identified.

The following sections identify six incidents of elevated air concentrations that warrant further discussion.

a. Elevated Plutonium-239 and Americium-241 at Station 34 at TA-54, Area G, during the First and Second Quarters of 1999. The 1999 first quarter air concentrations at station 34, at the northeast corner of Area G, were elevated above normal for americium-241 (24 aCi/m^3) and plutonium-239 (206 aCi/m^3). The measured concentrations were well above the six-year averages for these radionuclides: 5 and 19 aCi/m^3, respectively. Concentrations of plutonium-238 were also elevated. Discussions with operations staff at Area G revealed the following.

On March 15, 1999, a 55-gal. drum was retrieved as part of the Transuranic Waste Inspectable Storage Project (TWISP) at TA-54. Inspection revealed a small hole on the bottom, and alpha contamination was detected. Workers removed surface contamination and sealed the drum within a second drum. However, before the contamination was remediated, small amounts of radionuclides were released to the air. These releases caused increased concentrations at station 34, which is very close to the operations. If the releases had been large or widespread, we would have seen increases at other air monitoring stations nearby.

The operations group instituted radiologically engineered controls to help minimize future releases to the air during these activities. These features included more complete monitoring of drum surfaces at each step of drum handling, immediate bagging of drums with suspected contamination, continuous local air sampling, enhanced area swiping to identify contamination, and training of all employees in the new operation procedures.

In spite of these mitigation measures, air concentrations increased during second quarter, with americium-241 and plutonium-239 concentrations of 265 and 197 aCi/m^3, respectively. The operations group evaluated additional mitigation measures and implemented them during the third quarter. Plutonium concentrations returned to pre-1999 concentrations during the third quarter. Americium concentrations declined greatly by the third (68 aCi/m^3) and fourth quarters (32 aCi/m^3) but still remained elevated in comparison to pre-1999 concentrations (1–12 aCi/m^3). The annual average air concentrations of plutonium-239 and americium-241 at station 34 are both less than 0.01% of the DACs for workers.

b. Elevated Tritium near TA-33 during 1999. From the end of 1998 through 1999, decontamination and decommissioning operations at TA-33, Bldg. 86, produced increased tritium emissions that the AIRNET system detected. These operations, which were exhausted through a monitored stack, included characterization and depressurization of formerly used lines and vessels and were necessary before the building could be demolished.

These emissions resulted in exceedances of investigation levels at several stations in the vicinity of TA-33, Bandelier, and White Rock during the first quarter, in July, and in September. The Bandelier AIRNET station recorded peak concentrations of 14 pCi/m^3 in January. If this concentration had occurred for an entire year, the resulting dose would be less than 0.1 mrem.

Before initiating these operations, all environmental groups, including ESH-17, conducted a review of impacts. As a result of this review, ESH-17 worked with facility personnel to determine potential levels of emissions and to set limits on annual emissions. The decontamination and decommissioning operations are well within these limits and are considerably less than regulatory limits.

c. Elevated Tritium at the County Landfill during January and February 1999. Measurements at the county landfill exceeded investigation levels for tritium during the last two weeks of January and the first two weeks of February. The highest concentration measured was 9 pCi/m^3, which, if it had occurred for an entire year, would result in a concentration less than 0.06 mrem. No cause for these elevated concentrations was identified. Following this four-week period, concentrations were at typical levels for the remainder of the year.

d. Elevated Plutonium-239 at Station 07 during the Third and Fourth Quarters of 1999. During the third and fourth quarter of 1999, elevated concentrations of plutonium-239 were measured at station 07 (Shell Station) in the townsite. These higher measurements (12.6 and 14.0 aCi/m^3 respectively) appear to have been caused by soil disturbances associated with nearby construction activity at a former Laboratory technical site (TA-1) with contaminated soil that was subsequently remediated. Undoubtedly, trace amounts of contamination remained after cleanup, and the recent construction activity had resuspended the contamination. If these concentrations had been measured for an entire year, the dose impact would have been 0.07 mrem. Measurements of uranium-234 and uranium-238 concentrations were also elevated at this location during the fourth quarter, further demonstrating construction-related increases in resuspended particulate matter.

e. Elevated Tritium near TA-21 in December 1999. In December 1999, cleanup activities at the Tritium Science and Fabrication Facility (TA-21-209) produced higher than average tritium emissions. One on-site station (75) recorded a concentration of 22.5 pCi/m^3, exceeding an investigation level, and several nearby stations in the townsite measured higher than normal air concentrations. The annual average air concentration of tritium at station 75, 7.3 pCi/m^3, is more than one million times less than the DAC for occupational workers.

Before initiating these operations, all environmental groups, including ESH-17, conducted a review of impacts. As a result of this review, ESH-17 worked with facility personnel to determine potential levels of emissions and to set limits on annual emissions. The cleanup operations are well within these limits and are considerably less than regulatory limits.

f. Elevated Plutonium-239 at Station 45 TA-54, Area G, during the Fourth Quarter of 1999. During the fourth quarter of 1999, station 45 at TA-54, Area G, recorded an elevated plutonium-239 concentration. The concentration of 52 aCi/m^3 was the highest value recorded during 1999 but was similar to the highest values recorded in 1997 and 1998 at this station. The probable cause of this elevated value is resuspension of residual soil contamination at the eastern end of Area G. The annual average air concentration of plutonium-239 at station 45, 24.5 aCi/m^3 is about 0.001% of the DAC for workers.

g. Ongoing Investigations. A number of stations have measured elevated concentrations from Laboratory operations in past years. Several of these stations continue to measure somewhat elevated concentrations that we continue to monitor. We refer the reader to the earlier Environmental Surveillance Reports for a complete discussion of the sources of elevated emissions.

Elevated plutonium and americium concentrations continue to occur at TA-54, Area G, at stations 27 and 38, although much reduced from 1997 levels. Tritium concentrations at TA-16 at station 25 remained elevated during 1999. However, the peak concentration (104 pCi/m^3) is less than 1/10 of the 1998 peak (1528 pCi/m^3). The annual average air concentration of tritium at station 25, 55.1 pCi/m^3, is about 0.001% of the DAC for workers.

6. Long-Term Trends

Previous Environmental Surveillance Reports covered long-term trends for isotopic measurements (ESP 1997) and tritium (ESP 1998 and ESP 1999). Gross alpha, gross beta, and gamma measurements are evaluated here. Future reports will rotate between these three general categories.

The primary purpose of the AIRNET monitoring system is to provide measurements of air contaminants that are potentially released by LANL. However, most of the measurements are normally dominated by naturally occurring radionuclides: alpha measurements by the decay of polonium-210; beta measurements by the decay of bismuth-210; and gamma activity measurements by the decay of beryllium-7 and lead-210.

These naturally occurring radionuclides are present in the atmosphere as particulate matter, but essentially all are attributable to radioactive decay of atmospheric radon-222 (Figure 4-6), which is a gas, or cosmogenic production of beryllium-7 from cosmic ray interaction with common atmospheric gases. These radionuclides are derived from gas-phase stable isotopes that are either already well mixed such as nitrogen or become well mixed as a result of a relatively “long” half-life

(3.8 days for radon-222) compared to atmospheric turbulence. Ambient concentrations are relatively uninfluenced by particulate matter emissions, concentrations, or resuspension. In addition, these radionuclides are concentrated on fine particles and, as such, little affected by atmospheric deposition. Concentrations may vary regionally, but local concentrations of alpha, beta, and gamma emitters are comparable except when local sources become significant or when air sampling problems are encountered. Graphs of the gross alpha (Figure 4-7), gross beta (Figure 4-8), beryllium-7 (Figure 4-9), and lead-210 data (Figure 4-9) show the relatively low spatial variation when compared with the variation over time.

Historically, one of the primary advantages of measuring gross alpha, gross beta, and gamma radiation has been the promptness of the results and the subsequent assurance that no large releases were undetected. However, problems in the sampling and analytical processes reduced our ability in the past to use these data in this way. Improvements in the last four years, followed by extensive data analyses, have allowed us to use these data more effectively in our environmental surveillance program.

We have used the gross alpha measurements to retroactively identify local releases of plutonium and americium by using the gross alpha data from stations 27 and 38 above the 3-sigma control limits as shown in Figure 4-7. These two sites, which are co-located at Area G, represent only about 4% of the gross alpha measurements from 1997 through 1999, yet they account for nearly half of concentrations that are greater than the control limits. We originally identified this contamination when measured atmospheric concentrations of plutonium and americium had increased by about two orders of magnitude. Follow-up investigations found that a localized area of contaminated soil had been exposed during a trenching operation and that some of the contaminated material had been incorporated into a dirt road (Kraig and Conrad 2000). If a similar situation occurs in the future, comparison of the gross alpha measurements to the control limits may provide an indication of the problem before isotopic results are available.

LANL has no sources of beta radiation that could significantly increase the gross beta measurements, but the naturally occurring bismuth-210, which is the primary gross beta source, is easily detected. Lead-210, which decays to bismuth-210, is also a beta emitter, but it is not usually detected by the gross beta measurement process because of its low-energy beta emission. Gross beta measurements have been and still are used to correct errors in airflow measurements and calculations because the concentrations are comparable from site to site as with other decay products. More recently, we identified low beta concentrations outside the 3-sigma control limits at several stations (27, 32, and 38) as shown in Figure 4-7. These sites, which are located at Area G (27 and 38) and the county landfill (32), have high particulate matter concentrations. Even though they represent only about 6% of the gross beta measurements from 1997 through 1999, they account for more than half of the concentrations that are lower than the control limits. Many of these low beta measurements occurred in late 1998 and early 1999 when the weather was unusually dry (0.42 inches of precipitation were recorded at Area G from November 1, 1998, through February 28, 1999), which apparently increased the local particulate matter concentrations. Resolution of this problem is still in progress, but several possible causes have been identified.

Until recently our gamma measurements have not been useful for quantifying ambient concentrations of gamma emitters. Detection limits varied greatly and were generally so high that environmentally significant concentrations may have been missed. However, after working with our contract laboratories, increasing count times, and grouping filters together for analysis, the gamma measurements now represent an important component of our ability to detect unanticipated releases. The consistent and explainable measurements of lead-210 and beryllium-7 as shown in Figure 4-9 indicate that our sampling and analysis activities are performing as expected, and the low detection limits ensure that no significant releases of gamma emitters go undetected. Stations 27 and 38 are included in the TA-54 group, which had low beryllium-7 and lead-210 during early 1999 similar to the beta measurements pattern; these results once again indicate an air sampling problem for sites with high particulate matter concentrations.

B. Stack Air Sampling for Radionuclides *(Scott Miller)*

1. Introduction

Radioactive materials are an integral part of many activities at the Laboratory. Some operations may vent these materials to the environment through a stack or other forced air release point. Air Quality personnel at the Laboratory evaluate these operations 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 or greater in a year, the Laboratory must sample the stack in accordance with Title 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 1999, 29 stacks met this criterion. An additional two 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, we estimate emissions using engineering calculations and radionuclide materials usage information.

2. Sampling Methodology

As of the end of 1999, LANL continuously sampled 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 method, as described below.

Operations at facilities such as the Chemistry and Metallurgy Research Building (CMR) and TA-55 generate emissions of radioactive particulate matter that are sampled using a glass-fiber filter. A continuous sample of stack air is pulled through the filter, which captures small particles of radioactive material. 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 laboratory. That laboratory analyzes these composited samples to determine the total activity of materials such as uranium-234, -235, and -238; plutonium-238, plutonium-239, -240; and americium-241. ESH-17 then uses these data to calculate emissions.

Los Alamos Neutron Science Center (LANSCE) operations and hot cell activities at CMR and TA-48 generate VAP emissions such as selenium-75 and bromine-77 that are sampled with a charcoal cartridge. A continuous sample of stack air is pulled through a charcoal filter that adsorbs vaporous emissions of radionuclides. Gamma spectroscopy determines the amount and identity of the radionuclide(s) present on the filter.

A collection device known as a bubbler measures tritium emissions from the Laboratory's tritium facilities. 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 pulls a continuous sample of air from the stack, which then "bubbles" 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). "Bubbling" through these three vials removes essentially all HTO from the air, leaving only elemental tritium. The sample containing the elemental tritium passes through a palladium catalyst that converts the elemental tritium to HTO. The sample is then pulled through three additional vials containing ethylene glycol to collect 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).

Although the tritium bubbler described above is the Laboratory's preferred method for measuring tritium emissions, we employ a silica gel sampler at the LANSCE facility. 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. After the water is distilled from the sample, we analyze the water with LSC to determine the amount of HTO. Using silica gel is necessary because the ethylene glycol also collects some of the gaseous emissions other than tritium from LANSCE. These additional radionuclides interfere with the determination of tritium, resulting in less accurate results. Also, because the primary source for tritium is activated water, sampling for only HTO is appropriate.

We measure G/MAP emissions that result from activities at LANSCE using real-time monitoring data. A sample of stack air passes through an ionization chamber that measures the total amount of radioactivity in the sample. Gamma spectroscopy and decay curves identify specific radioisotopes.

3. Sampling Procedure and Data Management

Sampling and Analysis. We chose our analytical methods for compliance with EPA requirements (40 CFR 61, Appendix B, [EPA 19] Method 114). General discussions on the sampling and analysis methods for each of LANL's emissions follow.

Particulate Matter Emissions. We generally removed and replaced weekly glass-fiber filters that sampled facilities with significant potential for radioactive particulate emissions and transported them 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 checked 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 identified the energies of gamma ray emissions from the samples with gamma spectroscopy.

Because 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. HPAL analyzed glass-fiber filters from LANSCE using only gamma spectroscopy.

Because gross alpha/beta counting cannot identify specific radionuclides, the glass-fiber filters were composited every six months for radiochemical analysis at an off-site commercial laboratory. The data from these composite analyses quantified emissions of radionuclides such as the isotopes of uranium and plutonium. To ensure that the analyses requested (e.g., uranium-234, -235, -238; plutonium-238, -239, etc.) identified all significant activity in the composites, ESH-17 compares the results of the isotopic analysis to gross activity measurements.

VAP Emissions. We generally removed and replaced weekly the charcoal canisters that sampled facilities with the potential for significant VAP emissions. These samples went to the HPAL where gamma spectroscopy identified and quantified the presence of vaporous radioactive isotopes.

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

We used silica gel for sampling facilities with the potential for significant tritium emissions in the oxide form only where the bubbler system would not be appropriate. We transported these samples to the Inorganic Trace Analysis Group (CST-9). CST-9 staff distilled the water from the silica gel and determined the amount of tritium in the sample using LSC.

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

4. Analytical Results

Measurements of Laboratory stack emissions during 1999 totaled 1,900 Ci. Of this total, tritium emissions composed approximately 1,600 Ci, and air activation products from LANSCE contributed 300 Ci. Combined airborne emissions of materials such as plutonium, uranium, americium, and particulate/vapor activation products were approximately 0.007 Ci. Table 4-13 provides detailed emissions data for Laboratory buildings with sampled stacks. Table 4-14 provides a detailed listing of the constituent radionuclides in the groupings of G/MAP and particulate/vapor activation products (P/VAP). Table 4-15 presents the half-lives of the radionuclides emitted by the Laboratory. During 1999, nonpoint source emissions of activated air from the LANSCE facility (TA-53) comprised 17 Ci carbon-11 and 0.7 Ci argon-41, while TA-18 contributed 0.49 Ci argon-41.

5. Long-Term Trends

See Figures 4-10 through 4-13 for radioactive emissions from sampled Laboratory stacks. These figures illustrate trends in measured emissions for plutonium, uranium, tritium, and G/MAP emissions, respectively. As the figures demonstrate, emissions of uranium and G/MAP showed decreases while emissions of plutonium and tritium showed increases.

Figure 4-14 shows the total contribution of each of these emission types to the total Laboratory emissions. It clearly demonstrates that G/MAP emissions and tritium emissions make up the vast majority of radioactive stack emissions. In 1999, however, we notice that the relative percentages of G/MAP and tritium have exchanged places. This change is driven by two factors related to the operations of two facilities. Historically, the LANSCE stack has contributed greater than 90% of LANL's emissions; however, the LANSCE facility curtailed 1999 operations in the area that generates the majority of the short-lived activation products. As a result, emissions at LANSCE in 1999 totaled less than 5% of emissions reported in 1998. While operations at LANSCE were curtailed, cleanup efforts at a no longer used tritium facility increased. This facility, which historically housed high-pressure tritium operations at TA-33, has been shut down for several years. As facility personnel prepare to transfer the facility for decontamination and decommissioning, releases of tritium have increased. These increases result from activities such as opening pipes and containers to demonstrate that significant tritium has been removed. In total, these operations increased tritium emissions from 65 Ci in 1998 to slightly over 900 Ci in 1999. To ensure that emissions from these planned operations did not cause the Laboratory to approach the regulatory limit of 10 mrem/yr, these operations were administratively controlled not to exceed 1,500 Ci, which would have a dose impact < 0.1 mrem.

As described above, changes in emissions for tritium and G/MAP are related to operations. The same is true for the increase in plutonium emissions. The majority of these emissions resulted from operations at the CMR Facility involving plutonium powders. In all cases where increased emissions were detected, they are still well below the amounts that could result in an off-site individual receiving a dose equal to the regulatory limit of 10 mrem/yr.

C. Cosmic, Gamma, and Neutron Radiation Monitoring Program *(Mike McNaughton)*

1. Introduction

ESH-17 monitors gamma and neutron radiation in the environment, that is, outside of the workplace, according to the criteria specified in McNaughton et al., 2000.

This radiation consists of both naturally occurring and man-made radiation. Naturally occurring radiation originates from terrestrial and cosmic sources. Because the natural radiation doses are generally much larger than those from man-made sources, it is extremely difficult to distinguish man-made sources from the natural background.

Naturally occurring terrestrial radiation varies seasonally and geographically. Radiation levels can vary up 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). Spatial variation also results from the soil type. For example, dosimeters that are placed in a canyon will receive radiation from the sidewalls of the canyon as well as from the canyon bottom and will record higher radiation exposures than those dosimeters on a mesa top that don't receive exposure from the walls. The aerial survey of Los Alamos (DOE/NV 1998) shows variations of more than a factor of two, from about 60 mrem/yr on the mesa tops to 140 mrem/yr in some canyons.

Naturally occurring ionizing radiation from cosmic sources increases with elevation because of reduced atmospheric shielding (NCRP 1975). At sea level, the dose rate from cosmic sources is 27 mrem/yr. Los Alamos, with a mean elevation of about 2.2 km, receives 70 mrem/yr from cosmic sources, whereas White Rock, at an elevation of 1.9 km, receives 60 mrem/yr. Other locations in the region range in elevation from 1.7 km at Española to 2.7 km at the Pajarito Ski Hill, resulting in a corresponding range of 50 to 90 mrem/yr from cosmic sources. Cosmic sources 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.

In summary, the dose rate from natural terrestrial and cosmic sources varies from about 100 to 200 mrem/yr. In publicly accessible locations, the dose rate from man-made radiation is much smaller than, and difficult to distinguish from, natural radiation.

2. Monitoring Network

a. Regional, Perimeter, and On-Site Areas. In an attempt to distinguish any impact from Laboratory operations, ESH-17 has located 97 thermoluminescent dosimeter (TLD) stations around the Laboratory and in the surrounding communities. This network of dosimeters is divided into three groups: (1) The regional group has five locations ranging from approximately 6 to 20 km from the Laboratory boundary. These regional stations are located in the neighboring communities of Española, El Rancho, Santa Fe, San Ildefonso Pueblo, and Santa Clara Pueblo. (2) The perimeter group has 29 locations within 4 km of the Laboratory boundary (see Figure 4-15). (3) The 63 on-site locations are within Laboratory boundaries, generally around operations that may produce ionizing radiation.

b. LANSCE. We monitor external penetrating radiation from airborne gases, particles, and vapors resulting from operations of LANSCE at TA-53 with a network of 24 TLD stations. Twelve of these monitoring locations are approximately 800 m (0.5 mi) north of and downwind from the LANSCE stack. The other 12 TLD stations are about 9 km (5.5 mi) from LANSCE, near the southern boundary of the Laboratory, and serve as a background measurement.

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 external penetrating radiation from these areas, we have placed 97 dosimeters around the perimeter of these waste management areas. All waste management areas are controlled-access areas and are not accessible to the general public.

d. Technical Area 18 Albedo Dosimeters. We monitor potential neutron doses from criticality experiments at TA-18 with seven albedo TLD stations. We maintain these stations on the north, south, and east sides of TA-18. Albedo dosimeters are sensitive to neutrons and use a polyethylene phantom to simulate the human body, which causes neutron backscatter.

Each monitoring station has two albedo TLDs. If Pajarito Road closes during TA-18 experiments, one of the dosimeters is removed and stored at a control location until the road reopens. This procedure allows for a comparison of the total annual dose measured at these stations with the total annual dose that a member of the public could receive at these stations. Background stations are located at Santa Fe and TA-49, and a control dosimeter is kept in a shielded vault.

e. Direct-Penetrating-Radiation (DPR) Dosimeter Locations. Beginning in January 2000, the number of DPR-monitoring locations decreased from 240 to 140 as a consequence of the recommendations in McNaughton et al., 2000. The retired locations do not meet the criteria defined in the report. Typical reasons for retiring a location were as follows: some locations were too far from the Laboratory, e.g., the location at the Pajarito Ski Hill; some locations became redundant when the facility being monitored was closed, e.g., the Ion Beam Facility; some locations do not have a significant source of radiation, e.g., TA-59; and some locations are not accessible to the public, e.g., Area AB at TA-49. Three locations near the old LANSCE lagoons were moved to the new lagoons because the old lagoons are locked and no longer being used. McNaughton et al., 2000 contains details of these changes.

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

The environmental TLDs that the Laboratory uses are composed of natural lithium fluoride crystals, referred to by their trade name of TLD-100. After exposure to radiation, the TLD chips are collected, then heated in a laboratory to release the energy stored in the crystal. This stored energy is released in the form of light that is proportional to the amount of radiation the TLD has absorbed. The light released is measured and recorded.

ESH-17's operating procedures (ESH-17 1997) contain procedures that outline the QA/QC (quality assurance/quality control) protocols; placement and retrieval of the dosimeters; and reading of the dosimeters, data handling, validation and tabulation.

We encountered and corrected two problems that affected the data quality for 1999. During the second quarter of 1999, a new method of annealing the TLDs caused some of the dosimeters to emit 40% of the usual amount of light. A correction factor was derived using redundant dosimeters placed at the same location and also by comparing with previous data. The second problem concerned fading of the TLD signals during the three months in the field. The fade corrections were larger than usual (up to 27%) and also showed a larger variation than usual with an average standard deviation of 10%.

We estimated the uncertainty in the TLD-100 data by combining the uncertainties from three sources: the variation of individual TLD chips (3%), the light-output-to-dose calibration (8%), and the fade (10%). The overall one-standard-deviation uncertainty reported in Tables 4-16 and 4-17 is 13%.

The albedo dosimeters, provided by the Health Physics Measurements Group (ESH-4), are accredited by the DOE Laboratory Accreditation Program. ESH-4 provides quality assurance for the albedo dosimeters.

4. Analytical Results

a. Regional, Perimeter, and On-Site Areas. Table 4-16 presents the results for the regional, perimeter, and on-site locations. For some stations, one or more quarters of data are not available as a result of dosimeter loss. The missing data have been replaced by the average of the other quarters, as indicated in the footnote.

The annual dose equivalents at the perimeter and regional stations ranged from 100 to 180 mrem. These dose rates are consistent with natural background radiation and with previous measurements. The largest dose rates are in areas to the northeast, in particular at stations 10, 20, 24, 37, and 51, where terrestrial background is high (DOE/NV/11718-107). None of these measurements indicates a contribution from Laboratory operations.

The annual dose rates at most on-site locations listed in Table 4-16 are less than 180 mrem, which is consistent with the dose rate expected from natural terrestrial and cosmic sources. The locations with doses greater than 200 mrem are at TA-53 and Mortandad Canyon.

Stations 61, 62, 63, and 104 are close to the TA-53 lagoons. As the water evaporates from the lagoons, the shielding is less and the dose rate increases, so the 1999 doses are larger than in previous years. Access to the lagoons is restricted to radiological workers with a written permit. Stations 64 and 65 are close to the TA-53 “boneyard” where radioactive materials are stored. The 1999 doses are similar to the doses in previous years.

Stations 69 and 97, 98, and 99 are in Mortandad Canyon, which receives treated effluent from the liquid-waste treatment plant at TA-50. These locations are not normally accessible to the public. The 1999 doses are similar to the 1998 values.

b. LANSCE. We compared the TLD measurements collected at the 12 stations located directly to the north of LANSCE with the 12 background stations at TA-49. The ratio of the dose north of LANSCE stations to the background stations was 1.02 ± 0.11 mrem. Therefore, there is no statistically significant difference between the site and background TLD measurements, which means that the man-made dose at this location was too small to measure using TLDs.

c. Low-Level Radioactive Waste Management Areas. Table 4-17 presents the results from monitoring the waste management areas. Annual doses at most locations were within the range 100 to 180 mrem, which is the expected range of doses from natural terrestrial and cosmic radiation. Higher doses, indicative of man-made radiation, were measured at one location in Area T and about half the locations at Area G.

The annual dose at station 323 at Area T is about twice the expected dose from natural terrestrial and cosmic radiation. This level is consistent with the measurements of soil contamination reported in LANL 1991, which indicate 50 pCi/g of cesium-137 in the soil at this location. The origin and type of the contamination is also discussed in LANL 1990 and Rogers 1977. Area T is not accessible to the public.

The highest waste management area doses for 1999 were measured at TA-54, Area G, LANL’s only active low-level radioactive waste area. The 35 environmental surveillance TLDs at TA-54, Area G, are located within the waste site and along the security fence. The doses measured at this site are representative of storage and disposal operations that occur at the facility. Evaluation of these data is useful in minimizing occupational doses. However, Area G is a controlled-access area, and these measurements are not representative of a potential public dose.

The readings from TLD stations at TA-54, Area G, in the vicinity of the TWISP were higher than in previous years. The TWISP project entails bringing transuranic (TRU) waste out of belowground storage for further characterization and ultimate shipment to the Waste Isolation Pilot Plant (WIPP). The radiological constituents of these drums vary greatly, and the drum inventory near the TLDs is changing constantly. Until the drums are shipped to WIPP, external penetrating radiation doses near the project are expected to increase.

The TLD locations at Area G are not in an area that members of the public are capable of routinely accessing. Calculations and measurements show that the dose from Area G is not detectable at the DOE boundary, 350 m to the north. Nevertheless, we are continuing to monitor these dose rates closely.

We have two systems deployed at Area G for monitoring the DPR: TLDs or electrets ion chambers (EIC). Because of large differences between the two systems at locations near certain TWISP operations, we performed tests to assess TLD and EIC response to gamma energy levels similar to those in TRU waste. We found that our TLD dosimeters overrespond by about 50% to the low-energy gamma radiation from TRU materials (Kraig et al., 1999). Therefore, some of the results reported in Table 4-17 reflect this over-response. Actual doses at many Area G locations are smaller than reported.

d. Technical Area 18 Albedo Dosimeters. Table 4-18 presents the monitoring results from the TA-18 albedo dosimeter monitoring network. Two dosimeters were placed at each of the seven locations around TA-18. In previous years, we removed one dosimeter whenever Pajarito Road was closed. In 1999, Pajarito Road was never closed, so both dosimeters were continuously in place and received the same dose. The difference between the two dosimeter readings indicates the typical uncertainty from random processes such as variability of individual TLDs and fading during the three months in the field. This uncertainty is estimated to be ± 4 mrem.

An additional uncertainty of about a factor of two comes from the neutron correction factor, NCF. The neutron dose a dosimeter measures depends on the neutron-energy spectrum. The actual neutron dose is obtained by multiplying the dosimeter reading by the NCF. The albedo dosimeter data reported in the 1997 and 1998 environmental surveillance reports were calculated with NCF = 0.07. We calculated the data in the present report with NCF = 0.145, which corresponds to the neutron energy spectrum from the DOE-standard D_2O-moderated neutron spectrum from californium-252. Given the uncertainty in the neutron energies from TA-18, we do not have a perfect measurement of the NCF. We chose the higher value because it is more conservative, and it derives from a DOE standard (McNaughton 2000).

The maximum value in Table 4-18 is 36.5 mrem, which occurred at station 03, the parking lot to the east of TA-18. Routine public access is usually confined to locations 4–7, along Pajarito Road. For these locations, the maximum is 16.4 mrem.

The values in Table 4-18 would apply to a hypothetical individual who remains continuously at the specified location. According to Table 4 (page 65) of NCRP Report No. 49 (NCRP 1976), an occupancy factor of 1/16 is appropriate for “outside areas used only for pedestrians or vehicular traffic.” Under this assumption, the neutron dose would be about 2 mrem.

D. Nonradioactive Emissions Monitoring *(Jean Dewart, Craig Eberhart)*

1. Introduction

The Laboratory, in comparison with industrial sources such as power plants, semiconductor manufacturing plants, and refineries, is a relatively small source of nonradioactive air pollutants. Thus, opacity monitoring was the only nonradioactive air emissions monitoring we performed as required by state or federal air quality regulations during 1999.

We calculated emissions from industrial-type sources annually as the New Mexico Environment Department (NMED) required. These sources are responsible for the majority of all the nonradiological air pollutant emissions at the Laboratory. See Chapter 2 for these data. 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.

Because Laboratory nonradioactive air emissions are small, the ambient monitoring program is limited in scope. We conduct particulate matter sampling during wildland fires in the vicinity of the Laboratory. NMED permits for prescribed burns for forest fire management require particulate matter sampling; the Laboratory conducted one prescribed burn in November 1999. We also performed ambient sampling for beryllium to determine the impact of Laboratory beryllium emissions.

2. Particulate Matter Sampling

We took particulate matter (PM-10) samples (particles less than 10 µm in aerodynamic diameter) on West Jemez Road during a prescribed burn in November 1999. The measured value on November 6 was 10.2 ug/m^3. This reading is well below the 24-hour National Ambient Air Quality Standard for PM-10 of 150 ug/m^3.

3. Detonation and Burning of Explosives

a. Total Quantities. The Laboratory tests explosives by detonating them at firing sites that the Dynamic Testing Division operates. The Laboratory maintains monthly shot records that include the type of explosives used as well as other material expended at each site. Table 4-19 summarizes the amounts of expended materials. The Laboratory also burns scrap and waste explosives because of treatment requirements and safety concerns. In 1999, the Laboratory burned 3.8 tons of high explosives.

An assessment of the ambient impacts of high-explosives testing, presented in the Site-Wide Environmental Impact Statement for Los Alamos (DOE 1999), indicates that high-explosives testing produces no adverse air quality impacts. The actual quantities of materials detonated during 1999 were less than the amounts for which impacts are analyzed in the Site-Wide Environmental Impact Statement.

b. Beryllium Quantities. In the early 1990s, we analyzed a limited number of AIRNET samples for beryllium in an attempt to detect potential impact from regulated sources and releases from explosive testing. All values were well below the New Mexico 30-day ambient air quality standard of 10 nanograms per cubic meter. With the recent heightened interest in the health effects of beryllium, AIRNET samples are again being analyzed for this contaminant.

However, New Mexico no longer has an ambient air quality standard for beryllium for comparison with AIRNET measurements. Therefore, we selected another air quality standard to use for comparison purposes: the NESHAP standard of 10 ng/m^3 (40 CFR Part 61 Subpart C National Emission Standard for Beryllium) can be, with EPA approval, an alternative to meeting the emission standard for beryllium. LANL is not required to use this alternative standard because the permitted sources meet the emission standards, but it is used in this case for comparative purposes.

We analyzed quarterly composited samples from 23 sites for beryllium in 1999, an increase in four locations from the 1998 program. We selected the original 19 sites because they were located near potential beryllium sources or in nearby communities. The 1998 results indicated that the source of beryllium in our AIRNET samplers was naturally occurring beryllium in resuspended dust. Dust may be resuspended mechanically, by vehicle traffic on dirt roads or construction activities, or by the wind in dry periods. To verify this conclusion, we added seven additional sampling locations (including two QA stations for nine samplers total), four of which are routinely impacted by above normal amounts of resuspended dust. The locations selected for high resuspended dust were at Jemez Pueblo and three locations at TA-54, Area G. The Jemez Pueblo station is located in a dirt parking lot near the visitor’s center, next to a dirt road. The TA-54, Area G, sites are located near dirt roads and earthmoving activities. In addition, each of these four locations is in an area with lower rainfall, where the wind resuspends more dust than in a wetter area. Three stations that monitored an environmental restoration project at TA-49 were discontinued at the end of 1998.

Air concentrations for 1999, shown in Table 4-20 are, on average, higher than the 1998 values. These higher concentrations are due to a number of reasons: the selecting of additional sampling locations highly impacted by resuspended dust, discontinuing of sampling locations with relatively low impact from resuspended dust, drier conditions in 1999 than in 1998, and a major construction project taking place near AIRNET station 07. All values are less than 7% of the NESHAP standard. It should be noted that these quarterly concentrations have not been corrected for the small amounts of beryllium present in the filter material.

The highest measured beryllium concentrations occur at TA-54, Area G. These stations also routinely measure the highest amounts of naturally occurring uranium. Because this site has no beryllium handling operations, the source of the beryllium is most likely from naturally occurring beryllium in the soils, resuspended by the wind or by vehicles on dirt roads and earthmoving/construction operations. TA-54, Area G, is located in the drier portion of the Laboratory, making wind resuspension a more important contributor than at other Laboratory locations. The next highest beryllium concentrations were measured at the county landfill and at station 07. The earth-moving operations and vehicle traffic on dirt roads at the county landfill are the largest sources of resuspended dust impacting the AIRNET station. A construction project began immediately adjacent to station 07 during 1999, causing a large increase in the amount of resuspended dust and, therefore, beryllium in comparison with 1998.

Earlier in this chapter, we used the ratio of uranium-238 to uranium-234 to detect impacts from LANL because these isotopes are naturally present at a constant ratio. No comparable situation exists for beryllium isotopes, but the ratio of beryllium to other elements or radionuclides will be relatively constant if the local sources of particulate matter are similar. Because most of our sites are located on the Pajarito Plateau, a direct relationship between the ambient concentrations of uranium-234 and beryllium is likely unless there are naturally occurring local variations or releases to the environment. The direct correlation of beryllium to uranium-234 for all 1999 samples, as shown in Figure 4-16, indicates no unexpectedly high beryllium concentrations at any of the 23 sampling locations, including the TA-15-36 sites where beryllium has been used in explosives testing.

We performed cerium analyses on AIRNET filters, beginning in the second quarter of 1999, to assist in the interpretation of measured beryllium concentrations. Because LANL could be a source of uranium-234, potentially undermining the comparison of beryllium and uranium-234, AIRNET filters were analyzed for cerium, a rare earth element occurring in our soils and not emitted by Laboratory activities. The three quarters of cerium results correlate with beryllium in a fashion almost identical to uranium-234, supporting the conclusion that beryllium concentrations are from natural levels in resuspended soils. A full year of cerium data will be published for CY2000.

E. Meteorological Monitoring *(George Fenton)*

1. Introduction

Data obtained from the meteorological monitoring network support many Laboratory activities, including emergency management and response, regulatory compliance, safety analysis, engineering studies, and environmental surveillance programs. To accommodate the broad demands for weather data at the Laboratory, we measure a wide variety of meteorological variables across the network, including wind, temperature, pressure, relative humidity and dewpoint, precipitation, and solar and terrestrial radiation. The Meteorological Monitoring Plan (Baars et al., 1998) provides the details of the meteorological monitoring program. An electronic copy of the Meteorological Monitoring Plan is available on the World Wide Web at *http://www.weather.LANL.gov/monplan/mmp1998.pdf*.

2. Climatology

Los Alamos has a temperate, semiarid mountain climate. However, large differences in locally observed temperature and precipitation exist because of the 1,000-ft elevation change across the Laboratory site.

Four distinct seasons occur in Los Alamos. Winters are generally mild, with occasional winter storms. Spring is the windiest season. Summer is the rainy season, with frequent afternoon thunderstorms. Fall is marked by drier, cooler, and calmer weather. The climate statistics summarized below are from analyses provided in Bowen (1990 and 1992).

Several factors influence temperatures in Los Alamos. Despite its southern location, summertime temperatures at the Laboratory (elevation 7,400 feet) are cooler than nearby locations at lower elevations. The sloped terrain of the Pajarito Plateau causes cooled air to drain off the plateau at night; thus nighttime low 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 below 0°F. Another factor affecting local temperature is the lack of moisture in the atmosphere. With less moisture, cloud cover is less and the atmosphere has a lower capacity to store heat, promoting daytime solar heating and nighttime radiative cooling. Wide variations in daily temperatures (a 23°F range on average) result from this diurnal heating and cooling cycle.

Winter temperatures range from 30°F to 50°F during the daytime and from 15°F to 25°F during the nighttime, with a record low temperature of –18°F. Winds during the winter are relatively light, so extreme windchills are uncommon. Summer temperatures range from 70°F to 88°F during the daytime and from 50°F to 59°F during the nighttime, with a record high temperature of 95°F.

The average annual precipitation (which includes both rain and the water equivalent for frozen precipitation) is 18.73 in. The average annual snowfall is 58.9 in., with freezing rain and sleet occurring rarely.

Winter precipitation in Los Alamos is often the result of storms approaching from the Pacific Ocean or of cyclones forming and/or intensifying leeward of the Rocky Mountains. Large snowfalls may occur locally from orographic lifting of the storms by the Jemez Mountains. The record single day snowfall is 22 in., and the record single season snowfall is 153 in. The snow is usually a dry, fluffy powder, with an equivalent water-to-snowfall ratio of 1:20.

The summer rainy season accounts for 37% of the annual precipitation. From July to August, afternoon thunderstorms form as a result of moist air advected from the Pacific Ocean and the Gulf of Mexico that convects and/or is orographically lifted by the Jemez Mountains. These thunderstorms can yield hail, large downpours, strong winds, and lightning. Local lightning density, among the highest in the USA, is estimated at 7 to 22 strikes per square mile per year. Approximately 90% of the detected local lightning activity (within a 30-mile radius) occurs from May to August.

The complex topography of Los Alamos influences local-scale wind patterns, notable in the absence of large-scale disturbances. Often a distinct diurnal cycle of winds is observed. Daytime upslope flow of heated air on the Pajarito Plateau adds a southeasterly component to the winds on the plateau. Nighttime downslope flow of cooled air from the mountain and plateau adds a light westerly to northwesterly component to local winds. Flow in the canyons of the Pajarito Plateau is very complex and different from flow over the plateau. Canyon flows are often aligned with the canyon axes, usually from the west as drainage flow. Canyon winds occasionally exhibit a rotating pattern, caused by an interaction of drainage flow down the canyon and mesa-top flows across the tops of the canyons.

3. Monitoring Network

A network of six towers gathers meteorological data (winds, atmospheric state, precipitation, and fluxes) at the Laboratory (see Fig. 13.1 in the Meteorological Monitoring Plan [Baars et al., 1998]). Four of the towers are located on mesa tops (TA-6, -49, -53, -54), one is in a canyon (TA-41), and one is on top of Pajarito Mountain (PJMT). The TA-6 tower is the official meteorological measurement site for the Laboratory. A sonic detection and ranging (SODAR) instrument is also located adjacent to the TA-6 meteorological tower. Precipitation is measured at TA-16, TA-74, and in the North Community of the Los Alamos townsite, in addition to each of the tower sites.

4. Sampling Procedures, Data Management, and Quality Assurance

Instruments in the meteorological network are sited in areas with good exposure to the elements being measured, usually in open fields, to avoid wake effects (from trees and structures) on wind and precipitation measurements. Open fields also prevent the obstruction of radiometers measuring solar and terrestrial radiation (ultraviolet to infrared spectra).

Temperature and wind are measured at multiple levels on open lattice towers. Instruments are positioned on west-pointing booms (toward the prevailing wind), at a distance of at least two times the tower width (to reduce tower wake effects). The multiple levels provide a vertical profile of conditions important in assessing boundary layer flow and stability conditions. The multiple levels also provide redundant measurements, which support data quality checks. The boom-mounted temperature sensors are shielded and aspirated to minimize solar heating effects.

Data loggers at the tower sites sample most of the meteorological variables at 0.33 Hz, store the data, then average the samples over a 15-minute period and transmit the data to a Hewlett Packard workstation by telephone or cell phone. The workstation automatically edits measurements that fall outside of allowable ranges and generates time series plots of the data for data quality review by a meteorologist. Daily statistics of certain meteorological variables (i.e., daily minimum and maximum temperatures, daily total precipitation, maximum wind gust, etc.) are also generated and checked for quality.

All meteorological instruments are refurbished and calibrated annually during an internal audit/inspection. Field instruments are replaced with backup instruments, and we check the replaced instruments to verify that they remained in calibration while in service. All instrument calibrations are traceable to the National Institute of Standards and Technology. An external audit is typically performed once every two or three years; the most recent audit took place during the summer of 1999. Initial results indicated no significant anomalies with the instruments in the network.

5. Analytical Results

For a graphical summary of Los Alamos weather for 1999, see Figure 4-17. The figure depicts the year's monthly average temperature ranges and monthly precipitation and monthly snowfall totals, compared with monthly normals (averaged from 1961–1990).

Climatologically, Los Alamos weather for 1999 was warmer and dryer than normal. Patterns were consistent with "La Niña" conditions, particularly during the winter months. Persistent high pressure over the Four Corners area frequently diverted storm systems away from Los Alamos, resulting in clear skies, decreased precipitation, warmer days, and cool nights.

Temperatures were 4° to 6°F above normal in January, February, March, October, and November and 2°F below normal from April through July. The average maximum of 58°F in November was the highest on record for Los Alamos. The year's average maximum and mean temperatures were 2°F and 1°F above normal, respectively, while the average minimum temperature was normal.

Monthly precipitation totals were 5% to 50% of normal for January, February, August, October, November, and December, whereas March through June, September, and October were 120% to 220% of normal. For the year, total precipitation was 87% of normal at 16.65 inches (see Table 4-21). Because of the dry winter, the annual snowfall total was 49% of normal at 28.8 inches. Snowfall totals for March and

April were 130% of normal, but the other months ranged from only 0% to 40% of normal.

Wind statistics, based upon 15-minute averaged wind observations at the four Pajarito Plateau towers and the Pajarito Mountain tower for 1999, appear as wind roses in Figures 4-18, 4-19, and 4-20. Wind roses depict the percentage of time that the wind blows from each of 16 compass rose points. The wind roses also show the distributions of wind speed for each of the 16 directions, displayed by shading of the rose barbs (see the wind rose legends). For example, at the TA-6 tower for all times (day and night, Figure 4-18), the most frequent wind direction was west-northwesterly, occurring 12% of the time. The winds were from the WNW at 0.5 to 2.5 m/s for 4.5% of the time, 5 to 7.5 m/s for 5.5% of the time, and greater than 7.5 m/s for about 1% of the time. Winds at TA-6 were calm 0 to 0.5 m/s (not attributable to a specific direction) for 1% of the time.

The four Pajarito Plateau towers measured daytime winds (sunrise to sunset) as predominately from the south because of upslope flow of heated daytime air (see Figure 4-19). Nighttime winds (sunset to sunrise) on the Pajarito Plateau were lighter and more variable than daytime winds and typically from the west, as a result of a combination of prevailing winds from the west and downslope drainage flow of cooled mountain air (see Figure 4-20). Winds atop Pajarito Mountain are more representative of upper-level flows and primarily ranged from the northwest to the southwest, largely because of the prevailing westerly winds.

F. Quality Assurance Program in the Air Quality Group *(Terry Morgan)*

1. Quality Assurance Program Development

During 1999, ESH-17 revised three quality plans that affect collection and use of air quality compliance data: the group Quality Management Plan, the project plan for the AIRNET system, and the project plan for the Meteorology Monitoring Project. The revisions reflect a new structure for the quality documents within the group. We also revised numerous implementing procedures to reflect the constant improvements in the processes. For example, we revised approximately 43 procedures related to environmental monitoring during 1999. QA plans for sampling systems follow the EPA QA-R/5 data quality objective process and incorporate required elements of DOE QA programs. 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 1999, two external laboratories performed all chemical analyses reported for AIRNET samples. The Wastren-Grand Junction analytical laboratory, associated with the DOE's Grand Junction Project Office, provided biweekly gross alpha, gross beta, and isotopic gamma analytical services. Paragon Analytics, Inc., Fort Collins, Colorado, provided biweekly AIRNET tritium analytical services. Wastren-Grand Junction also provided analytical chemistry services for alpha-emitting isotopes (americium, plutonium, and uranium) and stable beryllium on AIRNET quarterly composite samples. Our on-site Health Physics Analytical Laboratory performed all instrumental analyses (gross alpha, gross beta, isotopic gamma, and tritium) reported for stack emissions and in-stack samples. The Wastern-Grand Junction site analyzed semester composites of in-stack filters for alpha and beta emitting isotopes.

Application of the data quality objectives process led to definition of analytical chemistry requirements. The statements of work we used to procure chemical analyses from the commercial laboratories summarized these requirements. 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 all three laboratories during 1999 (Gladney 2000a, Gladney 2000b).

All three analytical laboratories participated in national performance evaluation studies during 1999. The DOE Environmental Measurements Laboratory in New York, NY, sponsors a DOE-wide environmental intercomparison study, sending spiked air filters twice a year to the participating laboratories. Other commercial and state agencies also produce materials and sponsor intercomparison programs. The results of these performance evaluations are included in each assessment report.

G. Unplanned Releases *(Scott Miller)*

During 1999, the Laboratory had no instances of increased airborne emissions of radioactive or nonradioactive materials that required reporting to either NMED or EPA.

Two instances of increased emissions in 1999 resulted from process problems. First, during the week of June 4, 1999, a small release of a radioactive form of silicon, silicon-32, occurred at the Radiochemistry facility, TA-48. This release comprised 5 microcuries and had a dose impact less than 1 microrem (0.001 mrem).

The second unplanned release was noted during the week of June 25, 1999. An operation at the CMR facility resulted in a small release of a radioactive form of technetium, technetium-99. An operation involving the heating of enriched uranium volatized technetium-99 present in the sample. An equipment malfunction allowed this technetium-99 to be released to the room and subsequently vented through the stack. This release comprised 50 microcuries and had a dose impact less than 1 microrem (0.001 mrem).

H. Special Studies—Neighborhood Environmental Watch Network Community Monitoring Stations

Neighborhood Environmental Watch Network (NEWNET) is a LANL Nonproliferation and International Security Division program for 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.

Station measurements include wind speed and wind direction, ambient temperature, relative humidity, and barometric pressure. Also, the station measures gross gamma radiation using a pressurized ion chamber; the radiation sensors are sampled at 5-second intervals and averaged every 15 minutes.

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, stored in a public access database, and presented on the World Wide Web. The data from all the stations are available to the public with, at most, a 24-hour delay. The NEWNET web page also includes a Spanish language version.

More information about NEWNET and the data is available at *http://newnet.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] 1999	EPA Concentration Limit[b]
Gross Alpha	fCi/m^3	1.0	NA[c]
Gross Beta	fCi/m^3	13.4	NA
^{234}U	aCi/m^3	19.2	7,700
^{235}U	aCi/m^3	2.1	7,100
^{238}U	aCi/m^3	17.3	8,300
^{238}Pu	aCi/m^3	–0.1	2,100
$^{239,240}Pu$	aCi/m^3	0.7	2,000
Tritium	pCi/m^3	0.3	1,500
^{241}Am	aCi/m^3	2.2	1,900

[a]Data from regional air sampling stations operated by LANL at Santa Fe (2 sites), El Rancho, and Española.
[b]Each EPA limit equals 10 mrem/yr.
[c]NA = not applicable.

Table 4-2. Airborne Long-Lived Gross Alpha Concentrations for 1999

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	26	0	1.86	0.39	0.96	0.41
03 Santa Fe	26	0	1.47	0.51	0.94	0.32
55 Santa Fe West (Buckman Booster #4)	26	0	2.09	0.41	0.94	0.51
56 El Rancho	25	0	2.05	0.37	1.02	0.54
Pueblo Stations						
41 San Ildefonso Pueblo	26	0	1.70	0.39	0.99	0.44
59 Jemez Pueblo-Visitor’s Center	25	0	2.51	0.48	1.09	0.51
Perimeter Stations						
04 Barranca School	26	0	1.90	0.44	0.89	0.41
05 Urban Park	26	0	1.79	0.40	0.93	0.34
06 48th Street	26	0	1.62	0.39	0.79	0.30
07 Gulf/Exxon/Shell Station	26	0	1.97	0.60	1.15	0.36
08 McDonald’s Restaurant	26	0	1.57	0.25	0.91	0.33
09 Los Alamos Airport	26	0	1.79	0.35	0.81	0.40
10 East Gate	25	0	2.03	0.43	0.92	0.42
11 Well PM-1 (E. Jemez Road)	26	0	1.97	0.32	0.90	0.43
12 Royal Crest Trailer Court	26	1	2.01	0.26	0.89	0.46
13 Rocket Park	26	0	2.04	0.29	0.86	0.48
14 Pajarito Acres	26	0	1.65	0.29	0.81	0.37
15 White Rock Fire Station	26	0	2.18	0.45	0.98	0.49
16 White Rock Nazarene Church	26	1	1.61	0.17	0.83	0.39
17 Bandelier Fire Lookout	26	0	2.17	0.30	0.87	0.45
26 TA-49	26	0	2.00	0.30	0.86	0.42
32 County Landfill (TA-48)	26	0	1.76	0.49	1.08	0.33
54 TA-33 East	26	0	2.43	0.25	0.95	0.53
60 LA Canyon	26	0	1.60	0.54	0.99	0.32
61 LA Hospital	26	0	1.97	0.42	0.95	0.37
62 Crossroads Bible Church	26	0	1.91	0.28	0.87	0.44
63 Monte Rey South	26	0	1.91	0.33	0.85	0.43
90 East Gate-Backup	1	0	1.79	1.79	1.79	
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	26	0	1.62	0.41	0.82	0.37
77 TA-36 IJ Site	26	0	1.79	0.35	0.79	0.41
78 TA-15-N	26	0	1.89	0.30	0.77	0.39
TA-21 Stations						
20 TA-21 Area B	26	0	1.48	0.32	0.85	0.31
71 TA-21.01 (NW Bldg 344)	26	0	1.76	0.32	0.84	0.42
72 TA-21.02 (N Bldg 344)	25	0	1.84	0.36	0.81	0.43
73 TA-21.03 (NE Bldg 344)	25	0	2.03	0.26	0.84	0.43
74 TA-21.04 (SE Bldg 344)	26	1	1.94	0.18	0.88	0.46
75 TA-21.05 (S Bldg 344)	26	0	1.54	0.38	0.84	0.33

Table 4-2. Airborne Long-Lived Gross Alpha Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	0	2.27	0.50	1.24	0.54
34	Area G-1 (behind trailer)	26	0	1.92	0.42	1.14	0.39
35	Area G-2 (back fence)	26	0	2.12	0.48	1.01	0.49
36	Area G-3 (by office)	26	0	1.64	0.44	0.98	0.39
45	Area G/South East Perimeter	26	0	2.25	0.79	1.33	0.36
47	Area G/North Perimeter	26	0	1.91	0.49	1.03	0.39
50	Area G-expansion	26	0	2.40	0.66	1.35	0.43
51	Area G-expansion pit	26	0	2.33	0.56	1.13	0.44
Other On-Site Stations							
23	TA-5	26	0	3.12	0.32	1.04	0.59
25	TA-16-450	26	0	1.48	0.29	0.85	0.31
30	Pajarito Booster 2 (P-2)	26	0	1.99	0.48	1.05	0.44
31	TA-3	26	0	1.83	0.40	0.99	0.40
33	TA-49 Area AB	1	0	0.74	0.74	0.74	
49	Pajarito Road (TA-36)	26	0	2.13	0.46	1.03	0.49
QA Stations							
38	TA-54 Area G-QA (next to #27)	26	0	4.60	0.46	1.25	0.85
39	TA-49-QA (next to #26)	26	0	1.76	0.48	0.90	0.36

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	103	0	2.09	0.37	0.96	±0.09	0.45
Pueblo	51	0	2.51	0.39	1.04	±0.13	0.47
Perimeter	546	2	2.43	0.17	0.91	±0.03	0.41
TA-15 and TA-36	78	0	1.89	0.30	0.79	±0.09	0.39
TA-21	154	1	2.03	0.18	0.84	±0.06	0.39
TA-54 Area G	208	0	2.40	0.42	1.15	±0.06	0.45
Other On-Site	131	0	3.12	0.29	0.99	±0.08	0.45

Concentration Guidelines

Concentration guidelines are not available for gross alpha concentrations.

[a] 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 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	26	0	25.2	8.1	14.3	4.7
03	Santa Fe	26	0	21.3	8.5	13.0	3.6
55	Santa Fe West (Buckman Booster #4)	26	0	24.0	5.8	13.2	4.4
56	El Rancho	25	0	22.9	7.7	13.2	4.2
Pueblo Stations							
41	San Ildefonso Pueblo	26	0	25.3	6.2	13.7	4.8
59	Jemez Pueblo-Visitor’s Center	25	0	17.2	7.9	11.7	2.6
Perimeter Stations							
04	Barranca School	26	0	21.3	7.6	12.5	3.3
05	Urban Park	26	0	18.6	8.0	11.8	2.7
06	48th Street	26	0	18.3	7.3	11.3	2.9
07	Gulf/Exxon/Shell Station	26	0	23.0	8.8	12.9	3.1
08	McDonald’s Restaurant	26	0	21.1	8.1	12.4	3.3
09	Los Alamos Airport	26	0	21.2	7.6	12.5	3.8
10	East Gate	25	0	23.5	7.9	12.8	3.9
11	Well PM-1 (E. Jemez Road)	26	0	22.3	7.0	11.7	4.0
12	Royal Crest Trailer Court	26	0	19.8	7.9	12.5	3.2
13	Rocket Park	26	0	22.5	7.5	13.0	4.1
14	Pajarito Acres	26	0	20.4	7.6	12.5	3.5
15	White Rock Fire Station	26	0	22.8	7.2	13.0	4.4
16	White Rock Nazarene Church	26	0	20.8	7.3	12.3	3.6
17	Bandelier Fire Lookout	26	0	22.5	7.8	13.3	4.0
26	TA-49	26	0	21.3	6.8	12.1	3.2
32	County Landfill (TA-48)	26	0	20.4	4.1	11.4	4.0
54	TA-33 East	26	0	22.4	7.7	13.4	4.2
60	LA Canyon	26	0	19.7	8.2	11.8	3.1
61	LA Hospital	26	0	21.8	7.8	12.6	3.7
62	Crossroads Bible Church	26	0	21.5	7.3	13.0	3.9
63	Monte Rey South	26	0	20.4	7.4	12.7	3.8
90	East Gate-Backup	1	0	18.6	18.6	18.6	
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	26	0	22.8	7.3	12.4	3.8
77	TA-36 IJ Site	26	0	22.3	7.8	12.5	3.7
78	TA-15-N	26	0	23.2	7.7	12.2	3.8
TA-21 Stations							
20	TA-21 Area B	26	0	21.4	8.3	12.7	3.3
71	TA-21.01 (NW Bldg 344)	26	0	22.0	8.0	12.6	3.6
72	TA-21.02 (N Bldg 344)	25	0	22.1	7.8	12.8	3.7
73	TA-21.03 (NE Bldg 344)	25	0	22.3	8.1	13.0	3.8
74	TA-21.04 (SE Bldg 344)	26	0	20.8	6.7	12.7	3.6
75	TA-21.05 (S Bldg 344)	26	0	21.8	7.7	12.9	3.7

Table 4-3. Airborne Long-Lived Gross Beta Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	0	24.3	4.1	11.6	5.2
34	Area G-1 (behind trailer)	26	0	19.7	7.5	12.7	3.5
35	Area G-2 (back fence)	26	0	20.3	7.5	12.1	3.6
36	Area G-3 (by office)	26	0	19.8	7.0	12.4	3.7
45	Area G/South East Perimeter	26	0	23.7	7.4	12.8	4.1
47	Area G/North Perimeter	26	0	22.3	7.3	12.5	3.8
50	Area G-expansion	26	0	22.2	8.3	13.0	3.8
51	Area G-expansion pit	26	0	21.6	7.8	12.3	3.5
Other On-Site Stations							
23	TA-5	26	0	20.7	8.0	12.8	3.5
25	TA-16-450	26	0	20.9	6.7	12.4	3.4
30	Pajarito Booster 2 (P-2)	26	0	21.6	6.6	12.7	3.9
31	TA-3	26	0	19.7	7.7	12.0	3.1
33	TA-49 Area AB	1	0	11.7	11.7	11.7	
49	Pajarito Road (TA-36)	26	0	24.0	7.6	13.1	4.2
QA Stations							
38	TA-54 Area G-QA (next to #27)	26	0	19.9	3.4	10.7	4.5
39	TA-49-QA (next to #26)	26	0	19.3	6.7	12.2	3.3

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	103	0	25.2	5.8	13.4	±0.8	4.2
Pueblo	51	0	25.3	6.2	12.7	±1.1	4.0
Perimeter	546	0	23.5	4.1	12.5	±0.3	3.6
TA-15 and TA-36	78	0	23.2	7.3	12.4	±0.8	3.7
TA-21	154	0	22.3	6.7	12.8	±0.6	3.6
TA-54 Area G	208	0	24.3	4.1	12.4	±0.5	3.9
Other On-Site	131	0	24.0	6.6	12.6	±0.6	3.6

Concentration Guidelines

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 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	24	21	2.5	–1.3[a]	0.3	0.8
03	Santa Fe	25	19	3.5	–2.5	0.3	1.1
55	Santa Fe West (Buckman Booster #4)	25	20	1.3	–1.5	0.2	0.6
56	El Rancho	25	19	1.9	–0.9	0.4	0.6
Pueblo Stations							
41	San Ildefonso Pueblo	26	15	1.9	–0.9	0.6	0.8
59	Jemez Pueblo-Visitor's Center	26	22	1.6	–1.0	0.1	0.7
Perimeter Stations							
04	Barranca School	26	6	3.7	–0.4	1.5	0.9
05	Urban Park	26	13	2.4	–1.2	0.7	0.8
06	48th Street	26	9	2.4	–1.6	0.9	0.9
07	Gulf/Exxon/Shell Station	26	5	2.9	–0.6	1.4	0.9
08	McDonald's Restaurant	26	1	5.9	0.8	2.6	1.2
09	Los Alamos Airport	26	1	9.6	0.0	3.6	1.9
10	East Gate	25	0	6.6	1.0	3.8	1.4
11	Well PM-1 (E. Jemez Road)	26	2	5.3	0.5	2.1	1.2
12	Royal Crest Trailer Court	26	4	3.7	0.5	1.8	1.0
13	Rocket Park	26	2	6.7	0.7	3.5	1.5
14	Pajarito Acres	26	2	6.5	0.5	2.4	1.6
15	White Rock Fire Station	26	4	4.6	0.7	2.2	1.1
16	White Rock Nazarene Church	26	2	8.3	0.8	3.5	2.1
17	Bandelier Fire Lookout	26	1	13.8	1.2	4.4	3.2
26	TA-49	26	1	8.3	1.1	3.6	1.6
32	County Landfill (TA-48)	26	5	8.6	–0.6	2.2	2.0
54	TA-33 East	26	1	11.9	0.9	4.0	2.9
60	LA Canyon	26	7	3.2	0.3	1.5	0.7
61	LA Hospital	26	10	3.0	–2.1	1.2	1.1
62	Crossroads Bible Church	26	6	6.5	–0.4	2.0	1.6
63	Monte Rey South	26	5	7.4	0.0	2.3	1.8
90	East Gate-Backup	1	0	6.1	6.1	6.1	
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	26	8	3.5	–1.1	1.4	1.2
77	TA-36 IJ Site	26	7	4.0	–1.1	1.7	1.2
78	TA-15-N	26	3	4.2	0.8	2.0	0.9
TA-21 Stations							
20	TA-21 Area B	26	0	9.6	1.9	4.5	2.1
71	TA-21.01 (NW Bldg 344)	26	1	10.6	0.6	3.7	2.0
72	TA-21.02 (N Bldg 344)	25	0	11.8	2.0	4.9	2.4
73	TA-21.03 (NE Bldg 344)	25	0	25.4	4.3	10.6	4.9
74	TA-21.04 (SE Bldg 344)	26	0	16.3	2.3	5.8	3.0
75	TA-21.05 (S Bldg 344)	26	1	22.5	0.6	7.3	4.8

Table 4-4. Airborne Tritium as Tritiated Water Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	0	65.1	3.7	18.3	16.3
34	Area G-1 (behind trailer)	26	0	30.8	4.6	12.7	7.0
35	Area G-2 (back fence)	25	0	3,654.3	39.4	767.8	1,001.1
36	Area G-3 (by office)	26	0	59.3	7.8	25.6	11.6
45	Area G/South East Perimeter	26	0	31.0	2.7	12.7	8.2
47	Area G/North Perimeter	26	0	61.3	3.7	19.1	16.1
50	Area G-expansion	25	0	36.6	3.9	13.5	8.0
51	Area G-expansion pit	26	0	19.8	2.7	9.7	4.6
Other On-Site Stations							
23	TA-5	26	5	4.7	–0.3	2.2	1.2
25	TA-16-450	26	0	113.2	12.8	55.1	28.6
30	Pajarito Booster 2 (P-2)	26	7	5.4	0.1	1.8	1.2
31	TA-3	26	2	6.8	1.2	2.7	1.4
33	TA-49 Area AB	1	0	2.7	2.7	2.7	
49	Pajarito Road (TA-36)	26	5	3.6	–0.8	1.7	1.1
QA Stations							
38	TA-54 Area G-QA (next to #27)	26	0	67.3	4.3	18.7	16.0
39	TA-49-QA (next to #26)	26	0	9.4	1.9	3.9	1.7

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	99	79	3.5	–2.5	0.3	±0.2	0.8
Pueblo	52	37	1.9	–1.0	0.4	±0.2	0.8
Perimeter	546	87	13.8	–2.1	2.4	±0.2	1.9
TA-15 and TA-36	78	18	4.2	–1.1	1.7	±0.2	1.1
TA-21	154	2	25.4	0.6	6.1	±0.6	4.1
TA-54 Area G	206	0	3,654.3	2.7	107.2	±57.6	421.9
Other On-Site	131	19	113.2	–0.8	12.6	±4.3	24.7

Concentration Guidelines

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

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[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 1999

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	4	0.1	–0.5[a]	–0.1	0.3
03 Santa Fe	4	4	0.0	–0.3	–0.1	0.1
55 Santa Fe West (Buckman Booster #4)	4	4	0.3	–0.3	0.0	0.2
56 El Rancho	4	4	0.5	–0.5	–0.1	0.4
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	0.4	–0.4	0.1	0.3
59 Jemez Pueblo-Visitor's Center	4	4	0.3	–0.3	0.1	0.3
Perimeter Stations						
04 Barranca School	4	4	0.4	–0.3	0.0	0.3
05 Urban Park	4	4	0.7	0.0	0.4	0.3
06 48th Street	4	4	0.4	–0.3	–0.1	0.3
07 Gulf/Exxon/Shell Station	4	4	0.6	–0.1	0.2	0.3
08 McDonald's Restaurant	4	4	0.0	–0.5	–0.3	0.2
09 Los Alamos Airport	4	4	0.1	–0.2	0.0	0.1
10 East Gate	4	4	0.5	–0.6	–0.1	0.5
11 Well PM-1 (E. Jemez Road)	4	4	0.3	–0.3	0.0	0.3
12 Royal Crest Trailer Court	4	4	1.9	–0.2	0.5	0.9
13 Rocket Park	4	4	0.6	–0.4	0.1	0.5
14 Pajarito Acres	4	4	0.0	–0.3	–0.2	0.1
15 White Rock Fire Station	4	4	0.4	–0.3	0.0	0.3
16 White Rock Nazarene Church	4	4	0.3	–0.6	–0.1	0.4
17 Bandelier Fire Lookout	4	4	1.4	0.1	0.5	0.6
26 TA-49	4	4	0.1	–0.3	–0.1	0.2
32 County Landfill (TA-48)	4	4	0.9	–0.6	0.2	0.6
54 TA-33 East	4	4	0.7	–0.3	0.0	0.4
60 LA Canyon	4	4	0.5	–0.3	0.1	0.3
61 LA Hospital	4	4	0.5	–0.6	0.0	0.5
62 Crossroads Bible Church	4	4	0.4	–0.5	0.0	0.4
63 Monte Rey South	4	4	0.5	0.0	0.2	0.3
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	4	0.9	–0.4	0.1	0.6
77 TA-36 IJ Site	4	4	0.5	–0.1	0.2	0.3
78 TA-15-N	4	4	0.3	–0.3	0.0	0.3
TA-21 Stations						
20 TA-21 Area B	4	4	0.2	–0.3	–0.1	0.3
71 TA-21.01 (NW Bldg 344)	4	4	0.2	–0.6	–0.2	0.3
72 TA-21.02 (N Bldg 344)	4	4	1.6	0.5	0.8	0.5
73 TA-21.03 (NE Bldg 344)	4	4	1.6	0.5	0.9	0.5
74 TA-21.04 (SE Bldg 344)	4	4	0.0	–0.8	–0.3	0.3
75 TA-21.05 (S Bldg 344)	4	4	0.4	–0.4	0.0	0.4

Table 4-5. Airborne Plutonium-238 Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	4	3.9	0.2	1.2	1.8
34	Area G-1 (behind trailer)	4	2	12.2	0.1	5.9	5.6
35	Area G-2 (back fence)	4	4	0.7	–0.1	0.3	0.4
36	Area G-3 (by office)	4	4	0.6	0.1	0.4	0.2
45	AreaG/South East Perimeter	4	4	2.1	0.0	1.2	1.0
47	Area G/North Perimeter	4	4	0.8	0.0	0.5	0.4
50	Area G-expansion	4	4	1.1	–0.3	0.4	0.6
51	Area G-expansion pit	4	4	0.4	–0.3	0.0	0.3
Other On-Site Stations							
23	TA-5	4	4	0.0	–0.8	–0.4	0.4
25	TA-16-450	4	4	0.0	–0.1	–0.1	0.1
30	Pajarito Booster 2 (P-2)	4	4	0.0	–0.8	–0.3	0.3
31	TA-3	4	4	1.8	0.0	0.8	0.8
49	Pajarito Road (TA-36)	4	4	1.4	–0.5	0.7	0.8
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	4	1.5	–0.5	0.6	1.0
39	TA-49-QA (next to #26)	4	4	1.2	–0.8	–0.1	0.9

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	0.5	–0.5	–0.1	±0.1	0.3
Pueblo	8	8	0.4	–0.4	0.1	±0.2	0.3
Perimeter	84	84	1.9	–0.6	0.1	±0.1	0.4
TA-15 and TA-36	12	12	0.9	–0.4	0.1	±0.3	0.4
TA-21	24	24	1.6	–0.8	0.2	±0.3	0.6
TA-54 Area G	32	30	12.2	–0.3	1.3	±0.9	2.6
Other On-Site	20	20	1.8	–0.8	0.1	±0.3	0.7

Concentration Guidelines

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

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[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 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	4	2.1	–0.9[a]	0.5	1.3
03	Santa Fe	4	4	1.9	–0.6	0.8	1.1
55	Santa Fe West (Buckman Booster #4)	4	4	1.6	–0.2	0.8	0.8
56	El Rancho	4	4	2.1	–1.4	0.6	1.5
Pueblo Stations							
41	San Ildefonso Pueblo	4	4	0.5	–0.7	0.1	0.5
59	Jemez Pueblo-Visitor's Center	4	4	3.7	–0.1	1.1	1.7
Perimeter Stations							
04	Barranca School	4	4	0.7	–1.2	–0.1	0.9
05	Urban Park	4	4	1.2	0.0	0.6	0.5
06	48th Street	4	4	1.3	0.5	0.9	0.4
07	Gulf/Exxon/Shell Station	4	2	14.0	0.8	7.4	6.9
08	McDonald's Restaurant	4	4	0.9	–0.1	0.4	0.4
09	Los Alamos Airport	4	4	2.9	0.0	1.7	1.4
10	East Gate	4	4	2.3	0.1	1.1	0.9
11	Well PM-1 (E. Jemez Road)	4	4	1.8	0.0	1.2	0.8
12	Royal Crest Trailer Court	4	4	1.3	–0.3	0.4	0.8
13	Rocket Park	4	4	1.0	0.1	0.4	0.4
14	Pajarito Acres	4	4	1.4	–0.3	0.6	0.7
15	White Rock Fire Station	4	4	1.2	0.1	0.7	0.5
16	White Rock Nazarene Church	4	4	3.0	–0.2	0.9	1.4
17	Bandelier Fire Lookout	4	4	1.1	–0.1	0.5	0.6
26	TA-49	4	4	1.3	0.1	0.6	0.5
32	County Landfill (TA-48)	4	4	8.1	2.4	4.0	2.7
54	TA-33 East	4	4	2.0	0.4	1.2	0.7
60	LA Canyon	4	4	1.6	0.0	1.0	0.7
61	LA Hospital	4	4	2.0	1.3	1.6	0.3
62	Crossroads Bible Church	4	4	1.7	0.1	0.6	0.7
63	Monte Rey South	4	4	1.9	0.0	0.9	0.8
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	4	4	1.9	–1.3	0.9	1.4
77	TA-36 IJ Site	4	4	1.1	–1.2	–0.1	1.0
78	TA-15-N	4	4	2.5	–1.2	0.6	1.5
TA-21 Stations							
20	TA-21 Area B	4	4	2.7	0.2	1.5	1.0
71	TA-21.01 (NW Bldg 344)	4	4	1.4	0.0	0.9	0.6
72	TA-21.02 (N Bldg 344)	4	4	6.5	0.5	3.4	2.5
73	TA-21.03 (NE Bldg 344)	4	2	10.9	–0.2	5.4	5.1
74	TA-21.04 (SE Bldg 344)	4	3	9.2	4.4	5.6	2.4
75	TA-21.05 (S Bldg 344)	4	4	4.3	2.0	2.9	1.0

Table 4-6. Airborne Plutonium-239 Concentrations for 1999 (Cont.)

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations						
27 Area G (by QA)	4	1	166.7	4.9	51.9	77.1
34 Area G-1 (behind trailer)	4	1	205.6	7.5	105.0	111.3
35 Area G-2 (back fence)	4	4	1.4	0.8	1.2	0.3
36 Area G-3 (by office)	4	4	1.5	–0.2	0.8	0.7
45 Area G/South East Perimeter	4	0	52.4	7.8	24.5	20.7
47 Area G/North Perimeter	4	4	4.8	0.6	3.2	1.9
50 Area G-expansion	4	4	6.9	2.3	4.7	1.9
51 Area G-expansion pit	4	4	3.1	–0.9	1.2	1.6
Other On-Site Stations						
23 TA-5	4	4	0.6	–0.1	0.2	0.3
25 TA-16-450	4	4	1.6	0.6	1.2	0.4
30 Pajarito Booster 2 (P-2)	4	4	1.5	0.0	0.7	0.6
31 TA-3	4	4	5.7	0.1	1.9	2.6
49 Pajarito Road (TA-36)	4	4	1.4	–0.6	0.1	0.9
QA Stations						
38 TA-54 Area G-QA (next to #27)	4	2	25.8	3.3	12.7	10.8
39 TA-49-QA (next to #26)	4	4	0.9	–0.1	0.3	0.4

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	2.1	–1.4	0.7	±0.6	1.1
Pueblo	8	8	3.7	–0.7	0.6	±1.1	1.3
Perimeter	84	82	14.0	–1.2	1.3	±0.5	2.2
TA-15 and TA-36	12	12	2.5	–1.3	0.5	±0.8	1.3
TA-21	24	21	10.9	–0.2	3.3	±1.2	2.9
TA-54 Area G	32	22	205.6	–0.9	24.1	±20.0	55.4
Other On-Site	20	20	5.7	–0.6	0.8	±0.6	1.3

Concentration Guidelines

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

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[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 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	4	2.7	1.9	2.3	0.4
03	Santa Fe	4	4	3.8	1.6	2.4	1.0
55	Santa Fe West (Buckman Booster #4)	4	4	4.1	0.9	2.5	1.3
56	El Rancho	4	4	2.5	0.9	1.7	0.8
Pueblo Stations							
41	San Ildefonso Pueblo	4	4	2.2	0.7	1.7	0.7
59	Jemez Pueblo-Visitor's Center	4	4	9.0	1.0	3.5	3.7
Perimeter Stations							
04	Barranca School	4	4	1.6	0.8	1.2	0.3
05	Urban Park	4	4	3.2	1.1	2.2	0.9
06	48th Street	4	4	5.0	1.3	3.2	1.6
07	Gulf/Exxon/Shell Station	4	4	5.9	1.6	2.9	2.1
08	McDonald's Restaurant	4	4	4.3	1.9	2.9	1.1
09	Los Alamos Airport	4	4	3.8	2.0	2.8	0.8
10	East Gate	4	4	3.5	2.1	2.7	0.6
11	Well PM-1 (E. Jemez Road)	4	4	1.9	0.5	1.3	0.6
12	Royal Crest Trailer Court	4	4	3.0	1.2	1.9	0.8
13	Rocket Park	4	4	3.5	1.2	2.6	1.0
14	Pajarito Acres	4	4	4.2	1.3	2.5	1.3
15	White Rock Fire Station	4	4	3.8	1.3	2.5	1.1
16	White Rock Nazarene Church	4	4	2.6	0.3	1.5	1.0
17	Bandelier Fire Lookout	4	4	3.0	1.4	2.3	0.8
26	TA-49	4	4	5.5	0.9	3.0	2.0
32	County Landfill (TA-48)	4	3	20.4	2.2	8.0	8.4
54	TA-33 East	4	4	4.3	0.9	2.5	1.4
60	LA Canyon	4	4	5.0	1.4	2.5	1.7
61	LA Hospital	4	4	3.4	1.6	2.4	0.9
62	Crossroads Bible Church	4	4	3.6	1.2	2.0	1.1
63	Monte Rey South	4	4	2.8	0.8	2.1	1.0
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly15-61)	4	4	4.3	1.4	3.1	1.2
77	TA-36 IJ Site	4	4	5.9	1.2	3.7	2.0
78	TA-15-N	4	4	2.4	0.6	1.4	0.8
TA-21 Stations							
20	TA-21 Area B	4	4	5.3	1.3	2.9	1.7
71	TA-21.01 (NW Bldg 344)	4	4	2.9	0.4	1.3	1.1
72	TA-21.02 (N Bldg 344)	4	4	5.0	1.5	3.1	1.6
73	TA-21.03 (NE Bldg 344)	4	4	6.1	2.1	4.1	1.9
74	TA-21.04 (SE Bldg 344)	4	4	3.1	1.4	2.5	0.8
75	TA-21.05 (S Bldg 344)	4	4	4.9	2.5	3.5	1.0

Table 4-7. Airborne Americium-241 Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	1	28.0	6.6	15.2	9.3
34	Area G-1 (behind trailer)	4	0	234.6	24.0	89.7	98.5
35	Area G-2 (back fence)	4	4	4.4	1.8	3.3	1.1
36	Area G-3 (by office)	4	4	4.2	1.3	2.6	1.4
45	Area G/South East Perimeter	4	1	13.1	7.0	10.9	2.7
47	Area G/North Perimeter	4	3	7.8	1.9	4.4	2.5
50	Area G-expansion	4	4	5.7	2.4	3.8	1.4
51	Area G-expansion pit	4	4	3.4	1.4	2.3	0.9
Other On-Site Stations							
23	TA-5	4	4	4.7	2.2	3.6	1.0
25	TA-16-450	4	4	5.2	1.7	3.2	1.7
30	Pajarito Booster 2 (P-2)	4	4	4.4	1.0	2.9	1.5
31	TA-3	4	4	2.7	1.8	2.2	0.4
49	Pajarito Road (TA-36)	4	4	4.5	1.7	3.4	1.3
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	2	16.4	5.0	10.2	5.1
39	TA-49-QA (next to #26)	4	4	4.7	1.5	2.5	1.5

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	16	16	4.1	0.9	2.2	±0.5	0.9
Pueblo	8	8	9.0	0.7	2.6	±2.2	2.7
Perimeter	84	83	20.4	0.3	2.6	±0.5	2.3
TA-15 and TA-36	12	12	5.9	0.6	2.7	±1.1	1.7
TA-21	24	24	6.1	0.4	2.9	±0.7	1.5
TA-54 Area G	32	21	234.6	1.3	16.5	±15.1	41.9
Other On-Site	20	20	5.2	1.0	3.1	±0.6	1.2

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace 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 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	0	25.9	10.5	20.5	6.9
03	Santa Fe	4	0	41.1	14.9	25.6	11.7
55	Santa Fe West (Buckman Booster #4)	4	0	16.1	10.8	13.2	2.3
56	El Rancho	4	0	21.7	11.8	17.6	4.9
Pueblo Stations							
41	San Ildefonso Pueblo	4	0	32.8	11.8	26.0	9.6
59	Jemez Pueblo-Visitor's Center	4	0	49.7	29.6	37.5	8.6
Perimeter Stations							
04	Barranca School	4	0	14.4	7.9	11.8	2.8
05	Urban Park	4	0	25.3	9.3	19.4	7.0
06	48th Street	4	1	7.6	5.3	6.3	1.0
07	Gulf/Exxon/Shell Station	4	0	70.2	20.2	35.3	23.4
08	McDonald's Restaurant	4	0	11.6	7.6	9.9	1.7
09	Los Alamos Airport	4	1	13.6	5.7	8.4	3.5
10	East Gate	4	0	18.4	5.3	11.1	5.6
11	Well PM-1 (E. Jemez Road)	4	1	10.0	5.2	7.7	2.3
12	Royal Crest Trailer Court	4	0	15.3	8.2	11.4	3.1
13	Rocket Park	4	0	9.6	7.3	8.4	1.0
14	Pajarito Acres	4	0	9.4	6.0	8.0	1.5
15	White Rock Fire Station	4	0	15.7	6.5	11.6	4.1
16	White Rock Nazarene Church	4	1	11.5	5.5	9.0	2.6
17	Bandelier Fire Lookout	4	2	9.3	5.4	7.1	2.0
26	TA-49	4	2	13.7	4.8	8.3	4.1
32	County Landfill (TA-48)	4	0	75.6	39.0	58.1	19.5
54	TA-33 East	4	0	11.9	6.3	9.2	2.6
60	LA Canyon	4	0	15.7	5.7	11.6	4.2
61	LA Hospital	4	0	32.0	9.1	18.3	9.7
62	Crossroads Bible Church	4	1	10.9	5.3	8.3	2.3
63	Monte Rey South	4	0	11.5	6.1	9.3	2.3
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	4	2	12.3	4.4	6.9	3.7
77	TA-36 IJ Site	4	0	16.5	11.1	13.1	2.3
78	TA-15-N	4	0	10.9	4.1	8.2	2.9
TA-21 Stations							
20	TA-21 Area B	4	0	40.5	6.8	15.7	16.5
71	TA-21.01 (NW Bldg 344)	4	1	14.3	6.4	9.1	3.5
72	TA-21.02 (N Bldg 344)	4	0	13.9	6.4	9.0	3.4
73	TA-21.03 (NE Bldg 344)	4	1	11.2	8.2	10.0	1.3
74	TA-21.04 (SE Bldg 344)	4	1	17.4	5.3	9.8	5.3
75	TA-21.05 (S Bldg 344)	4	0	14.7	5.7	10.1	3.8

Table 4-8. Airborne Uranium-234 Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	0	304.7	29.8	115.6	129.1
34	Area G-1 (behind trailer)	4	0	63.9	17.5	34.4	20.4
35	Area G-2 (back fence)	4	0	25.6	9.1	19.7	7.5
36	Area G-3 (by office)	4	0	51.8	18.1	28.9	15.7
45	Area G/South East Perimeter	4	0	72.7	44.1	58.7	12.1
47	Area G/North Perimeter	4	0	30.1	8.1	19.5	10.3
50	Area G-expansion	4	0	249.9	49.2	115.5	91.9
51	Area G-expansion pit	4	0	96.5	21.2	47.4	33.6
Other On-Site Stations							
23	TA-5	4	0	11.5	7.8	9.8	1.6
25	TA-16-450	4	0	8.9	5.4	7.4	1.4
30	Pajarito Booster 2 (P-2)	4	0	11.4	6.5	8.7	2.2
31	TA-3	4	0	10.6	6.6	8.8	2.1
49	Pajarito Road (TA-36)	4	0	16.1	5.7	11.0	5.0
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	0	138.7	28.5	69.7	52.0
39	TA-49-QA (next to #26)	4	1	15.8	3.5	8.3	5.3

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	16	0	41.1	10.5	19.2	±4.3	8.1
Pueblo	8	0	49.7	11.8	31.7	±8.7	10.4
Perimeter	84	9	75.6	4.8	13.7	±2.9	13.5
TA-15 and TA-36	12	2	16.5	4.1	9.4	±2.5	3.9
TA-21	24	3	40.5	5.3	10.6	±3.0	7.1
TA-54 Area G	32	0	304.7	8.1	55.0	±23.0	63.7
Other On-Site	20	0	16.1	5.4	9.1	±1.3	2.8

Concentration Guidelines

DOE Derived Air Concentation (DAC) Guide for workplace exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 7,700 a Ci/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 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	4	2.1	1.0	1.6	0.6
03	Santa Fe	4	4	4.8	2.9	3.6	0.9
55	Santa Fe West (Buckman Booster #4)	4	4	2.2	0.2	1.3	0.8
56	El Rancho	4	4	1.9	1.4	1.7	0.3
Pueblo Stations							
41	San Ildefonso Pueblo	4	4	2.5	0.8	1.6	0.7
59	Jemez Pueblo-Visitor's Center	4	3	7.3	2.3	4.1	2.2
Perimeter Stations							
04	Barranca School	4	4	1.2	0.0	0.6	0.5
05	Urban Park	4	4	2.2	0.3	1.1	0.9
06	48th Street	4	4	2.0	0.4	1.3	0.7
07	Gulf/Exxon/Shell Station	4	3	5.9	1.3	3.0	2.2
08	McDonald's Restaurant	4	4	1.2	0.5	0.9	0.3
09	Los Alamos Airport	4	4	2.2	0.4	1.1	0.8
10	East Gate	4	4	1.6	0.6	1.2	0.5
11	Well PM-1 (E. Jemez Road)	4	4	2.1	1.0	1.5	0.5
12	Royal Crest Trailer Court	4	4	1.5	0.0	0.9	0.6
13	Rocket Park	4	4	2.3	0.6	1.3	0.7
14	Pajarito Acres	4	4	2.5	–0.5[a]	1.0	1.3
15	White Rock Fire Station	4	4	1.9	1.6	1.8	0.1
16	White Rock Nazarene Church	4	4	2.7	0.3	1.2	1.1
17	Bandelier Fire Lookout	4	4	2.0	1.6	1.8	0.2
26	TA-49	4	4	2.1	0.2	1.1	0.8
32	County Landfill (TA-48)	4	3	4.9	1.9	3.0	1.4
54	TA-33 East	4	4	3.3	0.2	1.3	1.3
60	LA Canyon	4	4	3.7	1.2	2.1	1.1
61	LA Hospital	4	4	2.9	1.3	1.8	0.8
62	Crossroads Bible Church	4	4	2.4	0.4	1.1	0.9
63	Monte Rey South	4	4	1.9	0.0	1.1	0.8
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	4	4	1.8	0.5	1.2	0.5
77	TA-36 IJ Site	4	4	2.5	0.9	1.5	0.7
78	TA-15-N	4	4	2.5	–0.3	1.3	1.2
TA-21 Stations							
20	TA-21 Area B	4	4	2.0	–0.5	1.3	1.2
71	TA-21.01 (NW Bldg 344)	4	4	2.3	–0.1	1.3	1.1
72	TA-21.02 (N Bldg 344)	4	4	2.2	0.4	1.2	0.9
73	TA-21.03 (NE Bldg 344)	4	4	2.9	0.0	1.3	1.3
74	TA-21.04 (SE Bldg 344)	4	4	2.6	–0.1	1.3	1.2
75	TA-21.05 (S Bldg 344)	4	4	0.8	0.0	0.5	0.4

Table 4-9. Airborne Uranium-235 Concentrations for 1999 (Cont.)

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations						
27 Area G (by QA)	4	3	19.7	2.3	7.2	8.4
34 Area G-1 (behind trailer)	4	3	4.9	0.6	2.0	1.9
35 Area G-2 (back fence)	4	4	1.7	0.1	0.9	0.8
36 Area G-3 (by office)	4	3	4.3	0.0	1.6	1.9
45 Area G/South East Perimeter	4	1	5.1	2.2	3.7	1.2
47 Area G/North Perimeter	4	4	2.6	1.0	1.6	0.7
50 Area G-expansion	4	1	12.6	1.5	6.7	4.8
51 Area G-expansion pit	4	3	6.5	1.3	3.2	2.4
Other On-Site Stations						
23 TA-5	4	4	2.8	1.1	1.9	0.7
25 TA-16-450	4	4	2.1	0.5	1.2	0.7
30 Pajarito Booster 2 (P-2)	4	4	1.6	0.3	1.2	0.6
31 TA-3	4	4	1.8	–0.3	0.9	0.9
49 Pajarito Road (TA-36)	4	4	3.4	0.8	2.1	1.3
QA Stations						
38 TA-54 Area G-QA (next to #27)	4	3	12.1	1.0	4.5	5.1
39 TA-49-QA (next to #26)	4	4	1.1	0.5	0.7	0.3

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	4.8	0.2	2.1	±0.6	1.1
Pueblo	8	7	7.3	0.8	2.8	±1.7	2.0
Perimeter	84	82	5.9	–0.5	1.4	±0.2	1.0
TA-15 and TA-36	12	12	2.5	–0.3	1.3	±0.5	0.8
TA-21	24	24	2.9	–0.5	1.1	±0.4	1.0
TA-54 Area G	32	22	19.7	0.0	3.4	±1.4	4.0
Other On-Site	20	20	3.4	–0.3	1.5	±0.4	0.9

Concentration Guidelines

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

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[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 1999

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	0	25.3	11.8	20.9	6.2
03 Santa Fe	4	0	35.4	9.7	21.3	11.7
55 Santa Fe West (Buckman Booster #4)	4	0	13.4	8.3	11.7	2.4
56 El Rancho	4	0	17.5	12.7	15.4	2.0
Pueblo Stations						
41 San Ildefonso Pueblo	4	0	33.0	13.6	24.5	8.0
59 Jemez Pueblo-Visitor's Center	4	0	50.8	27.0	36.8	10.0
Perimeter Stations						
04 Barranca School	4	0	15.5	11.0	12.7	1.9
05 Urban Park	4	0	24.7	7.9	18.2	7.3
06 48th Street	4	1	6.5	4.8	5.7	0.9
07 Gulf/Exxon/Shell Station	4	0	68.9	19.9	33.1	23.9
08 McDonald's Restaurant	4	0	12.2	9.6	10.6	1.1
09 Los Alamos Airport	4	0	10.9	7.2	8.8	1.6
10 East Gate	4	0	20.0	7.6	12.5	5.3
11 Well PM-1 (E. Jemez Road)	4	0	7.9	6.3	6.8	0.8
12 Royal Crest Trailer Court	4	0	19.4	9.1	13.7	4.2
13 Rocket Park	4	0	10.6	6.5	8.5	1.8
14 Pajarito Acres	4	0	18.4	6.1	10.6	5.5
15 White Rock Fire Station	4	0	13.5	9.0	12.2	2.1
16 White Rock Nazarene Church	4	0	10.6	6.1	8.8	1.9
17 Bandelier Fire Lookout	4	1	10.0	3.6	7.5	2.8
26 TA-49	4	0	14.8	6.3	9.2	4.0
32 County Landfill (TA-48)	4	0	73.7	41.3	57.4	18.6
54 TA-33 East	4	0	11.5	7.0	9.6	1.9
60 LA Canyon	4	0	14.2	6.1	10.4	3.3
61 LA Hospital	4	0	26.7	9.0	16.1	7.7
62 Crossroads Bible Church	4	0	10.3	6.2	8.9	1.8
63 Monte Rey South	4	0	27.0	4.7	11.4	10.4
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	1	11.7	7.1	8.6	2.1
77 TA-36 IJ Site	4	0	40.5	20.4	30.2	8.8
78 TA-15-N	4	2	24.7	2.7	11.9	9.8
TA-21 Stations						
20 TA-21 Area B	4	1	38.1	4.0	14.6	15.8
71 TA-21.01 (NW Bldg 344)	4	0	10.8	8.3	9.7	1.2
72 TA-21.02 (N Bldg 344)	4	0	10.1	6.0	7.9	2.1
73 TA-21.03 (NE Bldg 344)	4	0	14.0	10.3	11.8	1.7
74 TA-21.04 (SE Bldg 344)	4	0	10.2	6.5	8.2	1.6
75 TA-21.05 (S Bldg 344)	4	1	9.6	5.5	7.8	1.8

Table 4-10. Airborne Uranium-238 Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	0	296.6	30.5	114.4	125.2
34	Area G-1 (behind trailer)	4	0	71.3	21.8	36.7	23.2
35	Area G-2 (back fence)	4	0	24.8	11.0	19.4	6.0
36	Area G-3 (by office)	4	0	49.5	24.1	37.5	13.5
45	Area G/South East Perimeter	4	0	75.0	51.3	62.6	11.2
47	Area G/North Perimeter	4	0	27.8	10.2	19.6	8.4
50	Area G-expansion	4	0	261.0	50.1	118.7	97.2
51	Area G-expansion pit	4	0	102.8	25.5	50.4	35.3
Other On-Site Stations							
23	TA-5	4	1	13.5	5.6	9.6	3.2
25	TA-16-450	4	0	8.6	3.1	6.6	2.5
30	Pajarito Booster 2 (P-2)	4	0	12.8	7.9	9.8	2.3
31	TA-3	4	0	11.5	5.1	9.0	3.0
49	Pajarito Road (TA-36)	4	0	16.0	8.7	12.0	3.5
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	0	140.8	30.9	70.4	52.1
39	TA-49-QA (next to #26)	4	1	13.8	5.0	8.6	4.1

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	16	0	35.4	8.3	17.3	±3.9	7.4
Pueblo	8	0	50.8	13.6	30.6	±8.9	10.7
Perimeter	84	2	73.7	3.6	13.9	±2.9	13.2
TA-15 and TA-36	12	3	40.5	2.7	16.9	±7.7	12.1
TA-21	24	2	38.1	4.0	10.0	±2.7	6.4
TA-54 Area G	32	0	296.6	10.2	57.4	±22.9	63.5
Other On-Site	20	1	16.0	3.1	9.4	±1.5	3.2

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace 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 Gamma-Emitting Radionuclides that are Potentially Released by LANL Operations

Gamma Emitting Radionuclide	Number of Results	Number of Results ≤MDA	Mean (fCi/m^3)	Measured Average MDA as a Percent of the Required MDA
^{73}As	324	324	<<0.75	0.1
^{74}As	324	324	<<0.63	0.6
^{109}Cd	324	324	<<0.07	0.3
^{57}Co	324	324	<<0.13	0.2
^{60}Co	324	324	<<0.29	34.6
^{134}Cs	324	324	<<0.27	20.0
^{137}Cs	324	324	<<0.24	25.5
^{54}Mn	324	324	<<0.28	2.0
^{22}Na	324	324	<<0.30	23.2
^{83}Rb	324	324	<<0.51	3.0
^{86}Rb	324	324	<<4.96	17.7
^{103}Ru	324	324	<<0.26	0.2
^{75}Se	324	324	<<0.21	2.4
^{65}Zn	324	324	<<0.61	13.4

Table 4-12. Airborne Concentrations of Gamma-Emitting Radionuclides that Naturally Occur in Measurable Quantities

Gamma Emitting Radionuclide	Number of Results	Number of Results <MDA	Mean (fCi/m^3)	Estimated Dose (mrem)
^{7}Be	324	0	85	0.04
^{210}Pb	324	0	11	41

Table 4-13. Airborne Radioactive Emissions from Laboratory Buildings with Sampled Stacks in 1999 (Ci)

TA-Building	^{3}H[a]	^{241}Am	Pu[b]	U[c]	Th	P/VAP[d]	G/MAP[e]
TA-03-029		2.6×10^{-6}	2.1×10^{-5}	6.1×10^{-6}	2.1×10^{-7}		
TA-03-035				1.2×10^{-6}	6.4×10^{-9}		
TA-03-102				3.3×10^{-7}	3.8×10^{-9}		
TA-16-205	1.6×10^{2}						
TA-21-155	6.6×10^{1}						
TA-21-209	4.2×10^{2}						
TA-33-086	9.4×10^{2}						
TA-41-004	1.3×10^{1}						
TA-48-001				6.1×10^{-10}		3.9×10^{-3}	
TA-50-001		1.3×10^{-7}	5.1×10^{-8}		3.7×10^{-8}		
TA-50-037				1.9×10^{-8}			
TA-50-069			9.9×10^{-11}				
TA-53-003	1.8×10^{0}						4.3×10^{0}
TA-53-007	4.5×10^{-1}					2.5×10^{-3}	3.0×10^{2}
TA-55-004	1.8×10^{0}	5.4×10^{-8}	6.3×10^{-8}	7.1×10^{-8}			

[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] P/VAP—Particulate/vapor activation products.
[e] G/MAP—Gaseous/mixed activation products.

Table 4-14. Detailed Listing of Activation Products Released from Sampled Laboratory Stacks in 1999 (Ci)

TA-Building	Radionuclide	Emission
TA-48-001	^{73}As	1.83×10^{-5}
TA-48-001	^{74}As	4.49×10^{-5}
TA-48-001	^{77}Br	1.15×10^{-5}
TA-48-001	^{68}Ga	1.73×10^{-3}
TA-48-001	^{68}Ge	1.73×10^{-3}
TA-48-001	^{75}Se	3.50×10^{-4}
TA-53-003	^{41}Ar	1.50×10^{-1}
TA-53-003	^{11}C	4.11×10^{0}
TA-53-007	^{41}Ar	1.29×10^{1}
TA-53-007	^{76}Br	2.32×10^{-4}
TA-53-007	^{82}Br	6.27×10^{-4}
TA-53-007	^{10}C	4.24×10^{-2}
TA-53-007	^{11}C	2.62×10^{2}
TA-53-007	^{60}Co	3.97×10^{-6}
TA-53-007	^{197}Hg	1.60×10^{-3}
TA-53-007	^{13}N	1.59×10^{0}
TA-53-007	^{16}N	1.50×10^{-2}
TA-53-007	^{14}O	1.00×10^{-1}
TA-53-007	^{15}O	1.89×10^{1}

Table 4-15. 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	2.4 d
^{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 4-16. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1998–1999

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
Regional	01	Española	NA[a]	1–4	110 ± 14
	53	San Ildefonso Pueblo	121 ± 7	1–4	116 ± 15
	95	El Rancho	NA[a]	1–4	133 ± 17
	101	Santa Fe West	138 ± 8	1–4	127 ± 17
	103	Santa Clara Pueblo	NA[a]	1–4	145 ± 19
Perimeter	05	Barranca School, Los Alamos	148 ± 8	1–4	134 ± 17
	07	Cumbres School, Los Alamos	140 ± 8	1–4	132 ± 17
	08	48th Street, Los Alamos	159 ± 9	1–4	156 ± 20
	09	Los Alamos Airport	140 ± 9	1–4	154 ± 20
	10	Bayo Canyon, Los Alamos	182 ± 10	1–4	171 ± 22
	11	Shell Station, Los Alamos	161 ± 9	1–4	158 ± 21
	12	Royal Crest Trailer Court, Los Alamos	148 ± 8	1–4	139 ± 18
	13	White Rock Fire Station	149 ± 9	1–4	140 ± 18
	14	Pajarito Acres, White Rock	141 ± 8	1–4	136 ± 18
	15	Bandelier National Monument	160 ± 9	1–4	157 ± 20
	16	Pajarito Ski Area	NA[a]	2–4[b]	142 ± 18
	41	McDonald’s Restaurant, Los Alamos	162 ± 9	1–4	147 ± 19
	42	Los Alamos Airport-South	162 ± 10	1–4	135 ± 18
	43	East Gate Business Park, Los Alamos	155 ± 9	1,4[b]	126 ± 16
	44	Big Rock Loop, Los Alamos	186 ± 11	1–4	170 ± 22
	45	Cheyenne Street, Los Alamos	176 ± 10	1–4	156 ± 20
	46	Los Pueblos Street, Los Alamos	174 ± 10	1–4	153 ± 20
	47	Urban Park, Los Alamos	154 ± 9	1–4	143 ± 19
	49	Piñon School (Rocket Park) White Rock	105 ± 7	1–4	130 ± 17
	50	White Rock Church of the Nazarene	100 ± 6	1–4	130 ± 17
	51	Bayo Canyon Well, Los Alamos	177 ± 10	1–4	168 ± 22
	55	Monte Rey South, White Rock	136 ± 7	1–4	132 ± 17
	56	East Gate (mid station)	175 ± 10	1–4	160 ± 21
	60	Piedra Drive, White Rock	135 ± 8	1–4	133 ± 17
	66	East Gate	NA[a]	1–4	150 ± 19
	67	Los Alamos Hospital	NA[a]	2–4[b]	134 ± 17
	68	Trinity (Crossroads) Bible Church	169 ± 10	1–4	156 ± 20
	80	TA-16 SR4 Back Gate	152 ± 9	1–4	148 ± 19
	81	TA-16 SR4 Ponderosa Camp	143 ± 20	1–4	147 ± 19
On-Site	17	TA-21 (DP West)	172 ± 10	1–4	154 ± 20
	18	TA-6 (Two Mile Mesa)	154 ± 9	1–4	145 ± 19
	19	TA-53 (LANSCE)	190 ± 11	1–4	158 ± 21
	20	Well PM-1 (SR4 and Truck Rt.)	179 ± 10	1–4	169 ± 22
	21	TA-16 (S-Site)	146 ± 10	1–4	154 ± 20
	22	Booster P-2	155 ± 9	1–4	154 ± 20
	23	TA-3 East Gate of SM 43	NA[a]	1–4	122 ± 16
	24	State Highway 4	194 ± 11	1–4	182 ± 24
	25	TA-49 (Frijoles Mesa)	150 ± 8	1–4	140 ± 18
	26	TA-2 (Omega Stack)	156 ± 9	1–4	135 ± 18
	28	TA-18 (Pajarito Site)	NA[a]	1–4	189 ± 25

Table 4-16. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1998–1999 (Cont.)

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
On-Site (Cont.)	29	TA-35 (Ten Site A)	137 ± 8	1–4	131 ± 17
	30	TA-35 (Ten Site B)	133 ± 8	1–4	130 ± 17
	31	TA-59 (Occupational Health Lab)	NA[a]	1–4	145 ± 19
	32	TA-3-16 (Van de Graaff)	158 ± 9	1–4	144 ± 19
	33	TA-3-316 (Ion Beam Bldg.)	156 ± 9	1–4	145 ± 19
	34	TA-3-440 (CAS)	174 ± 10	1–4	171 ± 22
	35	TA-3-420 (CMR Bldg. West Fence)	146 ± 8	1–4	133 ± 17
	36	TA-3-102 (Shop)	149 ± 9	1–4	141 ± 18
	37	TA-72 (Pistol Range)	168 ± 10	1–4	177 ± 23
	38	TA-55 (Plutonium Facility South)	164 ± 8	1–4	162 ± 21
	39	TA-55 (Plutonium Facility West)	183 ± 10	1–4	165 ± 21
	40	TA-55 (Plutonium Facility North)	142 ± 8	1–4	143 ± 19
	48	Los Alamos County Landfill	148 ± 9	1–4	140 ± 18
	56	East Gate Mid Station	175 ± 10	1–4	160 ± 21
	57	TA-54 West (TLD Lab)	182 ± 10	1–4	150 ± 19
	58	TA-54 Lagoon (TA-36 Pajarito Road)	170 ± 10	1–4	167 ± 22
	59	Los Alamos Canyon	NA[a]	1–4	167 ± 22
	61	S. LANSCE Lagoons	NA[a]	1–4	2,157 ± 280
	62	N. LANSCE Lagoons	NA[a]	1–4	347 ± 45
	63	E. LANSCE Lagoons	NA[a]	1–4	3,122 ± 406
	64	NE LANSCE Area A Stack	NA[a]	1–4	240 ± 31
	65	NW LANSCE Area A Stack	NA[a]	1–4	219 ± 28
	69	TA-50 Old Outfall	189 ± 10	1–4	185 ± 24
	70	TA-50 Dirt Road to Outfall	163 ± 9	1,2,4[b]	175 ± 23
	71	TA-50 Dirt Road Turnoff	159 ± 9	1–4	157 ± 20
	72	TA-50 East Fence, S. Corner	157 ± 9	1–4	166 ± 22
	73	TA-50 East Fence, N. Corner	142 ± 8	1–4	148 ± 19
	74	TA-50 Pecos Drive	146 ± 8	1–4	141 ± 18
	75	TA-50-37 West	155 ± 9	1–4	158 ± 21
	76	TA-16-450 WETF	159 ± 9	1–4	141 ± 18
	77	TA-16-210 Guard Station	159 ± 9	1–4	147 ± 19
	78	Fitness Trail SW TA-8-24	154 ± 14	1–4	158 ± 21
	79	Fitness Trail SE TA-8-24	162 ± 9	1–4	157 ± 20
	82	TA-15 Phermex N TA-15-185	169 ± 10	1–4	163 ± 21
	83	TA-15 Phermex Entrance	144 ± 10	1,2,4[b]	120 ± 16
	84	TA-15 Phermex NNE Entrance	151 ± 9	1,2,4[b]	132 ± 17
	85	TA-15 Phermex N DAHRT	149 ± 10	1–4	146 ± 19
	86	TA-15-312 DAHRT Entrance	155 ± 9	1,2,4[b]	146 ± 19
	87	TA-15-183 Access Control	174 ± 10	1–4	157 ± 20
	88	TA-15 R-Site Road	163 ± 10	1–4	150 ± 20
	89	TA-15-45 SW	169 ± 10	1–4	153 ± 20
	90	TA-15-306 North	NA[a]	1–4	152 ± 20
	91	TA-15, IJ Firing Point	164 ± 9	1–4	151 ± 20
	92	TA-36 Kappa Site	NA[a]	1–4	160 ± 21
	93	TA-15 Ridge Road Gate	141 ± 8	1–4	138 ± 18
	94	TA-33 East (VLBA Dish)	129 ± 8	1–4	124 ± 16
	96	TA-54 Meteorological Tower	NA[a]	1–4	148 ± 19

Table 4-16. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1998–1999 (Cont.)

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999Annual Dose (mrem)
On-Site (Cont.)	97	TA-50 GS-1-1, Mortandad Canyon	182 ± 11	1–4	180 ± 23
	98	TA-50 GS-1-2, Mortandad Canyon	426 ± 22	1–4	379 ± 49
	99	Mortandad Canyon, MCO-5	447 ± 24	1–4	418 ± 54
	100	Mortandad Canyon, MCO-13	175 ± 8	1–4	155 ± 20
	104	E. LANSCE Lagoons	NA[a]	2–4[b]	242 ± 31

[a]NA = not applicable—the 1998 data for this station were incomplete.
[b]Data for the missing quarter(s) have been replaced with an average of the data for the other quarters.

Table 4-17. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1998–1999

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
Area A	201	TA-21 Area A-1	141 ± 9	1–4	140 ± 18
	202	TA-21 Area A-2	159 ± 9	1–4	157 ± 20
	203	TA-21 Area A-3	155 ± 8	1–4	155 ± 20
	204	TA-21 Area A-4	154 ± 9	1–4	141 ± 18
	205	TA-21 Area A-5	150 ± 9	1–4	146 ± 19
Area AB	221	TA-49 AB-1	142 ± 9	1–4	158 ± 21
	222	TA-49 AB-2	149 ± 9	1–4	163 ± 21
	223	TA-49 AB-3	151 ± 9	1–4	153 ± 20
	224	TA-49 AB-4	143 ± 9	1–4	155 ± 20
	225	TA-49 AB-5	142 ± 9	1–4	150 ± 19
	226	TA-49 AB-6	146 ± 8	1–4	150 ± 19
	227	TA-49 AB-7	141 ± 8	1–4	153 ± 20
	228	TA-49 AB-8	NA[a]	1–4	142 ± 19
	229	TA-49 AB-9	141 ± 8	1–4	149 ± 19
	230	TA-49 AB-10	142 ± 8	1–4	164 ± 21
Area B	241	TA-21 Area B-1	158 ± 15	1–4	147 ± 19
	242	TA-21 Area B-2	161 ± 9	1–4	157 ± 20
	243	TA-21 Area B-3	158 ± 9	1–4	147 ± 19
	244	TA-21 Area B-4	NA[a]	1–4	147 ± 19
	245	TA-21 Area B-5	NA[a]	1–4	140 ± 18
	246	TA-21 Area B-6	152 ± 8	1–4	148 ± 19
	247	TA-21 Area B-7	NA[a]	1–4	151 ± 20
	248	TA-21 Area B-8	161 ± 9	1–4	155 ± 20
	249	TA-21 Area B-9	157 ± 9	1–4	155 ± 20
	250	TA-21 Area B-10	157 ± 8	1–4	153 ± 20
	251	TA-21 Area B-11	163 ± 8	1–4	154 ± 20
	252	TA-21 Area B-12	167 ± 9	1–4	157 ± 20
	253	TA-21 Area B-13	164 ± 9	1–4	158 ± 21
	254	TA-21 Area B-14	171 ± 9	1–4	153 ± 20
Area C	261	TA-50 N Area C-1	150 ± 8	1–4	138 ± 18
	262	TA-50 N Area C-2	162 ± 9	1–4	166 ± 22
	263	TA-50 Area C-3	160 ± 10	1–4	167 ± 22
	264	TA-50 Area C-4	165 ± 9	1–4	181 ± 23
	265	TA-50 SE Area C-5	163 ± 10	1–4	159 ± 21
	266	TA-50 Area C-6	164 ± 9	1–4	164 ± 21
	267	TA-50 Area C-7	151 ± 8	1–4	154 ± 20
	268	TA-50 S Area C-8	147 ± 9	1–4	139 ± 18
	269	TA-50 Area C-9	159 ± 9	1–4	152 ± 20
	270	TA-50 W Area C-10	157 ± 8	1–4	161 ± 21
Area E	281	TA-33 Area E-1	155 ± 9	1–4	152 ± 20
	282	TA-33 Area E-2	162 ± 9	1–4	161 ± 21
	283	TA-33 Area E-3	168 ± 10	1–4	166 ± 22
	284	TA-33 Area E-4	169 ± 10	1–4	184 ± 24

Table 4-17. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1998–1999 (Cont.)

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
Area F	301	TA-6 Area F-1	135 ± 8	1–4	148 ± 19
	302	TA-6 Area F-2	142 ± 9	1–4	144 ± 19
	303	TA-6 Area F-3	143 ± 8	1–4	146 ± 19
	304	TA-6 Area F-4	159 ± 9	1–4	146 ± 19
Area G	601	TA-54 Area G-1	179 ± 10	1–4	192 ± 25
	602	TA-54 Area G-2	289 ± 16	1–4	291 ± 38
	603	TA-54 Area G-3	178 ± 12	1–4	184 ± 24
	604	TA-54 Area G-4	163 ± 9	1–4	180 ± 23
	605	TA-54 Area G-5	190 ± 13	1–4	198 ± 26
	606	TA-54 Area G-6	175 ± 10	1–4	295 ± 38
	607	TA-54 Area G-7	224 ± 15	1–4	245 ± 32
	608	TA-54 Area G-8	261 ± 16	1–4	254 ± 33
	610	TA-54 Area G-10	224 ± 12	1–4	236 ± 31
	611	TA-54 Area G-11	355 ± 21	1–4	473 ± 61
	613	TA-54 Area G-13	297 ± 17	1–4	357 ± 46
	614	TA-54 Area G-14	252 ± 14	1–4	291 ± 38
	615	TA-54 Area G-15	186 ± 10	1–4	192 ± 25
	616	TA-54 Area G-16	177 ± 13	1–4	184 ± 24
	617	TA-54 Area G-17	189 ± 18	1–4	185 ± 24
	618	TA-54 Area G-18	189 ± 12	1–4	179 ± 23
	619	TA-54 Area G-19	219 ± 11	1–4	219 ± 28
	620	TA-54 Area G-20	168 ± 11	2–4[b]	200 ± 26
	622	TA-54 Area G-22	245 ± 14	1–4	242 ± 31
	623	TA-54 Area G-23	168 ± 12	1–4	215 ± 28
	624	TA-54 Area G-24	172 ± 9	1–4	170 ± 22
	625	TA-54 Area G-25	207 ± 11	1–4	199 ± 26
	626	TA-54 Area G-26	178 ± 10	1–4	173 ± 22
	628	TA-54 Area G-28	208 ± 12	1–4	235 ± 31
	629	TA-54 Area G-29	197 ± 12	1–4	215 ± 29
	630	TA-54 Area G-30	241 ± 14	1,4[b]	257 ± 33
	631	TA-54 Area G-31	204 ± 13	1–4	190 ± 25
	634	TA-54 Area G-34	289 ± 16	1–4	269 ± 35
	635	TA-54 Area G-35	251 ± 15	2–4[b]	260 ± 34
	636	TA-54 Area G-36	176 ± 10	1–4	186 ± 24
	637	TA-54 Area G-37	184 ± 10	2–4[b]	183 ± 24
	638	TA-54 Area G-38	190 ± 11	1–4	166 ± 22
	639	TA-54 Area G-38	NA[a]	1–4	300 ± 39
	640	TA-54 Area G-38	NA[a]	1–4	271 ± 35
	641	TA-54 Area G-38	NA[a]	1–4	278 ± 36
Area T	321	TA-21 Area T-1	162 ± 9	1–4	160 ± 21
	322	TA-21 Area T-2	154 ± 8	1–4	153 ± 20
	323	TA-21 Area T-3	295 ± 17	1–4	297 ± 39
	324	TA-21 Area T-4	158 ± 11	1–4	151 ± 20
	325	TA-21 Area T-5	131 ± 7	1–4	135 ± 18
	326	TA-21 Area T-6	153 ± 9	1–4	148 ± 19
	327	TA-21 Area T-7	165 ± 9	1–4	152 ± 20

Table 4-17. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1998–1999 (Cont.)

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
Area U	341	TA-21 Area U-1	152 ± 8	1–4	140 ± 18
	342	TA-21 Area U-2	169 ± 9	1–4	154 ± 20
	343	TA-21 Area U-3	147 ± 9	1–4	149 ± 19
	344	TA-21 Area U-4	154 ± 9	1–4	144 ± 19
Area V	361	TA-21 Area V-1	143 ± 9	1–4	133 ± 17
	362	TA-21 Area V-2	152 ± 8	1–4	153 ± 20
	363	TA-21 Area V-3	156 ± 9	1–4	154 ± 20
	364	TA-21 Area V-4	154 ± 8	1–4	153 ± 20
Area W	381	TA-35 Area W-1	141 ± 8	1–4	138 ± 18
	382	TA-35 Area W-2	NA[a]	1–4	170 ± 22
	383	TA-35 Area X	139 ± 8	1–4	131 ± 17

[a]NA = not applicable—the 1998 data for this station were incomplete.
[b]Data for the missing quarter(s) have been replaced with an average of the data for the other quarters.

Table 4-18. TA-18 Albedo Dosimeter Network

Location ID#	Location	Dosimeter #1 (mrem)	Dosimeter #2 (mrem)
1	NEWNET Kappa Site	10.2	11.0
2	TA-36 Entrance	16.4	10.6
3	TA-18 Personnel Gate at Parking Lot	36.5	31.3
4	P2 Booster Station at TA-54 Entrance	8.5	6.6
5	TA-51 Entrance	5.0	3.3
6	Pajarito Hill West of TA-18 Entrance	9.9	10.8
7	TA-18 Entrance at Pajarito Road	17.0	16.0
8.1	TA-49 Background	3.9	NA[a]
8.2	Santa Fe Background	3.9	NA[a]
9	Vault Control	1.2	NA[a]

[a] NA = not applicable—background or control location with one dosimeter.

Table 4-19. DX Division Firing Sites Expenditures for Calendar Year 1999

(All units are in kilograms unless otherwise noted.)

CY 1999 Materials Expended	Material Totals
HE	1298
Aluminum	688
Beryllium	0.5
Brass	48
Copper	41
Depleted Uranium	67
Lead	0.5
Lexan	1
Uranium Oxide	0.075
Steel (RHA)	10
Stainless Steel	159
Tantalum	0.18
Teflon	0.005

Table 4-20. Airborne Beryllium Concentrations

Station Location	Number of Results	Maximum (ng/m^3)	Minimum (ng/m^3)	Mean (ng/m^3)	Sample Standard Deviation
Regional/Pueblo Stations					
01 Española	4	0.038	0.016	0.029	0.010
03 Santa Fe	4	0.053	0.021	0.033	0.015
41 San Ildefonso Pueblo	4	0.039	0.018	0.031	0.009
55 Santa Fe West (Buckman Booster #4)	4	0.016	0.012	0.014	0.002
56 El Rancho	4	0.022	0.011	0.017	0.005
59 Jemez Pueblo-Visitor's Center	4	0.096	0.059	0.077	0.015
Perimeter Stations					
04 Barranca School	4	0.024	0.009	0.017	0.006
07 Gulf/Exxon/Shell Station	4	0.121	0.025	0.057	0.044
09 Los Alamos Airport	4	0.013	0.006	0.010	0.003
10 East Gate	4	0.028	0.008	0.017	0.009
12 Royal Crest Trailer Court	4	0.017	0.008	0.012	0.005
16 White Rock Nazarene Church	4	0.012	0.005	0.009	0.003
26 TA-49	4	0.016	0.004	0.009	0.005
32 County Landfill (TA-48)	4	0.136	0.079	0.107	0.029
39 TA-49-QA (next to #26)	4	0.013	0.004	0.007	0.004
61 LA Hospital	4	0.033	0.013	0.022	0.009
On-Site Stations					
23 TA-5	4	0.013	0.008	0.010	0.002
31 TA-3	4	0.014	0.008	0.010	0.003
76 TA-15-41 (formerly 15-61)	4	0.010	0.005	0.007	0.002
77 TA-36 IJ Site	4	0.011	0.008	0.009	0.001
78 TA-15-N	4	0.009	0.004	0.006	0.002
TA-54 Area G Stations					
27 Area G (by QA)	4	0.693	0.060	0.260	0.296
35 Area G-2 (back fence)	4	0.053	0.018	0.039	0.015
36 Area G-3 (by office)	4	0.098	0.026	0.052	0.032
38 Area G-QA (next to #27)	4	0.312	0.056	0.152	0.120

Group Summaries

Station Location	Number of Results	Maximum (ng/m^3)	Minimum (ng/m^3)	Mean (ng/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional/Pueblo Stations	24	0.096	0.011	0.034	±0.009	0.023
Perimeter Stations	40	0.136	0.004	0.027	±0.011	0.034
On-Site Stations	20	0.014	0.004	0.009	±0.001	0.003
TA-54 Area G Stations	16	0.693	0.018	0.126	±0.084	0.171

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

Table 4-21. 1999 Precipitation (in.)

	TA-6	TA-16	TA-49	TA-53	TA-54	TA-74	North Community
January	0.15	0.18	0.08	0.17	0.08	0.00	0.14
February	0.07	0.13	0.05	0.07	0.02	0.00	0.01
March	1.44	1.55	1.36	1.25	1.11	0.38	1.34
April	2.41	3.41	2.17	2.01	2.19	1.98	2.62
May	1.81	2.57	1.63	1.13	1.66	2.56	2.07
June	1.72	2.18	1.86	1.50	3.75	2.83	1.41
July	3.01	4.49	2.65	1.44	1.70	1.80	4.10
August	2.06	2.06	3.15	3.05	4.10	3.57	3.16
September	2.71	2.30	1.88	1.29	1.45	1.26	2.23
October	0.57	1.74	0.51	0.45	0.50	0.41	0.50
November	0.36	0.03	0.01	0.03	0.29	0.04	0.04
December	0.34	0.48	0.33	0.26	0.24	0.22	0.23
Total	16.65	21.12	15.68	12.65	17.09	15.05	17.85

J. Figures

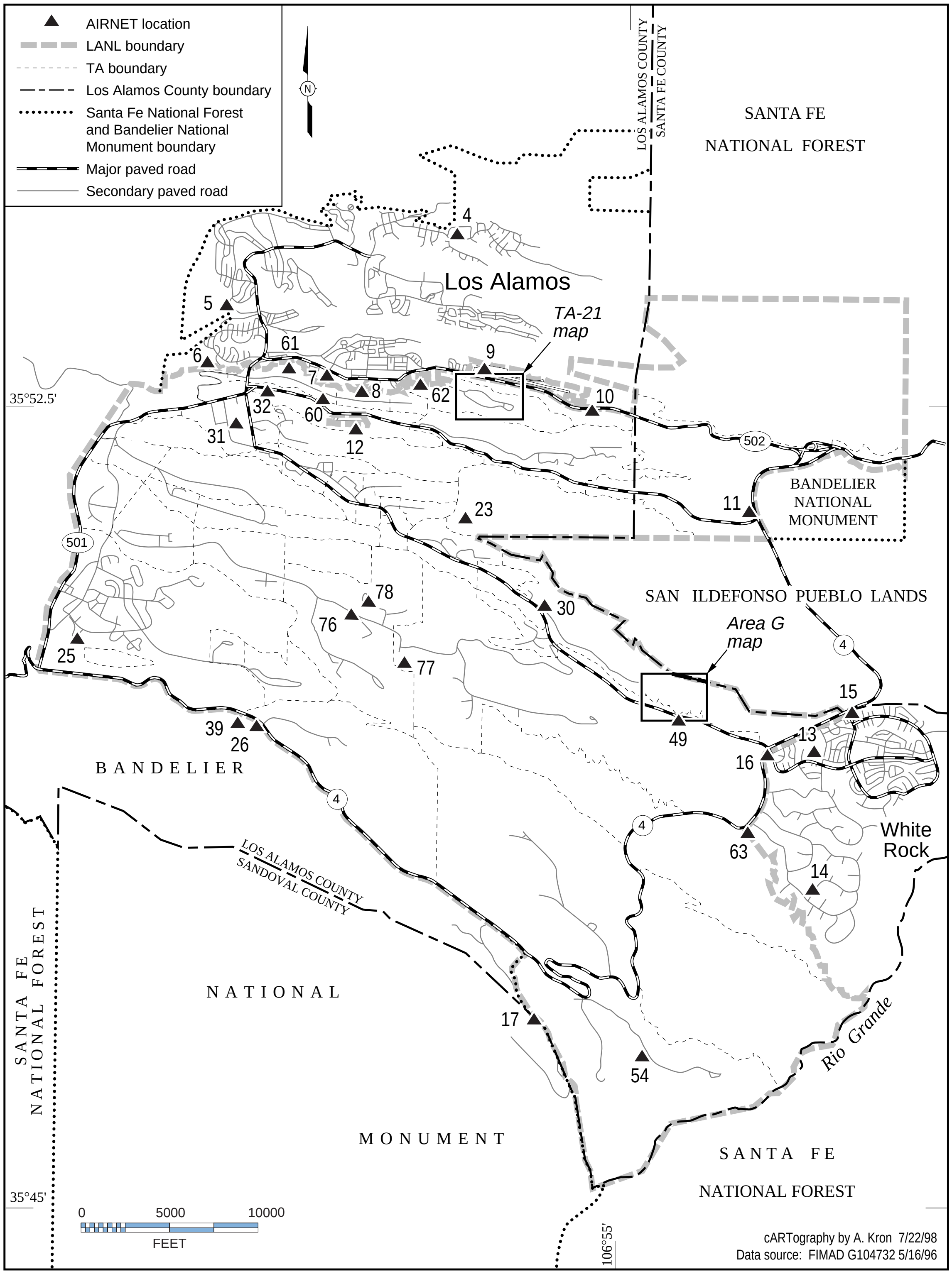

Figure 4-1. Off-site perimeter and on-site Laboratory AIRNET locations.

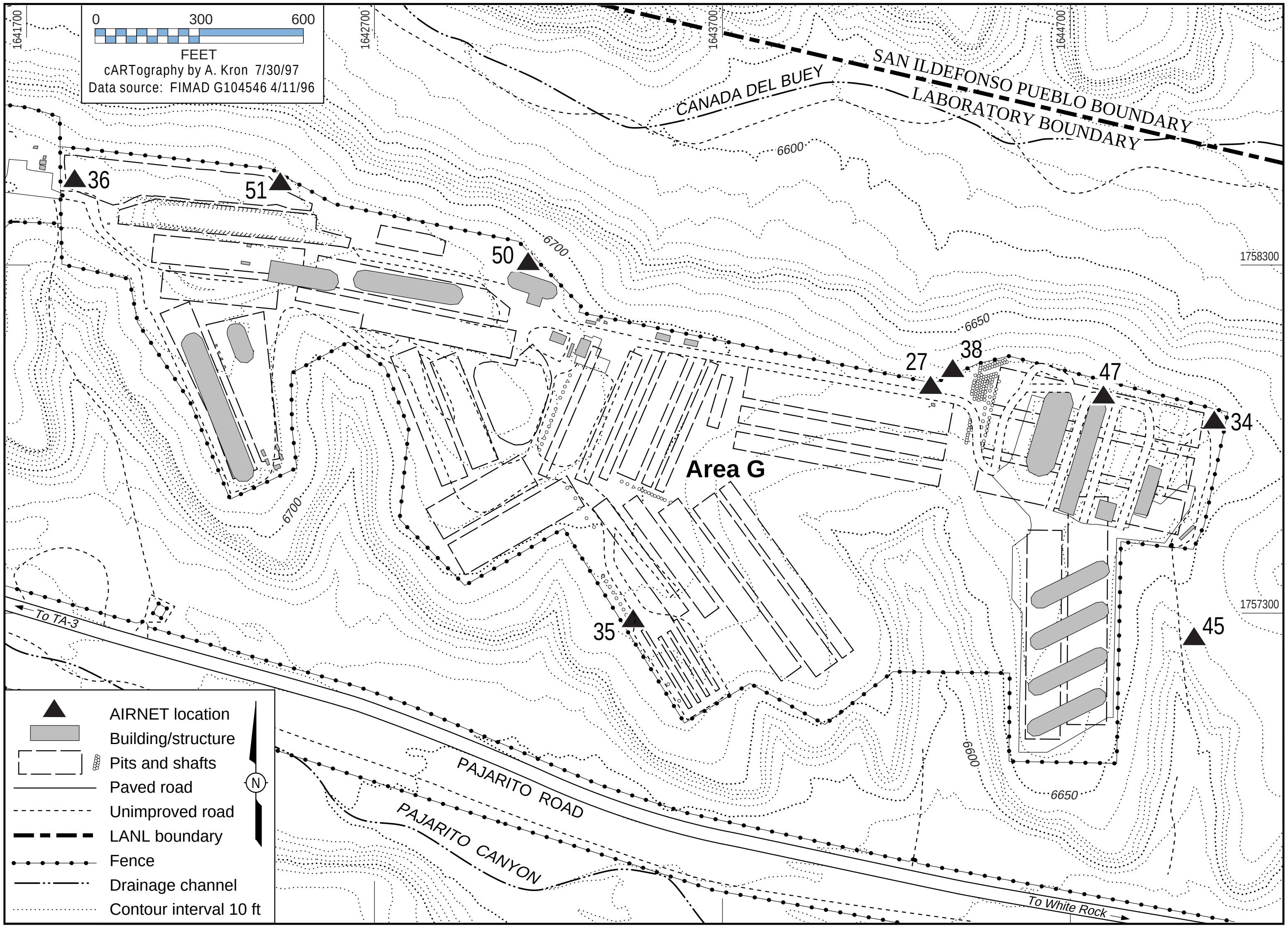

Figure 4-2. Technical Area 54, Area G, map of AIRNET locations.

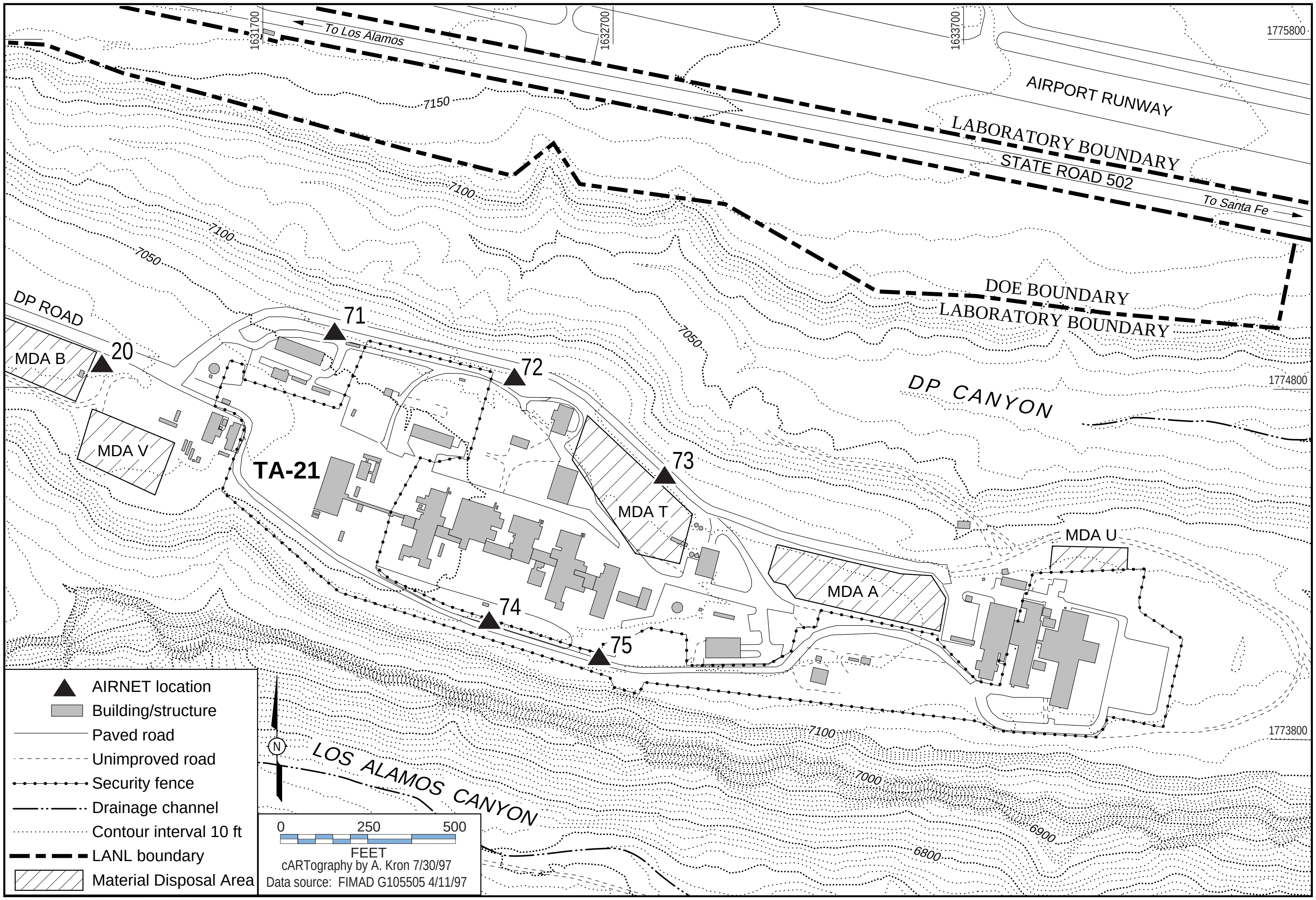

Figure 4-3. Technical Area 21 map of AIRNET locations.

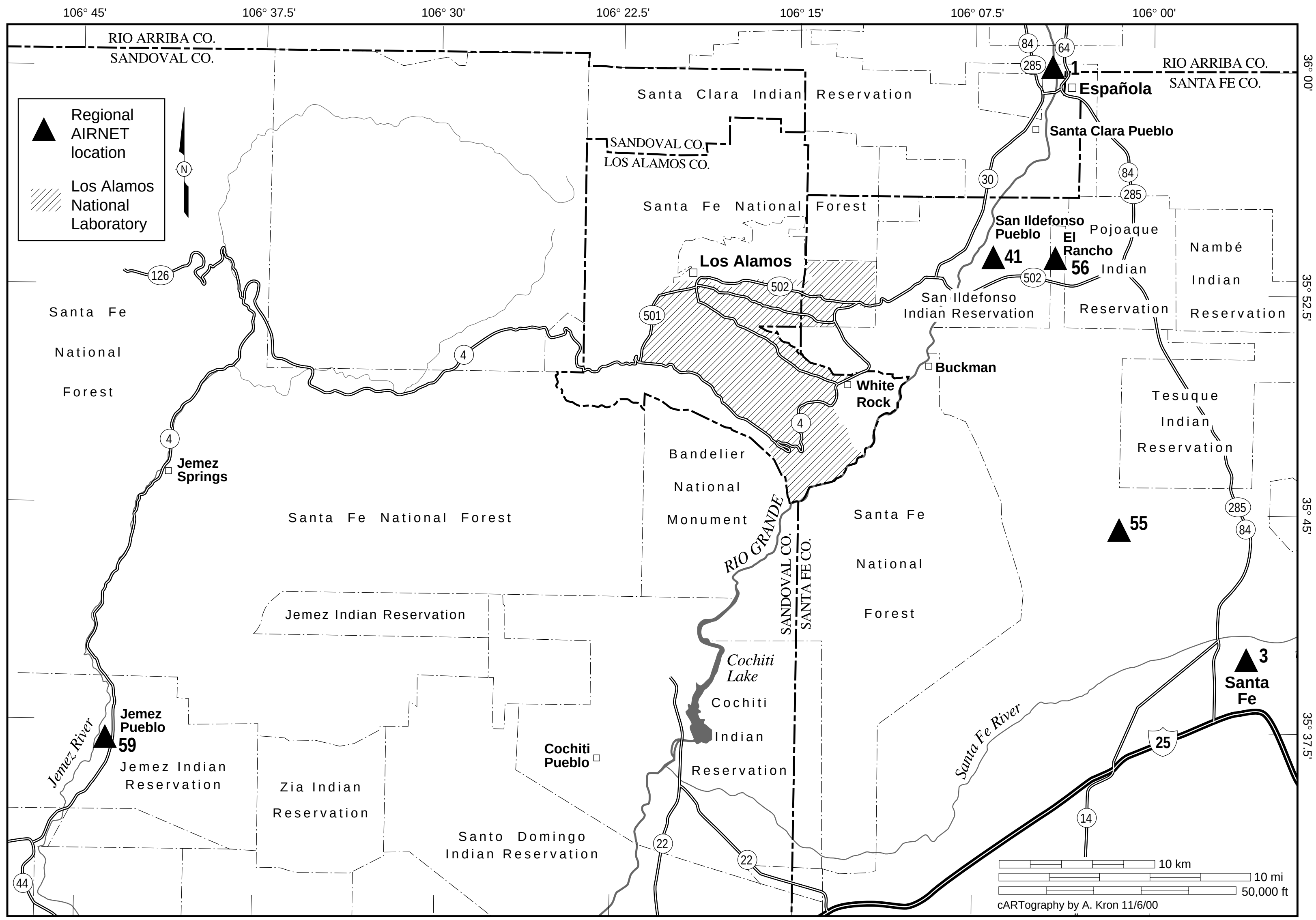

Figure 4-4. Regional and pueblo AIRNET locations.

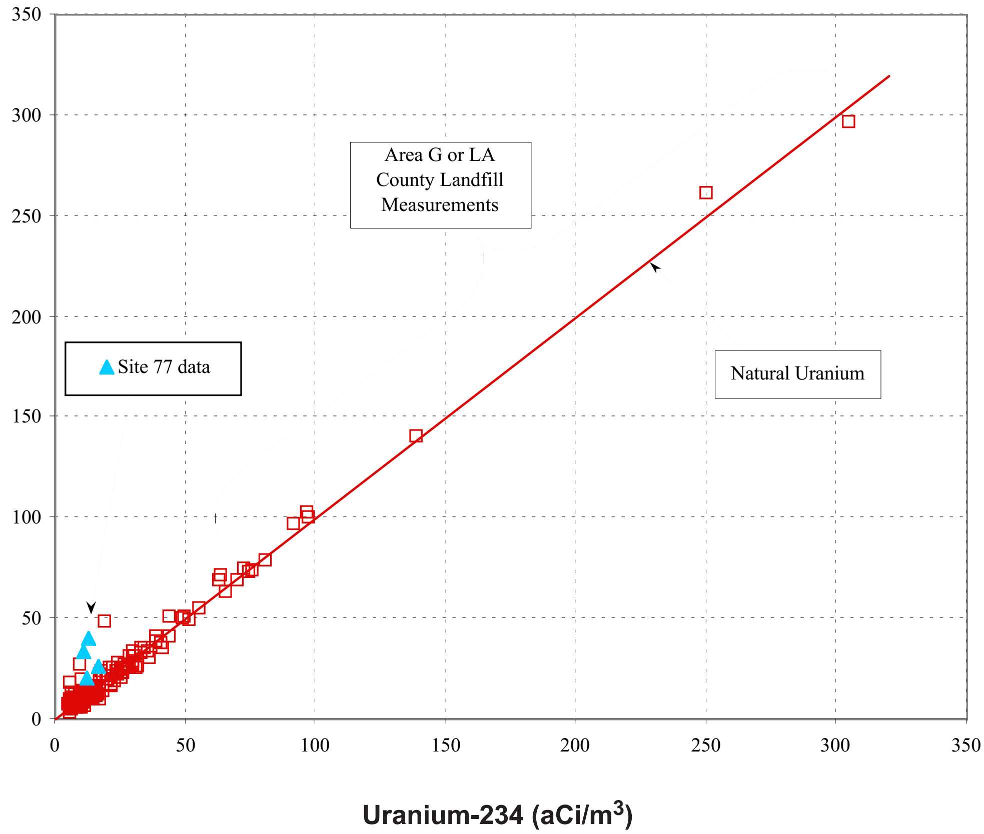

Figure 4-5. AIRNET uranium concentrations for 1999.

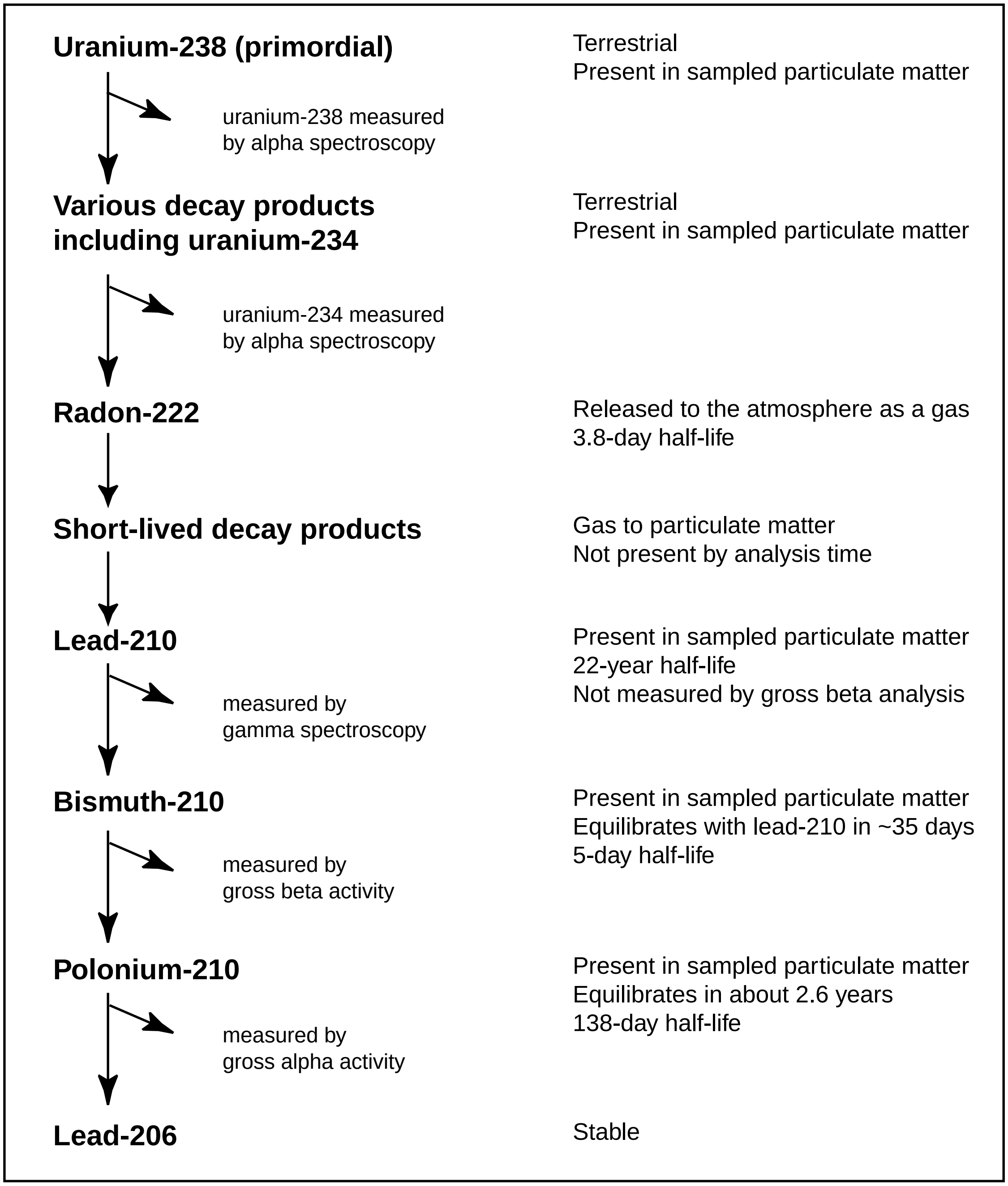

Figure 4-6. Uranium-238 decay series.

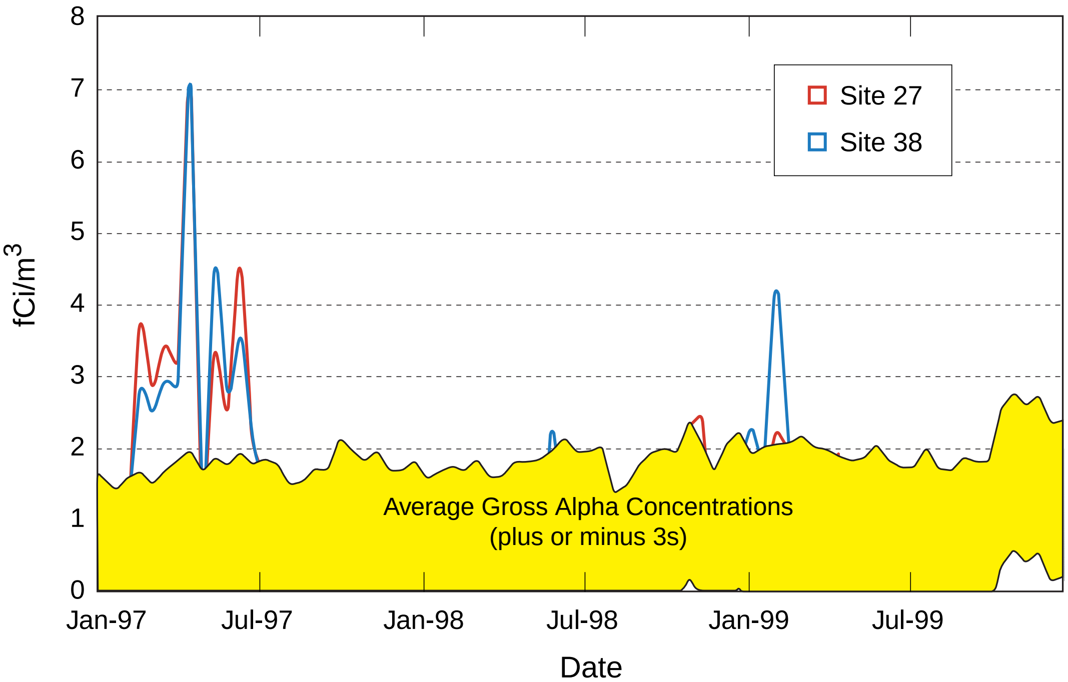

Figure 4-7. Biweekly gross alpha concentrations above the 3s control limits for sites with elevated americium and plutonium.

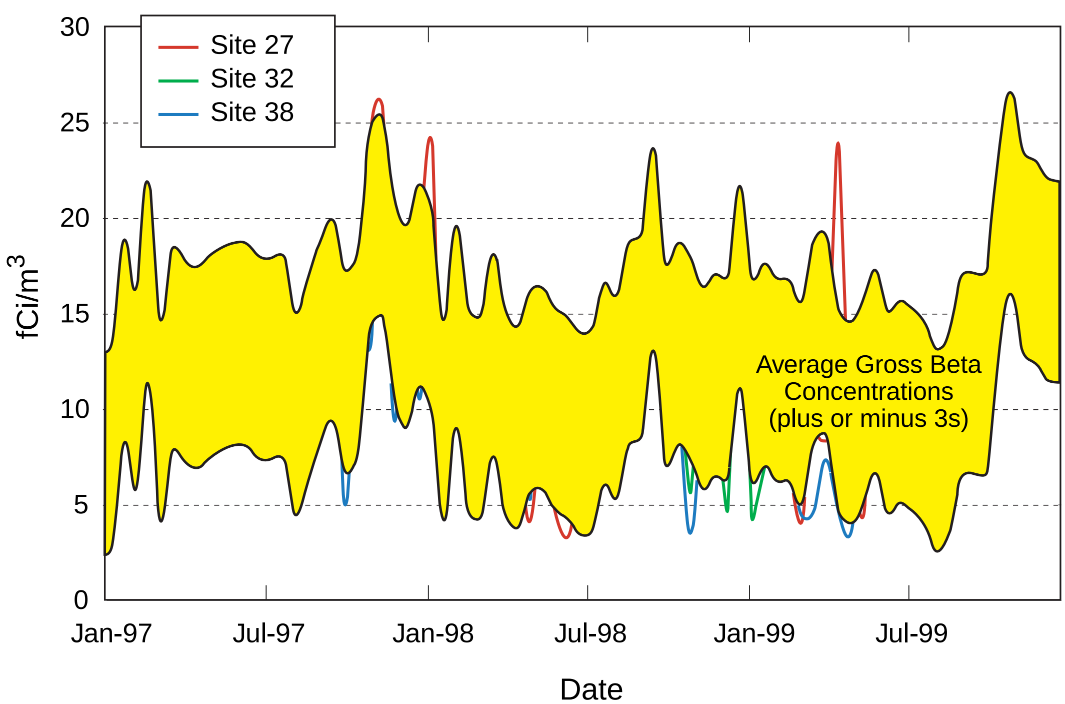

Figure 4-8. Biweekly gross beta concentrations outside the 3s control limits for sites with high levels of particulate matter.

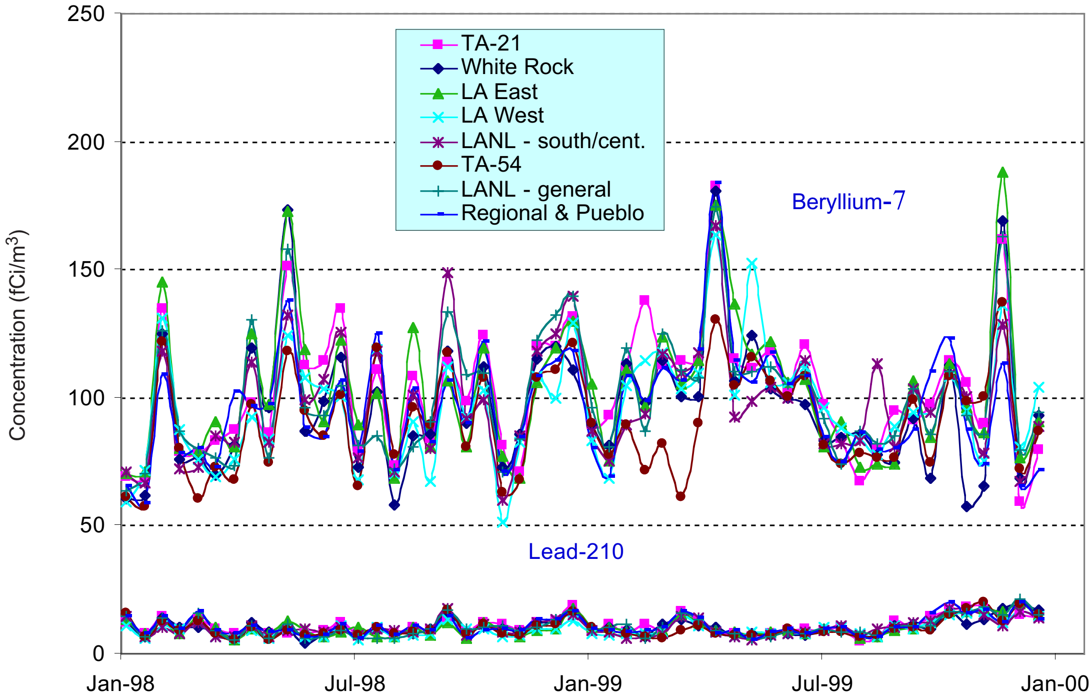

Figure 4-9. Gamma spectroscopy measurements grouped by general location.

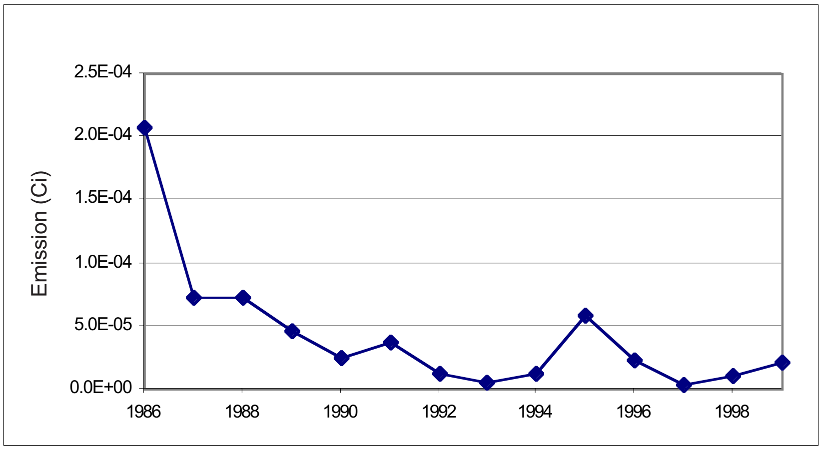

Figure 4-10. Plutonium emissions from sampled Laboratory stacks since 1986.

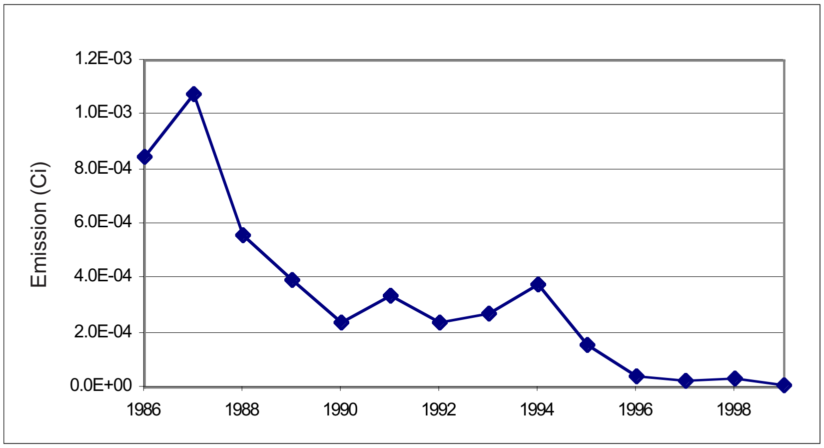

Figure 4-11. Uranium emissions from sampled Laboratory stacks since 1986.

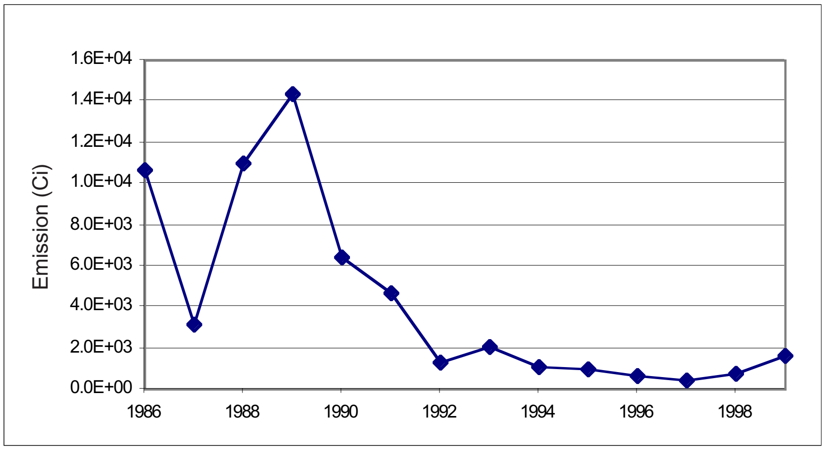

Figure 4-12. Tritium emissions from sampled Laboratory stacks since 1986.

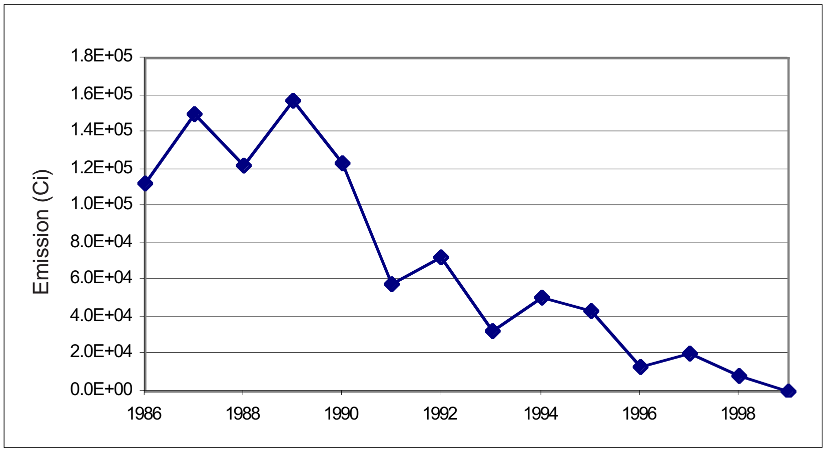

Figure 4-13. G/MAP emissions from sampled Laboratory stacks since 1986.

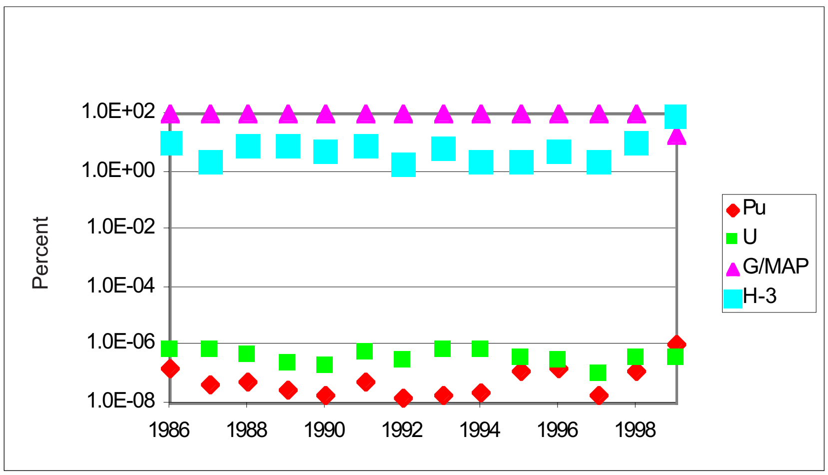

Figure 4-14. Percent of total emissions resulting from plutonium, uranium, tritium, and G/MAP.

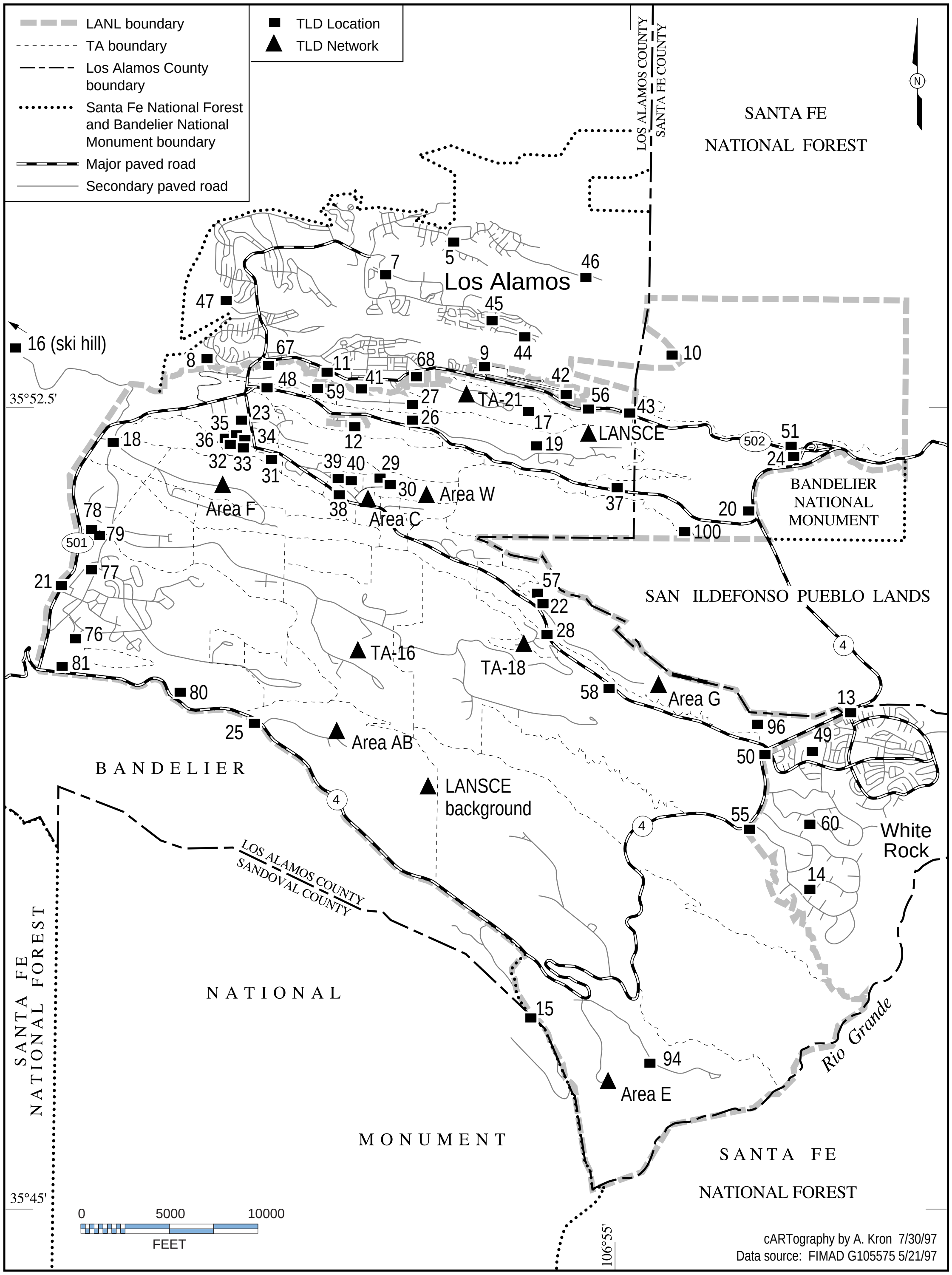

Figure 4-15. Off-site perimeter and on-site Laboratory TLD locations.

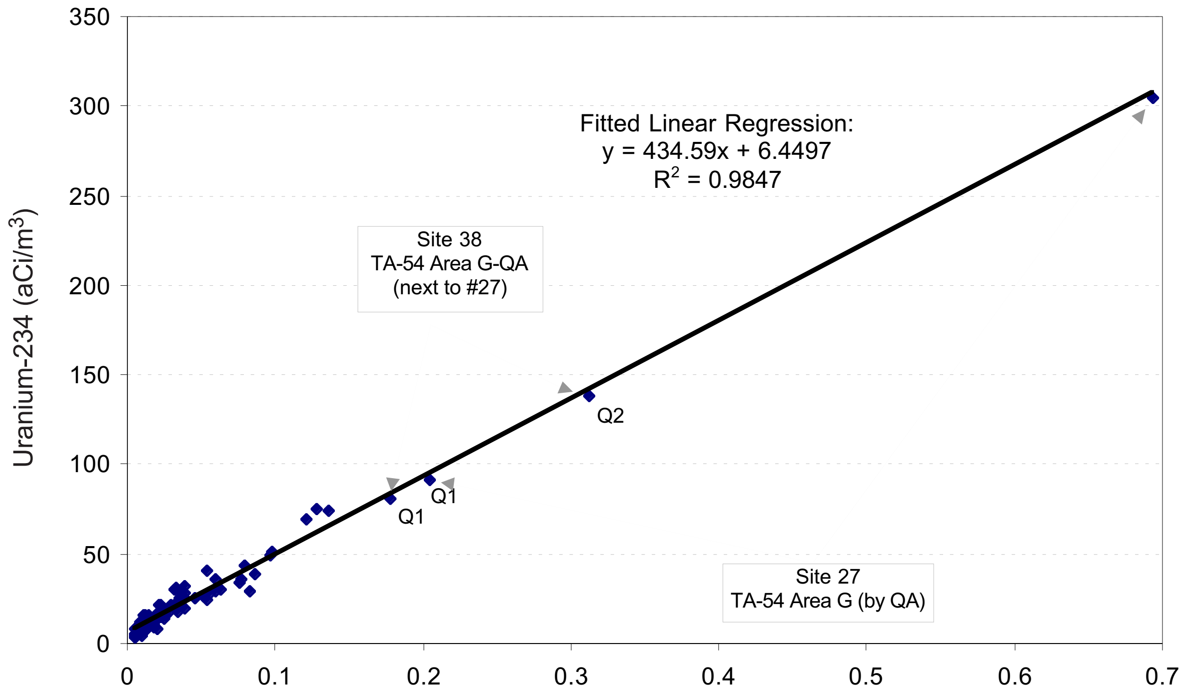

Figure 4-16. Quarterly beryllium and uranium-234 concentrations for 1999.

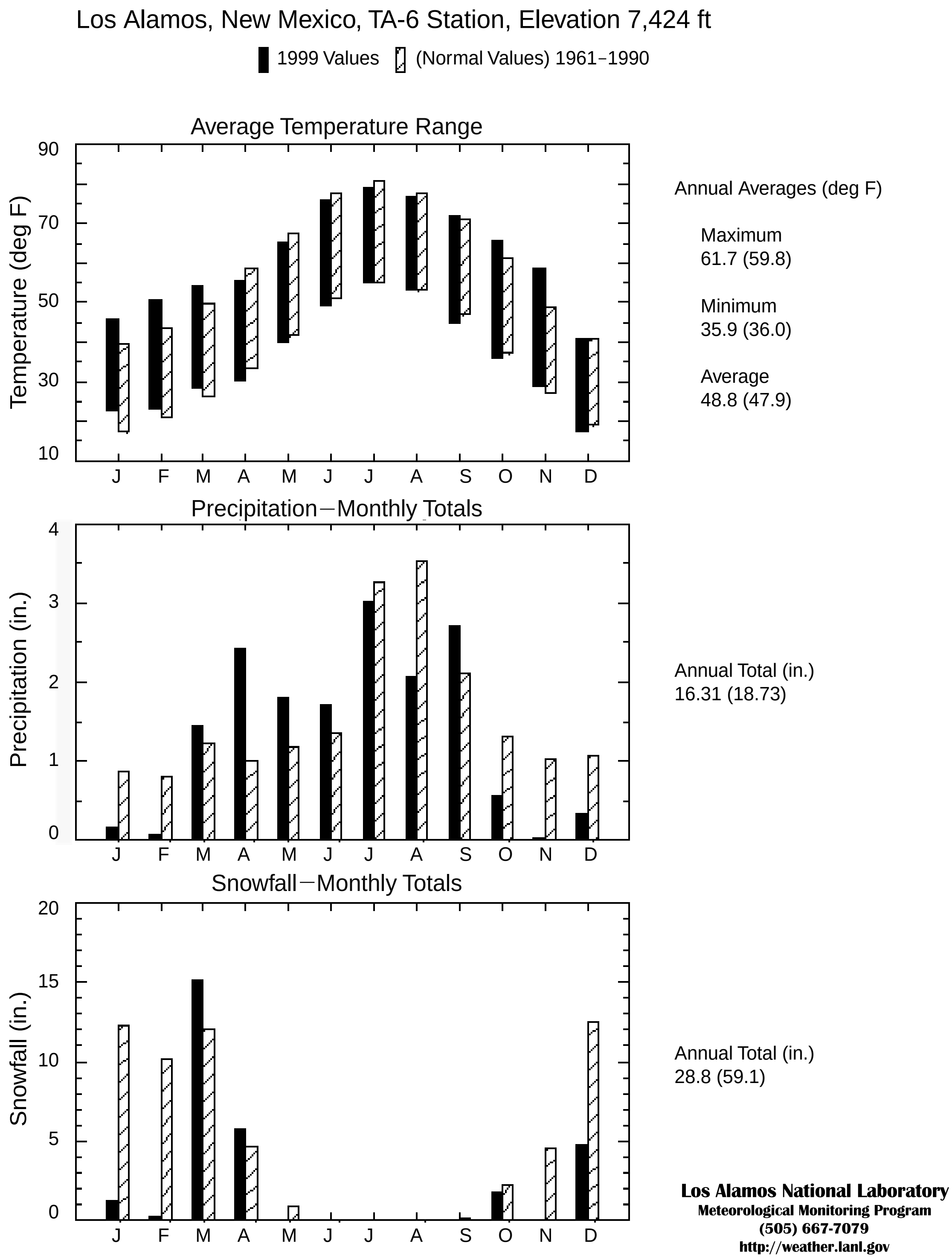

Figure 4-17. 1999 weather summary for Los Alamos.

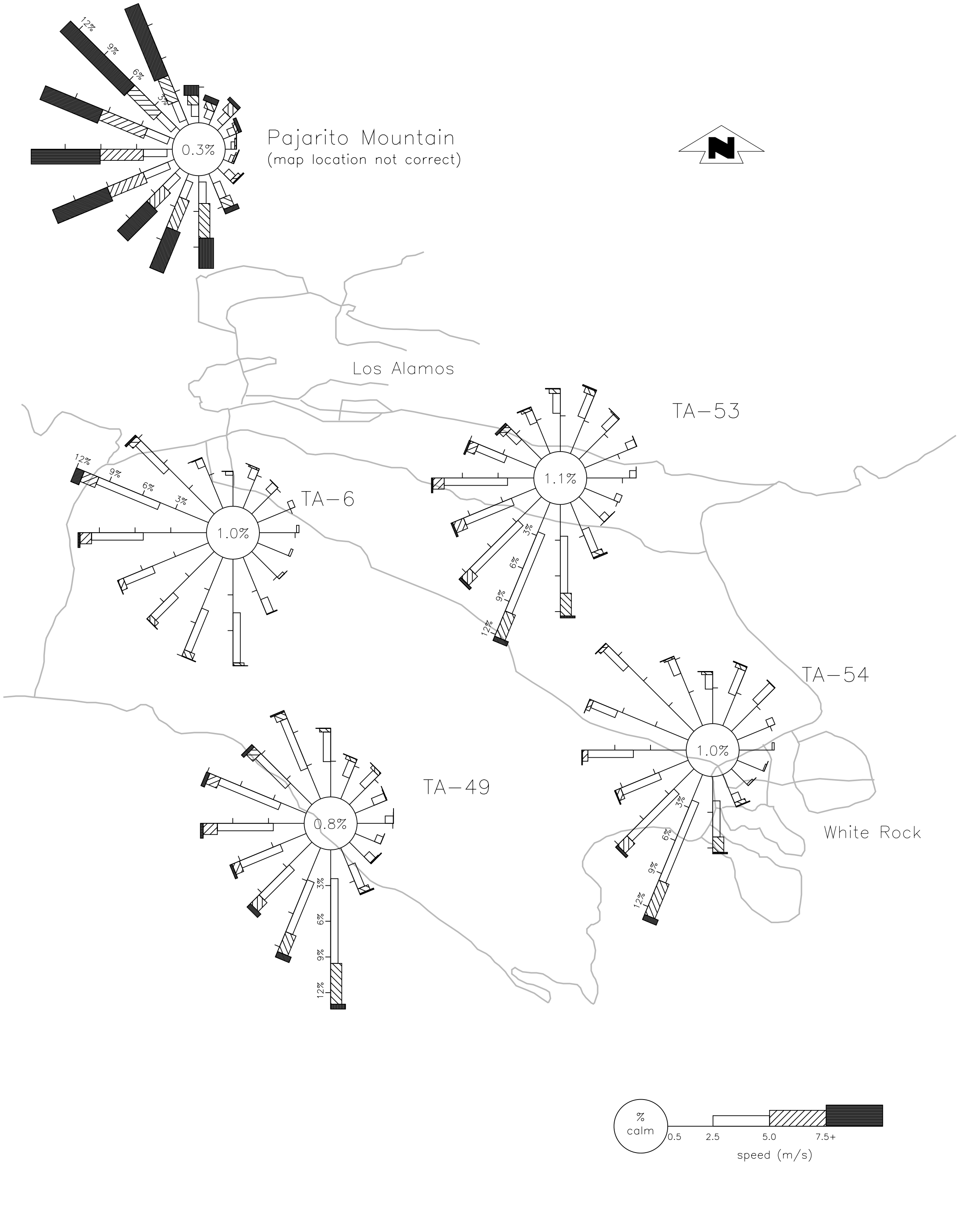

Figure 4-18. Total wind roses.

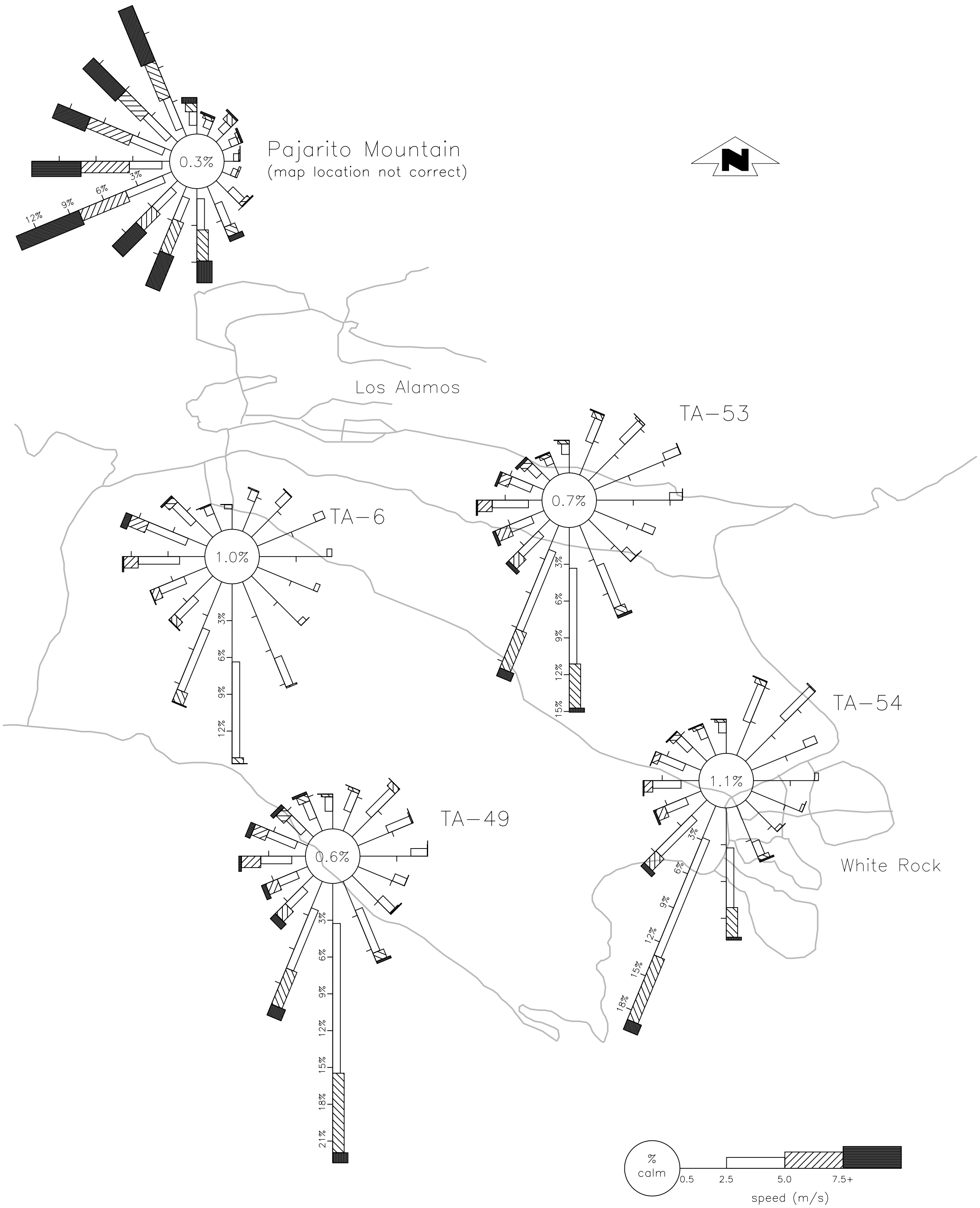

Figure 4-19. Daytime wind roses.

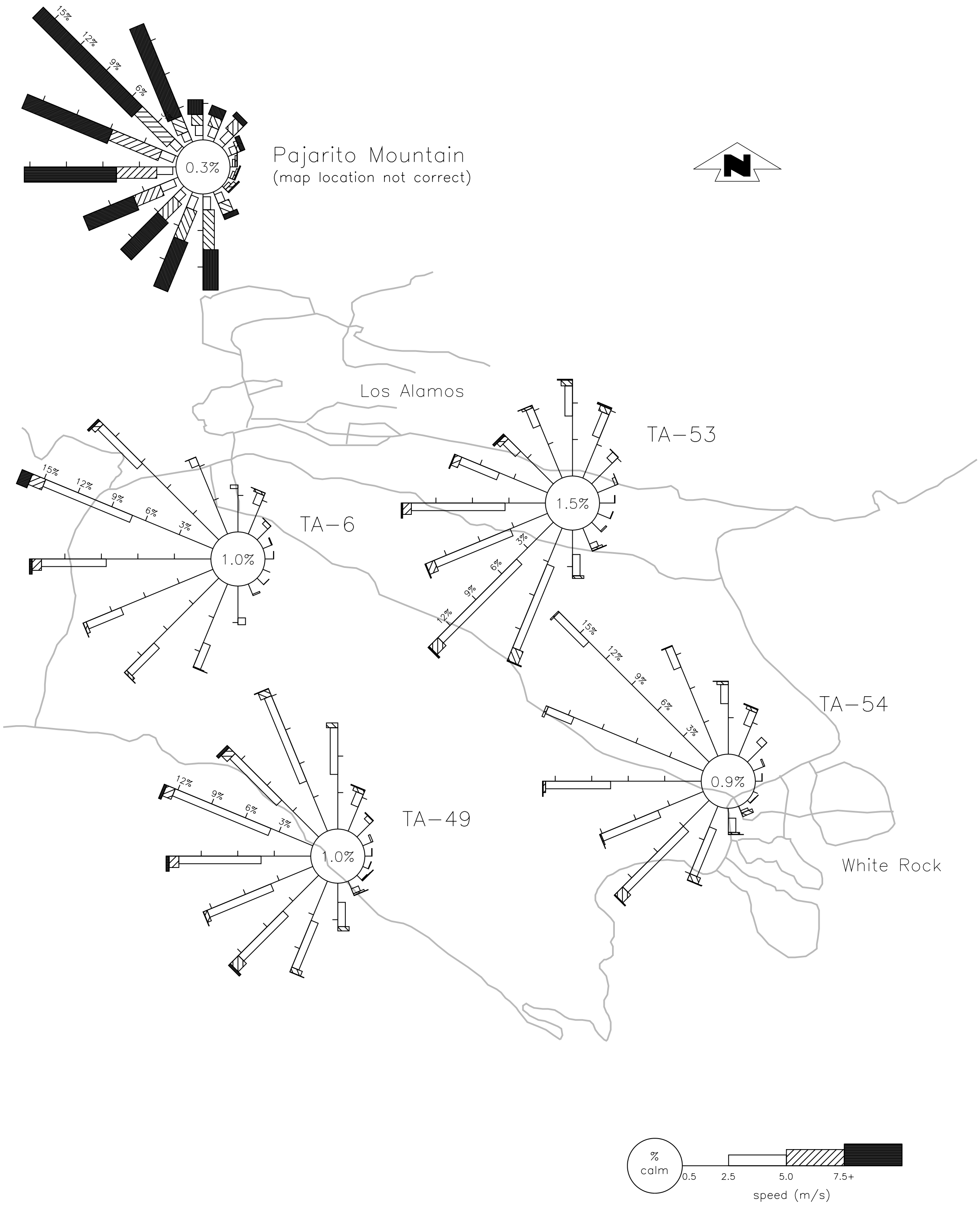

Figure 4-20. Nighttime wind roses.

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