Environmental Surveillance at Los Alamos during 2009

Los Alamos
NATIONAL LABORATORY
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It is the policy of Los Alamos National Laboratory that we will be responsible stewards of our environment. It is our policy to:

- Manage and operate our site in compliance with environmental laws and standards and in harmony with the natural and human environment
- Meet our environmental permit requirements
- Use continuous improvement processes to recognize, monitor and minimize the consequences to the environment stemming from our past, present, and future operations
- Prevent pollution
- Foster sustainable use of natural resources
- Work to increase the body of knowledge regarding our environment

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Waste and Environmental Services Division
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Environmental Data and Analysis Group
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TA-21 Closure Project
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505-665-8855

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505-665-0666

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Abstract

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

These annual reports summarize environmental data that are used to determine compliance 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 and explains the risks and the actions taken to reduce risks at the Laboratory from environmental legacies and waste management operations. Chapter 2 reports the Laboratory's compliance status for 2009. Chapter 3 provides a summary of the maximum radiological dose the public and biota populations could have potentially received from Laboratory operations and discusses chemical exposures. The environmental surveillance and monitoring data are organized by environmental media (air in Chapter 4; water and sediments in Chapters 5 and 6; soils in Chapter 7; and foodstuffs and biota in Chapter 8) in a format to meet the needs of a general and scientific audience. Chapter 9 provides a summary of the status of environmental restoration work around LANL. The new Chapter 10 describes the Laboratory's environmental stewardship efforts and provides an overview of the health of the Rio Grande. 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, Appendix C describes the Laboratory's technical areas and their associated programs, and Appendix D provides web links to more information.

In printed copies of this report, we have also enclosed a compact disc with a copy of the full report in Adobe Acrobat (PDF) format and detailed supplemental tables of data from 2009 in Microsoft Excel format. These files are also available for download from the web.

An on-line web survey for providing comments, suggestions, and other input on the report is available at the web address given below. Inquiries or comments regarding these annual reports may be directed to

US Department of Energy
Office of Environmental Operations
3747 West Jemez Road
Los Alamos, NM 87544
Telephone: 505-667-5491

or

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To obtain copies of the report, contact

ESR Coordinator
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This report is also available on the World Wide Web at
http://www.lanl.gov/environment/all/esr.shtml

Environmental Surveillance at Los Alamos during 2009

Executive Summary

Los Alamos
NATIONAL LABORATORY
EST. 1943

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Executive Summary

Los Alamos National Laboratory (LANL or the Laboratory) is located in Los Alamos County in north-central New Mexico (NM), approximately 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe (Figure ES-1). The 40-square-mile Laboratory is situated on the Pajarito Plateau, a series of mesas separated by deep east-to-west-oriented canyons cut by stream channels. 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 at White Rock Canyon. Most Laboratory and Los Alamos County community developments are confined to the mesa tops. With the exception of the towns of Los Alamos and White Rock, 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, the US Bureau of Land Management, Bandelier National Monument, the US General Services Administration, and Los Alamos County. In addition, Pueblo de San Ildefonso borders the Laboratory to the east.

The mission of LANL is to develop and apply science and technology to (1) ensure the safety and reliability of the US nuclear deterrent, (2) reduce global threats, and (3) solve other emerging national security challenges. Meeting this diverse mission requires excellence in science and technology to solve multiple national and international challenges. Inseparable from the Laboratory's focus on excellence in science and technology is its commitment to environmental stewardship and full compliance with environmental protection laws. Part of LANL's commitment is to report on its environmental performance. This report

- characterizes LANL's environmental management, including effluent releases, environmental monitoring, and estimated radiological doses to the public and the environment,
- summarizes environmental occurrences and responses,
- confirms compliance with environmental standards and requirements, and
- highlights significant programs and efforts.

Environmental Management System

As part of its commitment to protect the environment and improve its environmental performance, LANL continued the implementation of its Environmental Management System (EMS) pursuant to US Department of Energy (DOE) Order 450.1A and the international standard ISO14000-2004. DOE defines an EMS as "a continuous cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental missions and goals." The EMS provides a systematic method for assessing mission activities, determining the environmental impacts of those activities, prioritizing improvements, and measuring results.

- ***A recertification audit in 2009 by an independent registrar found that the Laboratory's EMS met all requirements for certification.***
- ***NNSA again recognized the success of the EMS management by giving the Laboratory the 2009 NNSA "Best in Class Award" and the "DOE E-Star" Award for institutional improvements made through the EMS from 2006 through 2008.***

In April 2006, LANL became the first National Nuclear Security Agency (NNSA) national laboratory and the first University of California-operated facility to receive full certification of its EMS. LANL's EMS was re-certified in 2009 after a thorough re-certification audit found that all requirements for certification were met. The auditors also noted that there was significant evidence that the EMS was maturing as a management system and that significant risk reduction measures were in place and working. Additionally, the program received NNSA's "Best in Class" Award and the "DOE E-Star" for the institutional improvements identified and implemented through the EMS from 2006 through 2008.

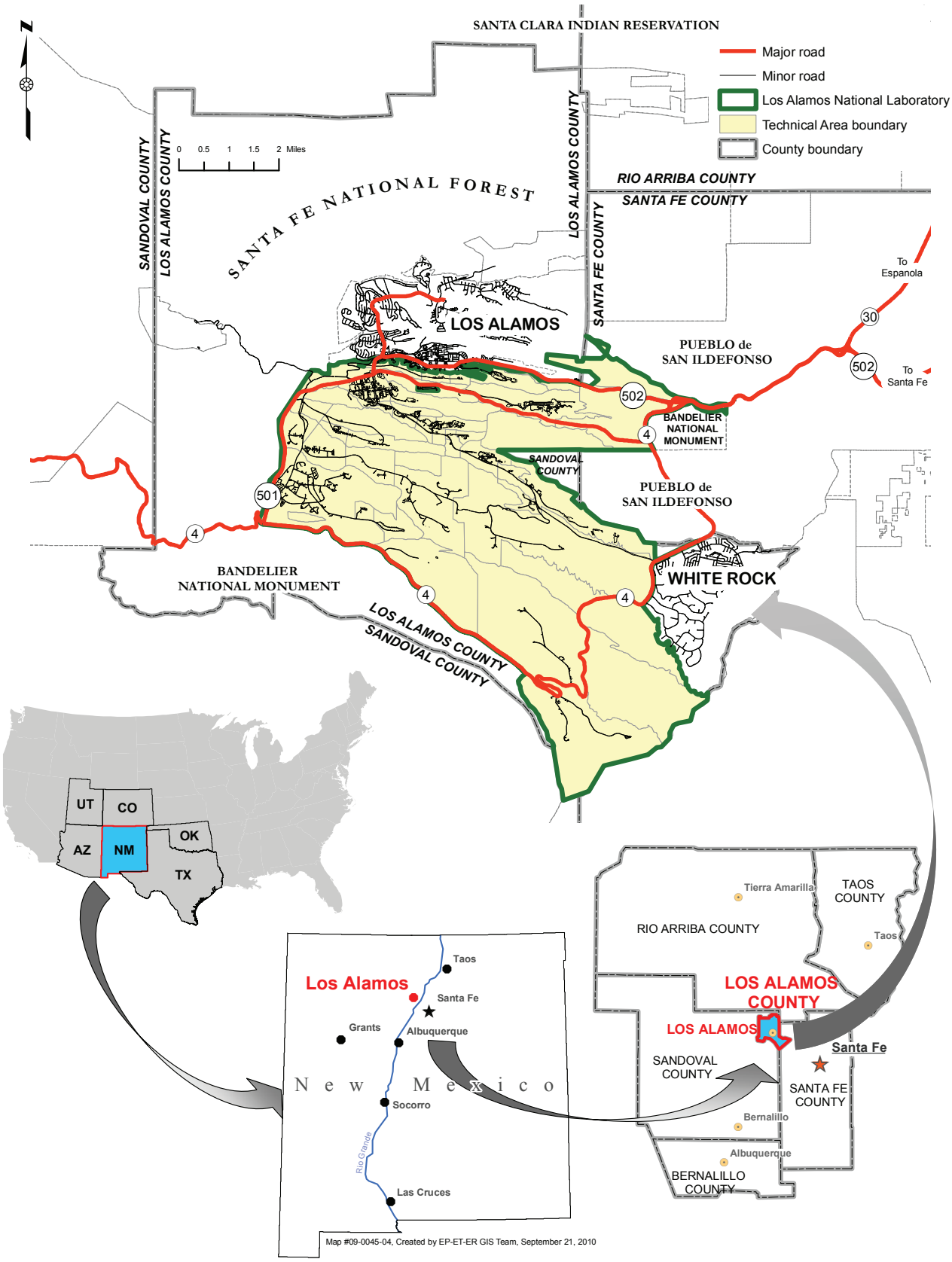


Figure ES-1. Regional location of Los Alamos National Laboratory.

The Pollution Prevention Program implements waste minimization, pollution prevention, sustainable design, and conservation projects to enhance operational efficiency, reduce life-cycle costs of programs or projects, and reduce risk to the environment. Reducing waste directly contributes to the efficient performance of the Laboratory's national security, energy, and science missions. LANL was awarded four NNSA awards in 2009:

The NNSA Best in Class Awards are as follows:

- RCRA-less Oxidation approach: replaces toxic Resource Conservation and Recovery Act (RCRA)-listed salts with non-toxic reagents for actinide separation schemes
- Radiological Laboratory/Utility/Office Building (RLUOB) Integrated Planning, Design, Procurement, and Construction: approximately 85% (by weight) of RLUOB construction waste was recycled or reused

The NNSA Environmental Stewardship Awards are as follows:

- Electronic Recycling Program: a new electronics recycling program shipped 93,554 lbs of e-waste to a company at Terrell, TX, where the electronics are crushed and recycled
- Alternative Fuel Use: At the end of 2009, one-half of LANL's fleet of vehicles was flex-fuel and 75 percent of the security officers' fleet in Los Alamos was powered by E-85 fuel

Federal Facility Compliance Agreement

The Laboratory's Federal Facility Compliance Agreement (FFCA), in effect since 2005, was replaced in February 2009 by an Individual Permit (IP) issued by the US Environmental Protection Agency (EPA). The permit became effective on April 1 and was subsequently appealed by a coalition of regional citizens' groups. Since that time, the final conditions of the IP continue to be negotiated under a proposed settlement agreement between Los Alamos National Security, LLC, DOE, EPA, and the citizens' groups. As a result of the permit appeal negotiations, it is expected that issuance of a modified IP will have requirements different from the original 2009 permit. During 2009, the DOE and the Laboratory continued to monitor and sample storm water under the previous requirements of the FFCA with the EPA and the NM Environment Department (NMED). LANL installed 52 new site-specific surface water samplers, maintained 60 runoff gage stations, collected 85 storm water samples, installed 150 new erosion control measures, and conducted over 1,000 inspections at 290 sites.

Compliance Order on Consent

The March 2005 Compliance Order on Consent (the Consent Order) between LANL, DOE, and NMED is the principal regulatory driver for LANL's environmental restoration programs. The Consent Order contains requirements for investigation and cleanup of solid waste management units (SWMUs) and areas of concern (AOCs) at the Laboratory. The major activities conducted by the Laboratory included investigations and cleanup actions. All major deliverables of the Consent Order were met by the Laboratory during 2009. The projects wrote and/or revised 26 work plans and 22 reports and submitted them to NMED. A total of 181 documents or reports were submitted to NMED. In October 2009, the NMED Hazardous Waste Bureau issued a Notice of Violation to DOE and LANL for alleged violations during the 2009 RCRA compliance inspection, though no penalty was assessed because these findings were adequately addressed during the inspection. DOE and LANS paid NMED penalties of $126,000 for a report that did not contain all the monitoring data required. DOE paid a penalty of $1,300,000 for failing to complete the plugging and abandonment of a well by the specified deadline.

- ***The Consent Order is the principal regulatory driver for the Laboratory's environmental restoration activities and the Water Stewardship Program. It specifies actions that the Laboratory must complete to characterize contaminated sites and monitor the movement of contaminants.***
- ***The Laboratory met all major deliverables of the Consent Order.***
- ***The NMED issued two Notices of Violation to LANL and DOE related to issues found during a RCRA inspection and for failing to plug and abandon a well by the specified date.***

Design of Surveillance System and Sample Locations

The Laboratory uses data from monitoring (surveillance) of known release points and multiple receptors (people, air, water, soil, sediment, foodstuffs, plants, and animals) over a long time period as a basis for policy and to determine actions to protect the environment. We collect data from the surrounding region to establish baseline environmental conditions in areas not influenced by LANL operations. We conduct regional monitoring to determine whether LANL operations are impacting areas beyond LANL's boundaries. Examples of regional monitoring include the radiological ambient air sampling network (AIRNET); soil, foodstuffs, and biota (plants and animals) sampling as far away as Dixon, NM (40 direct miles away); and sediment monitoring along the Rio Grande as far upriver as Abiquiu Reservoir and downriver as Cochiti Reservoir. We also collect data on-site and at the Laboratory perimeter to determine if operations are impacting LANL or neighboring properties (e.g., ueblo and Los Alamos County lands). Perimeter monitoring also measures the highest potential impact to the public. To better quantify releases, we monitor at specific discharge or release points or other locations on LANL property that are known to or have the potential to release contaminants. During 2009, the Laboratory collected almost 9,400 environmental monitoring samples from more than 700 locations and received almost 249,000 analyses or measurements on these samples.

Risk Reduction

Risk is evaluated either as current (present-day) or prospective (future) risk. The Laboratory assesses hazards and the corresponding risks by evaluating environmental data, measurements, inventories of buried or stored materials, and potential exposure pathways and scenarios. We use models, data, and computer programs to assist with these estimates.

- ***Past risk reduction successes include the reduction in the number of outfalls (plant and process discharges) and the volume of water released from them, the reduction in air emissions over the past several years, changes to effluent treatment processes at the TA-50 Radioactive Liquid Waste Treatment Facility, and the removal of contaminated material and waste at former waste disposal sites.***
- ***Ongoing risk reduction efforts include the transport of waste from Area G to permanent disposal at WIPP, studies of the movement of contaminants in groundwater, and planned or active cleanup operations at former waste and radionuclide processing sites.***

Over the years, the Laboratory has decreased its release of materials into the environment and has reduced the amount of legacy contamination. Examples include the reduction in both the number of outfalls (plant and process discharges) and the volume of water released, the reduction in air emissions, changes to effluent treatment processes at the Technical Area (TA)-50 Radioactive Liquid Waste Treatment Facility (RLWTF), and the removal of contaminated material and waste at sites such as Material Disposal Area (MDA) P. These efforts have significantly reduced or eliminated potential exposure and risk to workers, the public, and the environment.

Examples of ongoing risk reduction activities include the transport of stored legacy transuranic waste from Area G to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, NM, the planned cleanup and remediation of the former plutonium processing facility at TA-21, ongoing studies of groundwater contamination to evaluate future hazards and risks, and numerous investigations and corrective actions at potentially contaminated sites.

Compliance

The Laboratory uses the status of compliance with environmental requirements as a key indicator of its environmental performance. Federal and state regulations provide specific requirements and standards to implement these statutes and maintain environmental quality. The EPA and NMED are the principal administrative authorities for these laws. The Laboratory is also subject to DOE requirements for control of radionuclides. Table ES-1 presents a summary of the Laboratory's status in regard to environmental statutes and regulations for 2009.

Table ES-1
Environmental Statutes under which LANL Operates and Compliance Status in 2009

Federal Statute	What it Covers	Status
Resource Conservation and Recovery Act (RCRA)	Generation, management, and disposal of hazardous waste and cleanup of inactive, historical waste sites	The Laboratory completed 1,467 self-assessments that resulted in a non-conformance finding rate of 3.07%. All major deliverables required by the Consent Order were submitted to NMED on time. NMED issued a Notice of Violation to DOE and LANL for alleged violations during the compliance inspection, though no penalty was assessed because these findings were adequately addressed during the inspection. DOE and LANS paid NMED penalties of $126,000 for a report that did not contain all the monitoring data required.DOE paid a penalty of $1,300,000 for failing to complete the plugging and abandonment of a well by the specified deadline. LANL discovered three issues with hazardous waste packaging or labeling. All instances were corrected and did not result in actual or potential hazards to the environment or personnel. LANL is in compliance with groundwater monitoring requirements. LANL installed eight intermediate perched and six regional aquifer wells.
Clean Air Act	Air quality and emissions into the air from facility operations	The Laboratory was well below all permit limits for emissions to the air. Non-radiological air emissions were very similar to emissions over the previous four years and remain relatively constant. The annual dose to the maximally exposed individual (MEI) from radioactive air emissions was 0.55 mrem, which is the same as the very low dose for the previous year. LANL provided the first greenhouse gas emissions report to NMED. LANL removed 7,914 lbs of ozone-depleting refrigerants from inventory.
Comprehensive Environmental Response and Liability Act	Pollution and contaminants on property	No land transfers occurred in 2009. The LANL Natural Resource Trustee Council completed a pre-assessment screen in November 2009 and determined that a full-scale assessment is appropriate.
Clean Water Act	Water quality and effluent discharges from facility operations	Seven of 1,361 samples collected from industrial outfalls and none of the 76 samples collected from the Sanitary Wastewater Systems Plant's outfall exceeded effluent limits. Exceedences were for pH, residual chlorine levels, total suspended solids, or polychlorinated biphenyl (PCB) level concentration. The Laboratory conducted 471 storm water inspections and 99% of the Laboratory's 52 permitted construction sites were compliant with National Pollutant Discharge Elimination System requirements. The new Individual Permit (IP) was issued by EPA but subsequently appealed and implementation suspended. Under former Federal Facility Compliance Agreement (FFCA) requirements, the Laboratory installed 52 new site-specific surface water samplers, maintained 60 runoff gage stations, collected 85 storm water samples, installed 150 new erosion control measures, and conducted over 1,000 inspections at 290 sites.
Groundwater Discharge Plans	Discharges of water to groundwater	The Laboratory operated under one approved and two pending Discharge Plans submitted to or approved by the NMED. The approved plan regulates discharges from the sanitary wastewater treatment facility at TA-46 and the pending plans cover the TA-50 RLWTF and 21 domestic septic systems.
Aboveground Storage Tank Compliance Program	Liquid storage tank monitoring and compliance	Three tank systems were closed out with NMED in 2009. Three tank systems are operational and four are under temporary closure status. LANL completed additional characterization of the 2002 diesel release from a tank at TA-21.
Toxic Substances Control Act	Chemicals such as PCBs	The Laboratory shipped 263 containers of PCB waste, 1,941 lbs of capacitors, and 2,605 lbs of fluorescent light ballasts for disposal or recycling to EPA-permitted disposal and treatment facilities.
Federal Insecticide, Fungicide, and Rodenticide Act	Storage and use of pesticides and herbicides	The Laboratory remained in compliance with regulatory requirements regarding use of pesticides and herbicides. The Laboratory used 76.75 oz of insecticides, 127 gal. of herbicides, 600 lbs of fertilizers, 3,392 lbs plus 5.5 gal. of water treatment chemicals, and 5 gal. of color marker.

Table ES-1 (continued)

Federal Statute	What it Covers	Status
Emergency Planning and Community Right-to-Know Act	The public's right to know about chemicals released into the community	The Laboratory reported releases, waste disposal, and waste transfers totaling 9,790 lbs of lead, mostly at the firing range. No updates to Emergency Planning Notifications were necessary in 2009. Chemical Inventory Reports were updated to the Los Alamos County fire and police departments for 20 chemicals or explosives. There were no releases that triggered state or federal reporting requirements.
Endangered Species Act (ESA) and Migratory Bird Treaty Act (MBTA)	Rare species of plants and animals	The Laboratory maintained compliance with the ESA and MBTA and reviewed 612 excavation permits, 115 project profiles, and seven storm water plans for potential impacts to threatened or endangered species. The Laboratory conducted annual surveys for Mexican spotted owl, southwestern willow flycatcher, Jemez Mountains salamander, and grey vireo.
National Historic Preservation Act (NHPA) and others	Cultural resources	The Laboratory maintained compliance with the NHPA. The Laboratory conducted 40 projects that required some field verification of previous survey information and identified 21 new archaeological sites and seven new historic buildings. Five historic buildings were determined eligible for the National Register of Historic Places.
National Environmental Policy Act	Projects evaluated for environmental impacts	The Laboratory and NNSA released a second limited Record of Decision in July 2009 that accepts six additional elements of the Expanded Operations Alternative in the Site-wide Environmental Impact Statement of 2008.

Unplanned Releases

There were no unplanned airborne releases and no unplanned releases of radioactive liquids from LANL in 2009. There were 28 spills or releases of non-radioactive liquids, most of which were potable water, steam condensate, or domestic wastewater. Other liquids included propylene glycol, diesel fuel, hydraulic fluid, and groundwater communicating from upper aquifers to lower aquifers in monitoring wells. LANL reported all liquid releases to NMED; the releases will be administratively closed upon final inspection.

Radiological Dose Assessment

- ***As in 2008, the location of the hypothetical maximally exposed individual (MEI) for airborne radionuclides was determined to be at East Gate near the eastern edge of Los Alamos. This location received a combination of low levels of radiation from LANSCE and other stack emissions.***
- ***Radiation dose to the MEI was the same as the very low level calculated in 2008.***

Humans, plants, and animals potentially receive radiation doses from various Laboratory operations (Table ES-2). The DOE dose limits for the public and biota are the mandated criteria that are used to determine whether a measurement represents a potential exposure concern. Figure ES-2 shows doses to the hypothetical maximally exposed individual (MEI) via the air pathway over the last 10 years at an off-site location; this location was at East Gate in 2009, as it was in 2008 and in all years before 2006. (In 2006, it was at the Los Alamos County Airport terminal and in 2007 at a location along DP Road.) The annual dose to the MEI for the airborne pathway was approximately 0.55 mrem, the same as in 2008, and well under the regulatory limit of 10 mrem (Figure ES-2). During 2009, the population within 80 km of LANL received a collective dose of about 0.57 person-rem, down from 0.79 person-rem in 2008. The doses received in 2009 from LANL operations by an average Los Alamos residence and an average White Rock residence totaled about 0.035 mrem and 0.025 mrem, respectively. The maximum all-pathways dose, composed almost entirely of direct radiation from waste stored at TA-54, Area G, could result in an exposure of 1 mrem per year to a hypothetical individual in the adjacent sacred area of Pueblo de San Ildefonso.

Biota Dose

The DOE biota dose limits are intended to protect populations of plants and animals, especially with respect to preventing the impairment of reproductive capability within the biota population. All radionuclide concentrations

in vegetation sampled were far below the plant 0.1 rad/day biota dose screening level (10% of 1 rad/day dose limit), and all radionuclide concentrations in terrestrial animals sampled were far below the terrestrial animal 0.01 rad/day biota dose screening level (10% of 0.1 rad/day dose limit) (Table ES-2).

Table ES-2
What are the Sources of Radiological Doses?

Source	Recipient	Dose	Location	Trends
Background (includes human-made sources)	Humans	~700 mrem/yr*	Not applicable	Not applicable
Air	Humans	0.55 mrem/yr	East Gate in eastern Los Alamos	Similar to very low level in previous two years
Direct radiation	Humans	1 mrem/yr	San Ildefonso – offsite	Same as previous year
Food	Humans	<0.1 mrem/yr	All sites	Steady
Drinking water	Humans	<0.1 mrem/yr	All sites	Steady
All	Terrestrial animals	<20 mrad/day	TA-15 "EF site," TA-21 MDA B	Steady
All	Terrestrial plants	<50 mrad/day	TA-21 MDA B	Steady

* Increased from previous years due to new information about average medical doses.

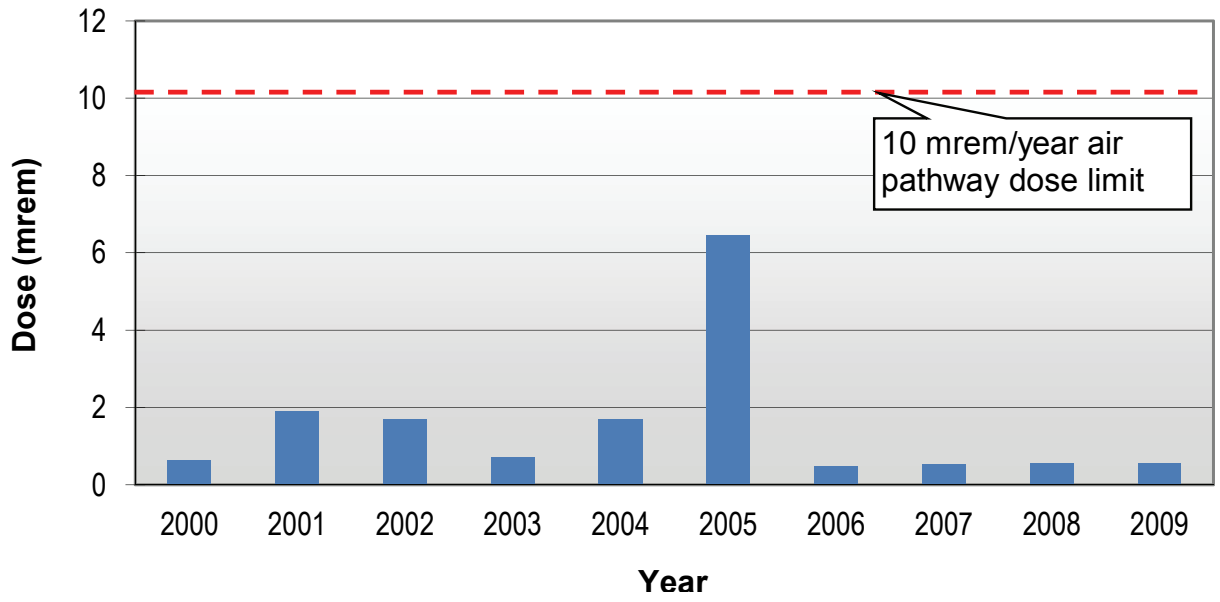


Figure ES-2. Annual airborne pathway dose (mrem) to the off-site MEI over the past 10 years. The 2009 location of the calculated MEI is at East Gate near the eastern side of Los Alamos County.

Radiological Air Emissions

The Laboratory measures the emissions of radionuclides at the emission sources (building stacks) and categorizes these radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous activation products, (3) tritium, and (4) gaseous air activation products (radioactive elements created by the Los Alamos Neutron Science Center [LANSCE] particle accelerator beam). In addition, the Laboratory collects air samples at general locations within LANL boundaries, at the LANL perimeter, and regionally to estimate the extent and concentration of radionuclides that may be released from Laboratory operations. These radionuclides include isotopes of plutonium, americium, uranium, and tritium.

- *The total radiation dose in 2009 to the nearest off-site member of the public from LANL radioactive air emissions remained very low.*
- *Emissions of short-lived air activation products from LANSCE contributed the largest proportion of radioactive air emissions.*
- *Tritium emissions decreased compared with 2008 and thus contributed an even smaller proportion (less than 10%) of the total radioactive emissions.*
- *Combined airborne emissions of other radionuclides such as plutonium and uranium contributed much less than a millionth of the total radioactive emissions.*

LANL continued to monitor 26 stacks for emissions of radioactive material to the ambient air. Total stack emissions during 2009 were approximately 796 curies (Ci), a decrease from 1,600 Ci in 2008, and includes 60 Ci of diffuse emissions from the LANSCE facility and other smaller sources. Tritium emissions composed about 80 Ci (780 in 2008) of the total. Short-lived air activation products from LANSCE stacks and diffuse emissions contributed 716 Ci (815 Ci in 2008) of the total. Most of the curies from LANSCE are from very short-lived radionuclides that decay significantly before reaching the location of the MEI. Combined airborne emissions of other radionuclides, such as plutonium, uranium, americium, and thorium, were less than 0.000027 Ci (an increase from 2008) and emissions of particulate/vapor activation products were up at 0.141 Ci (0.021 in 2008).

Radionuclide concentrations in ambient air samples in 2009 were generally comparable with concentrations in prior years. As in past years, the AIRNET system detected slightly elevated radionuclides from known areas of contamination. No new or increased airborne radioactivity was detected. At regional locations away from Los Alamos, all air sample measurements were consistent with background levels. Annual mean radionuclide concentrations at all LANL perimeter stations were less than 1% of the EPA dose limit for the public. Measurable amounts of tritium were reported at most on-site locations and at perimeter locations, but no elevated levels were detected in 2009. The highest off-site tritium concentration was 0.25% of the EPA public dose limit. The highest on-site tritium measurement (less than 3% of the DOE limit for worker exposure) was made at Area G near areas containing tritium-contaminated waste. Plutonium-239/240 from historical activities at LANL's old main technical area was detected near the Ashley Hotel and Suites (formerly Los Alamos Inn) at about 1.3% of the EPA public dose limit, and at very low levels near MDA B where soil disturbance from road construction occurred in preparation for remediation of the MDA. On-site detections of plutonium occurred at Area G (an area with known low levels of contamination) at levels substantially below 0.5% of the DOE limit for workplace exposure. The highest quarterly americium-241 levels were 0.1% and 0.01% of the public and worker limits, respectively. The maximum annual uranium concentrations were from natural uranium at locations with high dust levels from local soil disturbances. There was one detection of enriched uranium (near the eastern end of DP Road) and 15 likely detections of depleted uranium (which has lower radioactivity than natural uranium). All the depleted uranium detections occurred in the same quarter and appear to be from the same event. The source of this depleted uranium was probably legacy waste on LANL property lofted by strong winds.

- *As in previous years, PM 10 and PM 2.5 particulate measurements in ambient air were well below EPA standards.*
- *Most of the particles measured by the PM 10 and PM 2.5 samplers are from natural sources such as dust and wildfire smoke.*

- *No increased concentrations of radionuclides in ambient air were detected at regional sampling locations nor at most perimeter locations.*
- *As in previous years, there were no detections of radionuclides above background at Pueblo and regional locations.*
- *The highest mean air concentrations at perimeter locations were below 1% of the applicable EPA limits.*

Non-Radiological Air Emissions and Air Quality

LANL demonstrated full compliance with all Clean Air Act requirements. Except for a short delay in installing a datalogger at the asphalt plant, LANL met all permit reporting requirements and deadlines. Emissions of criteria pollutants (nitrogen oxides, sulfur oxides, carbon monoxide, particulate matter, volatile organic compounds, and hazardous air pollutants) were slightly lower than the average of the previous five years. In 2009, the TA-3 power

plant and boilers located across the Laboratory were the major contributors of nitrogen oxides, carbon monoxide, and particulate matter. Science research and development activities were responsible for most of the volatile organic compound and hazardous air pollutant emissions. In 2009, LANL provided the first greenhouse gas emissions report to NMED, as required by a new state regulation. The 2008 emissions of carbon dioxide (reported in 2009) were approximately 57,430 metric tons of carbon dioxide equivalents from the combustion of fossil fuels. During 2009, LANL removed over 7,900 pounds of ozone-depleting refrigerants from the active inventory.

Air monitoring for particles with diameters of 10 micrometers (μm) or less (PM-10) and for particles with diameters of 2.5 μm or less (PM-2.5) continued at one White Rock and one Los Alamos location. The annual averages at both locations for PM-10 was about 14 micrograms (μg)/m^3 (same as 2008) and about 7 μg/m^3 for PM-2.5 (8 μg/m^3 in 2008 and about 47% of the EPA standard) and were mostly caused by natural dust and wildfire smoke. In addition, the 24-hour maxima for both PM-10 and PM-2.5 at both locations did not exceed 25% and 57% of the respective EPA standards.

The Laboratory analyzed air filter samples from 38 sites for beryllium, aluminum, and calcium. These sites are located near potential beryllium sources at LANL and in nearby communities. All concentrations measured this year were below 1% of the National Emission Standards for Hazardous Air Pollutants standard of 10 ng/m^3 and were similar to those of recent years. Past studies closely correlated beryllium concentrations with aluminum concentrations, which indicates that all measurements of beryllium are from naturally occurring beryllium in re-suspended dust. Aluminum and calcium are used to evaluate elevated uranium measurements and no unusual concentrations were measured.

Groundwater Monitoring

Groundwater at the Laboratory occurs as a regional aquifer (water-bearing rock capable of yielding significant quantities of water to wells and springs) at depths ranging from 600 to 1,200 feet and as perched groundwater of limited thickness and horizontal extent, either in canyon alluvium or at intermediate depths of a few hundred feet (Figure ES-3). All water produced by the Los Alamos County water supply system comes from the regional aquifer and meets federal and state drinking water standards. No drinking water is supplied from the alluvial and intermediate groundwater.

- ***LANL continues to investigate the hexavalent chromium found at up to 20 times the NM groundwater standard in the regional aquifer under Mortandad Canyon and nearby Sandia Canyon.***
- ***Two of the 14 new monitoring wells installed in 2009 were installed as part of the ongoing characterization of the chromium contamination of the regional groundwater.***
- ***Two other wells were rehabilitated to improve their reliability and representativeness for sampling groundwater.***

In 2009, LANL installed six perched intermediate groundwater monitoring wells and eight regional aquifer monitoring wells. One well was installed south of Los Alamos Canyon to assess the southern extent of perched water identified in the canyon bottom, two wells were installed as part of the ongoing chromium contamination investigation, one well was installed in support of the MDA C investigation, six wells were installed to supplement the groundwater monitoring network around TA-54, and four wells were installed to monitor groundwater associated with historical TA-16 activities. In addition to the new wells, LANL rehabilitated two wells to improve their reliability and representativeness of the sampled groundwater.

Laboratory contaminants have affected deep groundwater, including intermediate perched zones and the regional aquifer, primarily through liquid effluent disposal. Since the early 1990s, the Laboratory has significantly reduced both the number of industrial outfalls (from 141 to 15 active) and the volume of water released (by 90%). From 1993 to 1997, total estimated average release was 1,300 million gal./yr; in 2006 through 2009, the annual releases were 222 million gal., 178 million gal., 158 million gal., and 133 million gal., respectively. In 2009, 1,430 of 1,437 industrial and sanitary samples met applicable federal and state standards for surface water discharges. Exceedences were recorded for pH, total residual chlorine, total suspended solids,

and PCBs. Where Laboratory contaminants are found at depth, the setting is either a canyon where alluvial groundwater is usually present (perhaps because of natural runoff or Laboratory effluents) or a location where large amounts of liquid effluent have been discharged (e.g., Mortandad Canyon and upper Sandia Canyon). During 2009, LANL received and evaluated over 162,000 analytical results for groundwater wells and springs alone. Table ES-3 summarizes contaminants detected in portions of the groundwater system.

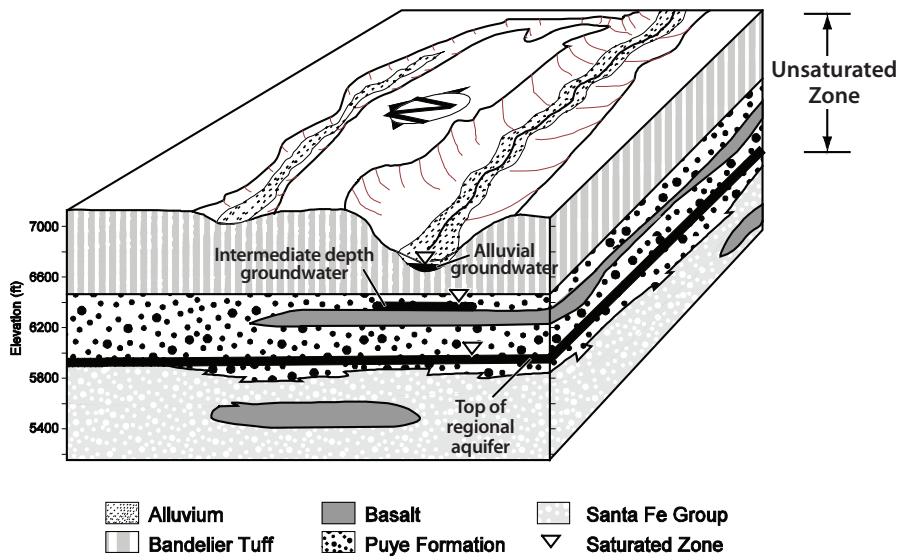


Figure ES-3. Illustration of geologic and hydrologic relationships in the Los Alamos area, showing the three modes of groundwater occurrence.

Table ES-3
Where Can We See LANL Impacts on Groundwater that Result in Values Near

Chemical	On-Site	Off-Site	Significance	Trends
Trichloroethane [1,1,1-]; dichloroethene[1,1-]	Regional aquifer Pajarito Canyon	No	Near PM-2, not found in that well.	Present for one year, approaching 60% of EPA screening level
Chromium	Regional aquifer in Mortandad Canyon, intermediate groundwater in Mortandad and Sandia Canyons	No	Found in regional aquifer above groundwater standards; not affecting drinking water supply wells; source eliminated in 1972.	Fairly steady over four years
Nitrate	Alluvial and intermediate groundwater in Pueblo and lower Los Alamos Canyons, regional groundwater in Sandia Canyon and Mortandad Canyon	Pueblo and Los Alamos Canyons	In Pueblo and lower Los Alamos Canyons, may be due to Los Alamos County's Bayo Sewage Treatment Plant; otherwise due to past effluent discharges	Generally variable in Pueblo, steady in Mortandad, Sandia
Fluoride	Intermediate groundwater in Pueblo Canyon, alluvial groundwater in DP and Mortandad Canyons	Pueblo Canyon	Result of past effluent releases; not affecting drinking water supply wells	In alluvium, slow decrease in concentration due to effluent quality improvement
Fluoride, uranium, nitrate, total dissolved solids	No	Pine Rock Spring, Pueblo de San Ildefonso	Water quality apparently affected by irrigation with sanitary effluent at Overlook Park	Steady over several years

Table ES-3 (continued)

Chemical	On-Site	Off-Site	Significance	Trends
Boron	Intermediate groundwater in Cañon de Valle	No	Not used as drinking water supply; limited in extent	Generally stable, seasonal fluctuations
Barium	Alluvial groundwater in Cañon de Valle and Water, Pajarito, and Mortandad Canyons	No	Not used as drinking water supply; limited in extent	Generally stable in Cañon de Valle, in others likely due to cation-exchange with road salts
RDX	Alluvial and intermediate groundwater in Cañon de Valle, intermediate groundwater in Pajarito Canyon	No	Not used as drinking water supply; limited in extent	Generally stable, seasonal fluctuations
Dioxane[1,4-]	Intermediate groundwater in Mortandad and Pajarito Canyons	No	Not used as drinking water supply; limited in extent	Fairly steady over three years in Mortandad; seasonal variation in Pajarito
Trichloroethane [1,1,1-]; dichloroethene[1,1-]	Intermediate groundwater near main warehouse	No	Not used as drinking water supply; limited in extent	Seasonally variable
Tetrachloroethene [1,1,1-], Trichloroethene	Alluvial and intermediate groundwater in Cañon de Valle	No	Not used as drinking water supply; limited in extent	Generally stable, seasonal fluctuations
Tritium	Intermediate groundwater in Mortandad Canyon	No	Not used as a drinking water supply	Decline over four years of sampling
Strontium-90	Alluvial groundwater in DP/Los Alamos and Mortandad Canyons	No	Not used as a drinking water supply; has not penetrated to deeper groundwater	Mainly fixed in location; some decrease due to effluent quality improvement
Chloride, total dissolved solids	Alluvial groundwater in Pueblo, DP, Sandia, Mortandad, Pajarito Canyons, intermediate groundwater near TA-3 main warehouse and in Sandia Canyon	Pueblo Canyon	May be caused by road salt in snowmelt runoff	Values generally highest in winter or spring samples
Perchlorate	Alluvial, intermediate, and regional groundwater in Mortandad Canyon; intermediate in Los Alamos Canyon; regional aquifer in Pueblo Canyon	Pueblo Canyon	Reflects past outfall discharges that have ceased	Decreasing in Mortandad Canyon alluvial groundwater due to effluent quality improvement; insufficient data for other groundwater
Bis(2-ethylhexyl) phthalate	Several new wells, regional aquifer monitoring wells	No	Used in plastics and sometimes appears in samples from wells with new sampling equipment or drilling	None

- ***All water produced by the Los Alamos County water supply system comes from the regional aquifer and meets federal and state drinking water standards. No drinking water is supplied from the alluvial and intermediate groundwater.***
- ***One unused drinking water supply well, Otowi-1, has been affected by levels of perchlorate at 16% of the EPA interim health advisory for drinking water and at 58% of the NM Consent Order screening level of 4 µg/L. No water from this well is used by Los Alamos County.***

Drainages that received liquid radioactive effluents in the past include Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon. Mortandad continues to receive discharges of treated effluent from the RLWTF. For the last nine years, including 2009, the RLWTF has met all DOE radiological discharge standards. For 2009, the RLWTF discharge of radionuclides was only 22% of established guidelines. Concentrations of nitrate, fluoride, and total dissolved solids in the effluent decreased substantially. A system for removing perchlorate from the RLWTF effluent became operational on March 26, 2002. Since then, perchlorate was detected in effluent samples only for five weeks in 2008.

The contaminated alluvial and intermediate perched groundwater bodies are separated from the regional aquifer by hundreds of feet of dry rock, so infiltration from the shallow groundwater occurs slowly. As a result, less contamination reaches the regional aquifer than the shallow perched groundwater bodies, and impacts on the regional aquifer are small.

Beginning in late 2008, trichloroethene was detected at 1,147 feet in Pajarito Canyon regional aquifer monitoring well R-20. Trichloroethene detections have continued for five consecutive sample events through the end of 2009. The concentrations have increased to 60% of the 5 µg/L EPA screening level.

The Laboratory detected hexavalent chromium and nitrate in several regional aquifer monitoring wells. The hexavalent chromium was found at eight and 20 times above the NM groundwater standard in two regional aquifer wells in Mortandad Canyon and at 70% of the standard in a regional well in nearby Sandia Canyon. A new intermediate zone well in Sandia Canyon contains chromium at 11.2 times the standard and supports LANL's model for the path of the chromium contamination from Sandia Canyon downward and slightly south into the regional aquifer below Mortandad Canyon. Nitrate was up to 70% of the NM groundwater standard in three regional aquifer monitoring wells. Perchlorate was also above the NM screening level in two regional aquifer wells.

One unused drinking water well in the Los Alamos area has been impacted by past Laboratory discharges of perchlorate. Well O-1 in Pueblo Canyon contains perchlorate at up to 16% of the EPA interim health advisory for perchlorate in drinking water of 15 µg/L and at 58% of the NM Consent Order screening level of 4 µg/L. Perchlorate is detected in most groundwater samples analyzed across northern NM. Naturally occurring perchlorate concentrations range from about 0.1 µg/L to 1.8 µg/L.

- ***Beginning in late 2008, trichloroethene was detected in Pajarito Canyon regional aquifer monitoring well R-20 for five consecutive sample events through the end of 2009. The concentrations have increased to 60% of the 5 µg/L EPA screening level.***
- ***Four of the 14 new monitoring wells installed in 2009 were installed to monitor groundwater in the area where trichloroethene was found.***

The intermediate groundwater in various locations shows localized levels of tritium, organic chemicals (RDX, chlorinated solvents, dioxane[1,4-]), and inorganic chemicals (hexavalent chromium, barium, boron, perchlorate, fluoride, and nitrate) from Laboratory operations.

The Laboratory uses federal and state drinking water and human health standards as "screening levels" to evaluate radionuclide concentrations in all groundwater, even though many of these standards only apply to drinking water. Only in the alluvial groundwater in portions of Mortandad and DP/Los Alamos Canyons does the total radionuclide activity from LANL discharges exceed the dose limit that is applicable to drinking water (4 mrem/yr). This is mainly due to the presence of strontium-90. The maximum strontium-90 concentrations in Mortandad Canyon and DP/Los Alamos Canyon alluvial groundwater were also above the EPA's drinking water standard though this water is not used for drinking water supply.

Watershed Monitoring

Watersheds that drain LANL property are dry for most of the year. Of the more than 80 miles of watercourse, approximately three miles are naturally perennial and approximately four miles are perennial water created by effluent discharges (most notably in upper Sandia Canyon). Snowmelt runoff originating in the Jemez Mountains can extend across the Laboratory to the Rio Grande. Storm water runoff transporting sediment can leave the Laboratory boundary, but is short-lived. The surface water within the Laboratory is not a source of municipal, industrial, or irrigation water, though wildlife does use the water. It is not a source of livestock watering west of NM State Highway 4 because there are no livestock in this area.

None of the streams within the Laboratory boundary average more than one cubic foot per second (cfs) of flow annually. It is unusual for the combined mean daily flow from all LANL canyons to be greater than 10 cfs. The largest flows in 2009 occurred on July 30, with a total estimated mean daily flow of 7.2 cfs resulting from storm water runoff in three canyons (Ancho Canyon, Cañada del Buey, and Los Alamos Canyon). By comparison, the average daily flow in the Rio Grande at Otowi Bridge on July 30 was 1,040 cfs, or approximately 145 times higher than the flow from LANL.

- ***Polychlorinated biphenyls (PCBs) are often measured in storm water in Sandia and Los Alamos Canyons above screening levels. PCBs are also detected above screening levels in runoff from the Los Alamos townsite and in background areas, the latter derived from regional atmospheric fallout.***
- ***Radioactive elements from past Laboratory operations are being transported by runoff events. All radionuclide levels are well below applicable guidelines or screening levels.***
- ***PCBs, radionuclides, and other contaminants adsorb onto sediment particles and thus overall water concentrations can be reduced by slowing the stream flows, reducing erosion, and allowing suspended sediment to settle out.***

Excluding effluent, stream flow in 2009 on the Pajarito Plateau was dominated by storm water runoff, mostly occurring in July. No snowmelt runoff was recorded crossing the eastern Laboratory boundary. Total storm water runoff measured at downstream gages in the canyons leaving the Laboratory was estimated at about 24 acre-feet, the least since 1995, the first year for which runoff estimates are available for all the canyons. In addition, approximately 28 acre-feet of effluent released from the Los Alamos County wastewater treatment plant is estimated to have passed the eastern LANL boundary in Pueblo Canyon.

- ***The overall quality of most surface water within the Los Alamos area is very good.***
- ***Of the more than 100 analytes measured, most are within normal ranges or at concentrations below regulatory standards or risk-based advisory levels.***
- ***Nearly every major watershed, however, shows some effect from Laboratory operations.***

There were no unusual storm water runoff events at LANL in 2009. The largest recorded flood was measured in Ancho Canyon below NM State Highway 4 (stream gage E275) on July 30, with an estimated peak discharge of 414 cfs. This was the fourth largest event in the 15 years of record at this station and occurred in response to a typical short-duration summer thunderstorm. No significant new sediment deposits resulted from this flood. All other recorded runoff events at LANL in 2009 had peak discharges of 60 cfs or less.

The overall quality of most surface water in the Los Alamos area is good, with low levels of dissolved solutes. Of the more than 100 analytes measured in sediment and surface water within the Laboratory, most are at concentrations far below standards and screening levels. However, nearly every major watershed indicates some effect from Laboratory operations, often for just a few analytes. Table ES-4 lists the locations of Laboratory-impacted surface water. All radionuclide levels are well below applicable guidelines or standards.

Laboratory activities have caused contamination of sediment in several canyons, mainly because of past industrial effluent discharges. These discharges and contaminated sediment also affect the quality of storm water runoff, which carries much of this sediment during short periods of intense flow. In some cases, sediment contamination is present from Laboratory operations conducted more than 50 years ago. However, all measured sediment contaminant levels are below screening levels for recreational uses.

Table ES-4
Where Can We See LANL Impacts on Surface Water that Result in Values Near or Above Screening Levels?

LANL Impact	On-Site	Off-Site	Significance	Trends
Specific radionuclides	No	No	No LANL-derived radionuclides exceeded DOE biota concentration guides or derived concentration guidelines in 2009	Steady
Gross alpha radioactivity	Pueblo and Los Alamos Canyons	No	38% of storm water results from 2009 greater than screening level. Major source is naturally occurring radioactivity in sediments, except in Mortandad, Pueblo, and Los Alamos Canyons where there are LANL contributions	Steady
Copper	DP and Sandia Canyons	No	Copper was elevated in 2009 at sites that receive runoff from developed areas, including the Los Alamos townsite	Steady
Cyanide	Pajarito Canyon	No	Cyanide was elevated in one sample collected from a small tributary drainage below Material Disposal Area G	Steady
Zinc	Mortandad and Sandia Canyons	No	Zinc was elevated only from locations with small drainage areas receiving runoff from paved roads and other developed areas	
High explosives	Cañon de Valle	No	RDX above screening levels in two samples from one location within the Laboratory; subject of corrective measures	Steady
Polychlorinated biphenyls (PCBs)	Los Alamos and Sandia Canyons	No	Above screening levels. Wildlife exposure potential in Sandia Canyon. PCBs are also above screening levels in drainages receiving runoff from developed areas, including the Los Alamos townsite, and in background areas on Santa Fe National Forest land, resulting from regional atmospheric fallout	Steady
Volatile organic compounds	Sandia Canyon	No	Bromodichloromethane and chloroform were above screening levels in samples collected from one location	Steady

- ***The highest concentrations of LANL-derived radionuclides in surface water samples were measured in various canyons (Chaquehui, DP, Los Alamos, and Mortandad Canyons). All measurements are consistent with previous years and are below screening levels.***
- ***The highest concentrations of radionuclides in sediment were obtained from a fine-grained sample from the Mortandad Canyon sediment traps, and are consistent with previous years.***

Consistent with previous years, many surface water samples in 2009 had gross alpha radiation greater than the surface water standard of 15 pCi/L for livestock watering. Of the 77 non-filtered samples analyzed from the Pajarito Plateau, 38% exceeded 15pCi/L, including samples from sites with no upstream releases of radionuclides from Laboratory activities (such as Chupaderos Canyon, north of Los Alamos). Laboratory impacts are relatively small and the majority of the alpha radiation in surface water on the plateau is due to the decay of naturally occurring isotopes in sediment and soil carried in storm water runoff from uncontaminated areas. This is supported by the generally positive correlation between gross alpha radiation and suspended sediment in non-filtered surface water samples.

We measured the highest concentrations of radionuclides with potential Laboratory contributions in surface water samples from Chaquehui, DP, Los Alamos, and Mortandad Canyons. The highest concentrations of americium-241 and plutonium-239/240 were measured in a sample collected in Los Alamos Canyon downstream from known releases of radioactive effluents from TA-1 and TA-21. The highest concentrations of

cesium-137, plutonium-238, and tritium were measured in a sample collected in Mortandad Canyon, downstream from the active RLWTF outfall. The highest concentration of strontium-90 was in a sample collected from DP Canyon below TA-21, below a former outfall that also released treated radioactive effluent. The highest concentrations of uranium-234, uranium-235, and uranium-238 were measured in a sample collected in Chaquehui Canyon at TA-33, a site with known releases of uranium. With the exception of the uranium isotopes in Chaquehui Canyon, all the other measurements discussed above are consistent with recent years, although there have been no other storm water samples collected from Chaquehui Canyon since 2005 to use for comparison.

- ***Concentrations of many inorganic chemicals are elevated in sediment along the Rio Grande and in the bottoms of Abiquiu and Cochiti Reservoirs relative to background levels because of different background source rock types along the Rio Grande and because the finer-grained sediment along the river and in the reservoirs can adsorb more chemicals in the same volume.***
- ***Monitoring results show no measurable effects of PCBs from LANL in the Rio Grande.***

Four radionuclides in sediment were detected above background concentrations in 2009: americium-241, cesium-137, plutonium-238, and plutonium-239/240. The maximum values for all four were from a fine-grained sediment layer at the Mortandad Canyon sediment traps, down canyon from the RLWTF, and were consistent with results from previous years.

Six inorganic chemicals were detected above screening levels in surface water samples from the Laboratory in 2009: aluminum, arsenic, copper, cyanide, manganese, and zinc. The distribution of aluminum, arsenic, and manganese indicates that they are derived from natural sources. Copper and zinc are only above screening levels in drainages that receive runoff from developed areas, including the Los Alamos townsite. Cyanide was only above the screening level in a single sample, from a small tributary drainage to Pajarito Canyon at TA-54.

The high explosive RDX was detected above the screening level in two surface water samples from Cañon de Valle, downstream from a high explosive machining facility at TA-16. These results are consistent with previous years. Corrective measures were implemented to address this high explosive contamination in 2009 and 2010.

The PCBs Aroclor-1254 and Aroclor-1260 were detected above the water screening level of 0.00064 µg/L in Los Alamos and Sandia Canyons. These results are consistent with previous years. PCBs were also measured above the screening level in runoff from developed areas, including the Los Alamos townsite, and in background areas, such as Chupaderos Canyon north of Los Alamos. The PCBs in background areas are derived from regional atmospheric fallout. In 2001, the Laboratory excavated PCB-contaminated soil at a former transformer storage area in the Sandia Canyon watershed, and in 2008, we began interim measures to address the transport of PCBs in storm water in Los Alamos and Pueblo Canyons. Monitoring results show no measurable levels of PCBs from LANL in the Rio Grande.

The volatile organic compounds bromodichloromethane and chloroform were detected above screening levels in samples collected from one location in upper Sandia Canyon. These results are consistent with previous years.

Concentrations of many inorganic chemicals are elevated in sediment along the Rio Grande and from the bottoms of Abiquiu and Cochiti Reservoirs relative to background levels in Pajarito Plateau sediment. These differences are due in part to different background source rock types along the Rio Grande, but also to the finer-grained nature of sediment along the river and in the reservoirs. Comparing data from samples with similar particle size characteristics upriver and downriver from LANL drainages indicates that there are no recognizable LANL influences on concentrations of metals in Rio Grande sediment.

We obtained PCB congener data from 20 sediment samples along the Rio Grande during low-water conditions in November 2009. Five samples were collected upriver from Los Alamos Canyon and five samples each from three different areas downriver from LANL drainages. Congener data were also obtained from 18 samples in the Los Alamos Canyon watershed for comparison. The congener data allow evaluation of similarities or differences in the PCBs present above LANL drainages and also allow further comparison with PCBs present in LANL

canyons. Consistent with data from 2008, the mixtures of PCB congeners upriver and downriver from LANL sources are essentially identical, but different than the PCB signature in LANL canyons. These congener data therefore show no measureable evidence of LANL contributions to PCBs along the Rio Grande.

The PCB data from the Rio Grande were also combined with data on suspended sediment flux to estimate PCB flux in the river above LANL drainages. These data indicate that, on average, about 0.16 to 0.35 kg of PCBs are transported past Otowi Bridge each year. In comparison, a preliminary estimate of PCB flux from Los Alamos Canyon is about 0.005 kg/yr, or 1% to 3% of the flux in the Rio Grande.

Soil Monitoring

LANL conducted large-scale soil sampling within and around the perimeter of LANL in 2009. Table ES-5 summarizes soil sampling results. In general, results confirmed the results from previous sampling events and show on-site and perimeter areas contained radionuclides at very low (activity) concentrations and most were either not detected or below regional statistical reference levels (RSRLs) (equal to the average plus three standard deviations). The few samples with radionuclide concentrations above the RSRLs were collected near known or expected areas of contamination. These samples are below residential screening levels and thus do not pose a potential unacceptable dose to the public.

Table ES-5
Where Can We See LANL Impacts on Mesa-Top Surface Soil that Result in Values Near or Above Background or Screening Levels?

LANL Impact	On-Site	Off-Site	Significance	Trends
Tritium	Above background at some sites, particularly at TA-54, Area G	No	Far below residential screening levels	Consistently detected in the south sections of Area G, but not increasing
Plutonium-239/240	Above background along State Road 502 at TA-73 (downwind of TA-21) and at TA-54, Area G	Above background along State Road 502 on the west side of the airport (downwind of TA-21)	Far below residential screening levels	Plutonium-239/240 downwind of TA-21 is highly variable from sample to sample but is generally not increasing. Also, it is consistently detected on the north, northeast, and eastern sections of Area G, mostly not increasing
Other radionuclides	Mostly depleted uranium at the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility	Mostly no	Far below residential screening levels	Uranium-238 at DARHT increased through 2006 but decreased after 2007 likely because of the use of steel containment vessels
Inorganic chemicals	Few detections	Mostly no	Far below residential screening levels	Steady
PCBs (Aroclors)	Most samples below detection limits	No	Far below residential screening levels	None
High explosives	Not detected	No	Minimal potential for exposure	None
Semi-Volatile Organic Compounds	Few detections	No	Far below residential screening levels	None

We also annually collect soil samples from two locations on the Pueblo de San Ildefonso land downwind of TA-54, Area G. Radionuclides and metals in these soil samples were below background or near background and were consistent with levels measured in previous years.

The annual samples from around the perimeter of Area G contained above-background concentrations of tritium, americium-241, plutonium-238, and plutonium-239/240 at levels similar to those found in previous years. The highest levels of tritium around Area G were detected at the southern end, and the highest levels of the americium and plutonium were detected around the northern, northeastern, and eastern sections. Although americium-241, plutonium-238, and plutonium-239/240 in soil along the northern, northeastern, and eastern sections of Area G are slightly elevated, all levels are well below residential screening levels used to trigger investigations and decrease rapidly with distance from Area G.

- ***Soil samples from all off-site locations show radionuclides and metals have not increased over the past years and are mostly at background levels.***
- ***Soil samples from all on-site locations show no increases and some decreases of radionuclides and metals from previous years.***

At the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility, uranium-238 from near a firing point showed significantly lower levels than measured in the past three years and is well below residential screening levels. High explosives were not detected in any samples around DARHT.

Fourteen soil samples on the north side of East Jemez Road along a 2.25-mile section were collected for the analysis of plutonium-239/240 (and other radionuclides like cesium-137 and plutonium-238). These sites are located on the south side of historic plutonium processing operations at TA-1 and TA-21. Results show no elevated levels of plutonium-238 and cesium, and the slightly elevated levels of plutonium-239/240 were still well below residential screening levels.

In 2009, we conducted additional sampling of soils from alfalfa fields irrigated with Rio Grande water from areas that were upstream and downstream from LANL. The upstream locations (background) were collected from three fields that were located just north of Española and one field was located on Pueblo de San Ildefonso land on the west side of the Rio Grande; and the five downstream locations were located below Cochiti Reservoir. Radionuclides and metals from upstream and downstream fields were not statistically different. No high explosives or semi-volatile organic compounds were detected in any of the field soils. PCBs collected from downstream fields were very low; upstream fields ranged in concentration from 126 to 6,080 pg/g, indicating some possible point source contamination. Though the average PCB concentration upstream is higher than downstream, the difference is not statistically significant because of the great variability in the values.

Foodstuffs Monitoring

In 2009, we collected crayfish (crawfish, crawdads, or mudbugs) (*Orconectes* spp.) from the Rio Grande within upstream and downstream reaches relative to the location of LANL. Upstream (or background) samples were collected starting from the Otowi Bridge north to the Black Mesa area (about a three-mile stretch) and downstream samples were collected from the Los Alamos Canyon confluence south (about a one-mile stretch). The concentrations of radionuclides were very low, similar between locations, and similar to levels in bottom-feeding fish collected from these same upstream and downstream reaches in past years. Some metals were higher in downstream crayfish as compared with upstream; however, the differences were small. PCB concentrations were low as compared with the fish consumption limit and are similar to other studies involving bottom-feeding fish and sediment that showed similar PCB concentrations between upstream and downstream locations. These data indicate that LANL is not a significant source of PCBs to the Rio Grande.

- ***Radionuclides, most metals, and PCBs in crayfish collected downstream of LANL were similar to upstream reaches, and indicate that LANL is not a significant source of contaminants to the Rio Grande.***

Biota Monitoring

Table ES-6 summarizes biota sampling results. In plants collected around Area G, only tritium and plutonium were detected in a few samples closest to the boundary fence and adjacent to known sources of these radionuclides.

Table ES-6
Where Can We See LANL Impacts on Foodstuffs and Biota that Result in Values

Media	LANL Impact	On-Site	Off-Site	Significance	Trends
Wild edible plants	Radionuclides	Tritium in plants from Cañada del Buey	Above background concentrations for strontium-90 in plants from Mortandad Canyon on Pueblo de San Ildefonso land in 2006	Far below screening level; higher strontium-90 in wild plants is a function of low calcium in the soil and not a result of increased contamination levels	Steady
	Inorganic chemicals	No	No	None	Steady
Native vegetation	Radionuclides	Mostly tritium and plutonium-239/240 at Area G; and depleted uranium at DARHT	No	Far below screening levels	Tritium and plutonium-239/240 are steady at Area G; uranium-238 in trees at DARHT increased through 2006, decreased after 2007
	Inorganic chemicals	Few detections	No	None	Steady for most metals
Small mammals, bees, and birds	Radionuclides	Depleted uranium at DARHT; some radionuclides in biota upstream of the Los Alamos Canyon Weir and the Pajarito Canyon Flood Retention Structure	No	Far below screening levels	Depleted uranium decreasing at DARHT
	Inorganic chemicals	Some detections in a bird at DARHT	No	One sample out of two	Steady
	PCBs	Detected in mice at the Los Alamos Canyon Weir	No	Far below soil ecological screening levels	Steady at Los Alamos Canyon Weir; PCBs in field mice significantly lower 4.5 miles downstream in Los Alamos Canyon
	Species diversity	Abundance and species diversity of birds at DARHT during operations are similar to baseline	None collected	No stress to birds near DARHT	Steady

In vegetation around the DARHT facility, no significantly elevated levels of radionuclides were detected; the levels are lower than in previous years, which may be because testing is now conducted in metal vessels instead of in the open. Mice at DARHT were not elevated in any radionuclides. Bees contained slightly higher levels of tritium, barium, and copper than previous years.

PCBs in mice are elevated around the Los Alamos Canyon Weir but are significantly lower in mice about 4.5 miles downstream. The concentrations of all radionuclides, metals, and PCBs in small mammals collected down gradient of the weir were below screening levels. Above the Pajarito Canyon Flood Retention Structure, no contaminants are significantly elevated in sampled biota.

For the first time, LANL sampled benthic macroinvertebrates in the Rio Grande upstream and downstream from LANL properties. Rock baskets were set in pools in the river for six weeks, the organisms living in the rocks were collected, and the variety and number of organisms were counted and classified. The numbers and types of organisms, quantified by metrics or indices, can provide an indication of water quality within

a stream system. In general, the results show a thriving benthic macroinvertebrate community both upstream and downstream of LANL. This indicates that potential Laboratory contributions, if any, are not significantly impacting the aquatic benthic macroinvertebrate community.

Environmental Restoration Program

Corrective actions proposed and/or conducted at LANL in 2009 follow the requirements of the NMED Consent Order. The goal of the investigation efforts is to ensure that waste and contaminants from past operations do not threaten human or environmental health and safety. The investigation activities are designed to characterize SWMUs, AOCs, consolidated units, aggregate areas, canyons, and watersheds. The characterization activities conducted include surface and subsurface sampling, drilling boreholes, geophysical studies, and installation of monitoring wells. Corrective action activities performed included the removal of structures (e.g., buildings, septic systems, sumps, and drain lines), excavation of contaminated media, and confirmatory sampling. These activities define the nature and extent of contamination and determine the potential risks and doses to human health and the environment.

- ***Characterization and cleanup of sites contaminated or potentially contaminated by past LANL activities follow the Consent Order.***
- ***LANL submitted 26 investigation work plans and 22 investigation reports to NMED in 2009.***

Accomplishments in 2009 include the completion of investigation activities, approvals of proposed investigation activities, and approvals of the work completed at some sites. Numerous sampling campaigns were conducted in 2009 and included sampling of locations in the area of the original Laboratory technical areas within the Los Alamos townsite; borehole sampling and excavation of soil at former firing sites and explosives development buildings; sampling and digging of test pits in Bayo Canyon where radioactive materials were used; sampling of former septic systems that served abandoned or decommissioned buildings; installing and testing vapor extraction systems near the TA-54 Area G waste storage site; sampling of sediment deposits in Sandia, Pajarito, and North Ancho Canyon watersheds; studying biota including sampling and nest box monitoring in Sandia and Pajarito Canyons; sampling of sediment in Cañada del Buey; and removal of contaminated soil and tuff at TA-21. In addition, corrective measures were implemented at Consolidated Unit 16-021(c)-99 (260 Outfall) at TA-16. After results are received and interpreted, LANL documents the investigation activities in reports to NMED. During 2009, environmental restoration activities collected more than 3,400 samples from more than 920 locations and requested more than 423,000 analyses or measurements on these samples.

- ***Vegetation at Area G contained elevated levels of radionuclides near known sources.***
- ***Biota samples at DARHT contained depleted uranium but the levels were lower than previous years probably because of new contained testing measures.***
- ***Biota samples collected above the Los Alamos Canyon Weir contained slightly elevated levels of some radionuclides and PCBs but far below screening levels.***

In 2009, LANL submitted 26 new or revised investigation work plans and 22 new or revised investigation reports to NMED. Four historical investigation reports were also submitted as companion documents to new work plans. In 2009, NMED approved a total of 13 plans and four reports, most with modifications or directions. In addition, LANL submitted 36 periodic monitoring reports on sampling activities, 62 plans and reports on groundwater monitoring well activities, and 15 miscellaneous reports or plans.

Monitoring of the Rio Grande

Data from samples of water, sediment, soil, alfalfa, fish, crayfish, and benthic macroinvertebrates, some collected for the first time in 2009 and others collected periodically over the past almost 30 years, show no measureable impact from LANL to the Rio Grande. These data do show, however, elevated levels of mercury and PCBs are present in the river and derive from sources upstream.

Benthic macroinvertebrates collected from the Rio Grande show a diverse and healthy community both upstream and downstream of Los Alamos Canyon, with some measures better in downstream locations.

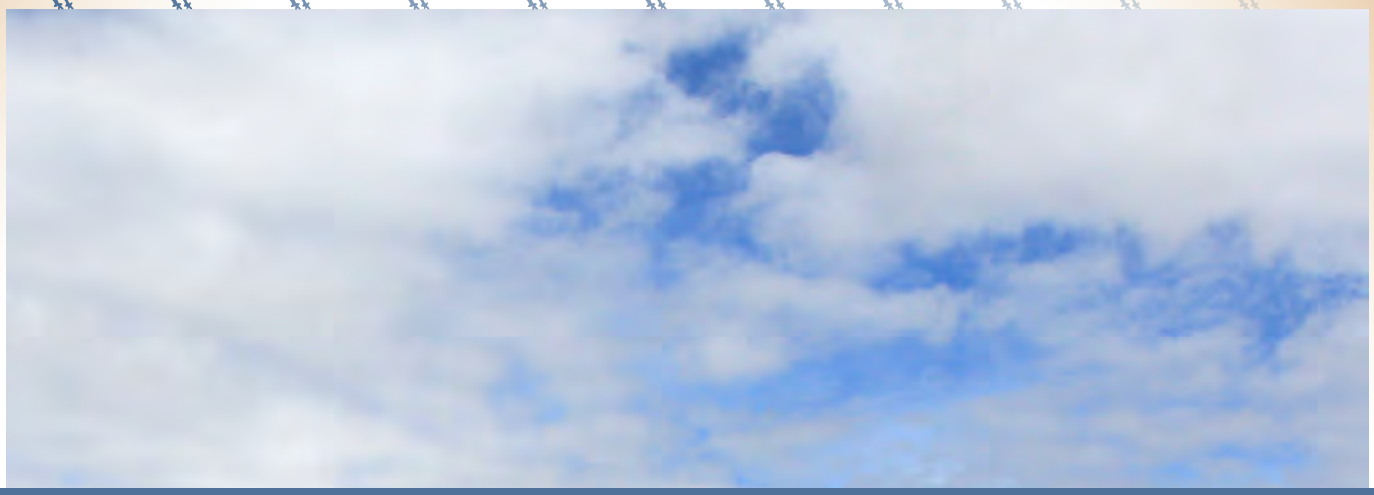
LANL installed sediment capture structures to help reduce the sediment from LANL property reaching the Rio Grande. Automated storm flow monitoring stations have been installed to notify Buckman Direct Diversion Project personnel of major flow events reaching the Rio Grande. Past risk assessments of the potential risk to the public from chemicals and radioactive materials released from the Cerro Grande fire found minimal exposure risks.

- ***The levels of PCBs and mercury are similar in sediments, fish, and crayfish from the Rio Grande taken upstream and downstream of the Laboratory and indicate a significant upstream source.***
- ***The types of PCBs in sediments, fish, and crayfish samples taken from the Rio Grande are different from the types detected in sediments on LANL property and indicate a different source.***
- ***Samples of all types of media from in and around the Rio Grande show no measurable contaminants from LANL, because potential LANL contributions are masked by normal analytical variability or because upstream contributions are much higher.***

In 2009, LANL sampled soil and alfalfa forage irrigated with Rio Grande water upstream and downstream of LANL. Radionuclides, metals, high explosives, PCBs, and semi-volatile organic compounds in soil from fields downstream of LANL were all similar to those from upstream sources.

Past fish sampling data have shown, on average, no differences between fish collected upstream and downstream of LANL, though fish contain elevated levels of mercury and PCBs. Crayfish were sampled for the first time in 2009 and some metals were statistically higher in crayfish collected downstream compared with crayfish collected upstream of LANL. These differences could be caused by LANL impacts to the Rio Grande or they may be explained by natural variability. The results were based on only three samples from each site and additional sampling in the future should help determine the nature and extent of the differences. Radionuclides and other elements in crayfish were similar between upstream and downstream samples.

In summary, any LANL contributions to the Rio Grande are masked and overwhelmed by contaminants from upriver sources. With the exception of mercury and PCBs in fish, the levels of contaminants in the Rio Grande are below all levels of concern.



1. Introduction

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A. BACKGROUND AND REPORT PURPOSE

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 require only 100 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. Through May 2006, the Laboratory was managed by the Regents of the University of California through the Los Alamos Site Office of the US Department of Energy (DOE). In June 2006, a new management organization, Los Alamos National Security (LANS), LLC, took over management of the Laboratory.

The Laboratory's original mission to design, develop, and test nuclear weapons has broadened and evolved as technologies, priorities, and the world community have changed. The current mission is to develop and apply science and technology to

- Ensure the safety and reliability of the United States' nuclear deterrent;
- Reduce global threats; and
- Solve other emerging national security challenges (LANL 2005a).

LANL defines its vision as: "Los Alamos, the premier national security science laboratory." The Laboratory has identified 12 strategic goals to implement its vision and mission:

- Make safety and security integral to every activity we do.
- Implement an information security system that reduces risk while providing exemplary service and productivity.
- Establish excellence in environmental stewardship.
- Assess the safety, reliability, and performance of LANL weapons systems.
- Transform the Laboratory and the nation's nuclear weapons stockpile to achieve the 2030 vision, in partnership with the [DOE] Complex.

- Leverage our science and technology advantage to anticipate, counter, and defeat global threats and meet national priorities, including energy security.
- Be the premier national security science laboratory and realize our vision for a capabilities-based organization.
- Provide efficient, responsive, and secure infrastructure and disciplined operations that effectively support the Laboratory mission and its workforce.
- Implement a management system based upon performance that drives mission and operational excellence.
- Deliver improved business processes, systems, and tools that meet the needs of our employees, reduce the cost of doing business, and improve the Laboratory's mission performance.
- Communicate effectively with our employees, customers, community, stakeholders, and the public at large.
- Develop employees and create a work environment to achieve employee and Laboratory success.

Inseparable from the Laboratory's commitment to excellence in science and technology is its commitment to complete all work in a safe, secure, and environmentally responsible manner. The Laboratory uses Integrated Safety Management (ISM) to set, implement, and sustain safety performance and meet environmental expectations. In addition, the Laboratory uses an International Standards Organization (ISO) 14001-2004 registered Environmental Management System (EMS) as part of ISM to focus on environmental performance, protection, and stewardship. (See Section D, Management of Environment, Safety, and Health, of this chapter for additional information.) The foundation of the EMS and the demonstration of the Laboratory's commitment comprise the LANL environmental policy:

- We approach our work as responsible stewards of our environment to achieve our mission.
- We prevent pollution by identifying and minimizing environmental risk.
- We set quantifiable objectives, monitor progress and compliance, and minimize consequences to the environment, stemming from our past, present, and future operations.
- We do not compromise the environment for personal, programmatic, or operational reasons.

2. Purpose of this Report

As part of the Laboratory's commitment to our environmental policy, we monitor and report on how Laboratory activities are affecting the environment. The objectives of this environmental surveillance report, as directed by DOE Order 231.1A (DOE 2004), are to

- Characterize site environmental management performance, including effluent releases, environmental monitoring, and estimated radiological doses to the public from releases of radioactive materials at DOE sites.
- Summarize environmental occurrences and responses reported during the calendar year.
- Confirm compliance with environmental standards and requirements.
- Highlight significant programs and efforts, including environmental performance indicators and/or performance measures programs.

The Laboratory establishes annual environmental objectives, targets, and key performance indicators, beyond the DOE requirements, through the EMS. The current objectives are to

- Ensure integrated compliance improvement.

- Achieve Laboratory-wide reductions in waste generation.
- Meet or exceed DOE energy and fuel conservation goals established for the Laboratory as defined by its Energy Management Program.

B. ENVIRONMENTAL SETTING

1. Location

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 40-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 streams. Mesa tops range in elevation from approximately 7,800 ft on the flanks of the Jemez Mountains to about 6,200 ft at the edge of White Rock Canyon. Most Laboratory and community developments are confined to the 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, the US Bureau of Land Management, Bandelier National Monument, the US General Services Administration, and Los Alamos County. The Pueblo de San Ildefonso borders the Laboratory to the east.

2. Geology and Hydrology

The Laboratory lies at the western boundary of the Rio Grande Rift, a major North American tectonic feature. Three major potentially active local faults constitute the modern rift boundary. 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 1-2) are formed from Bandelier Tuff, which includes ash fall, ash fall pumice, and rhyolite tuff. Deposited by major eruptions in the Jemez Mountains volcanic center 1.2–1.6 million years ago, the tuff is more than 1,000 ft thick in the western part of the plateau and thins to about 260 ft eastward above the Rio Grande.

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 ft thick.

Surface water in the Los Alamos region occurs primarily as short-lived or intermittent reaches of streams. Perennial springs on the flanks of the Jemez Mountains supply base flow into the upper reaches of some canyons, but the volume is insufficient to maintain surface flows across the Laboratory property before the water is depleted by evaporation, transpiration, and infiltration.

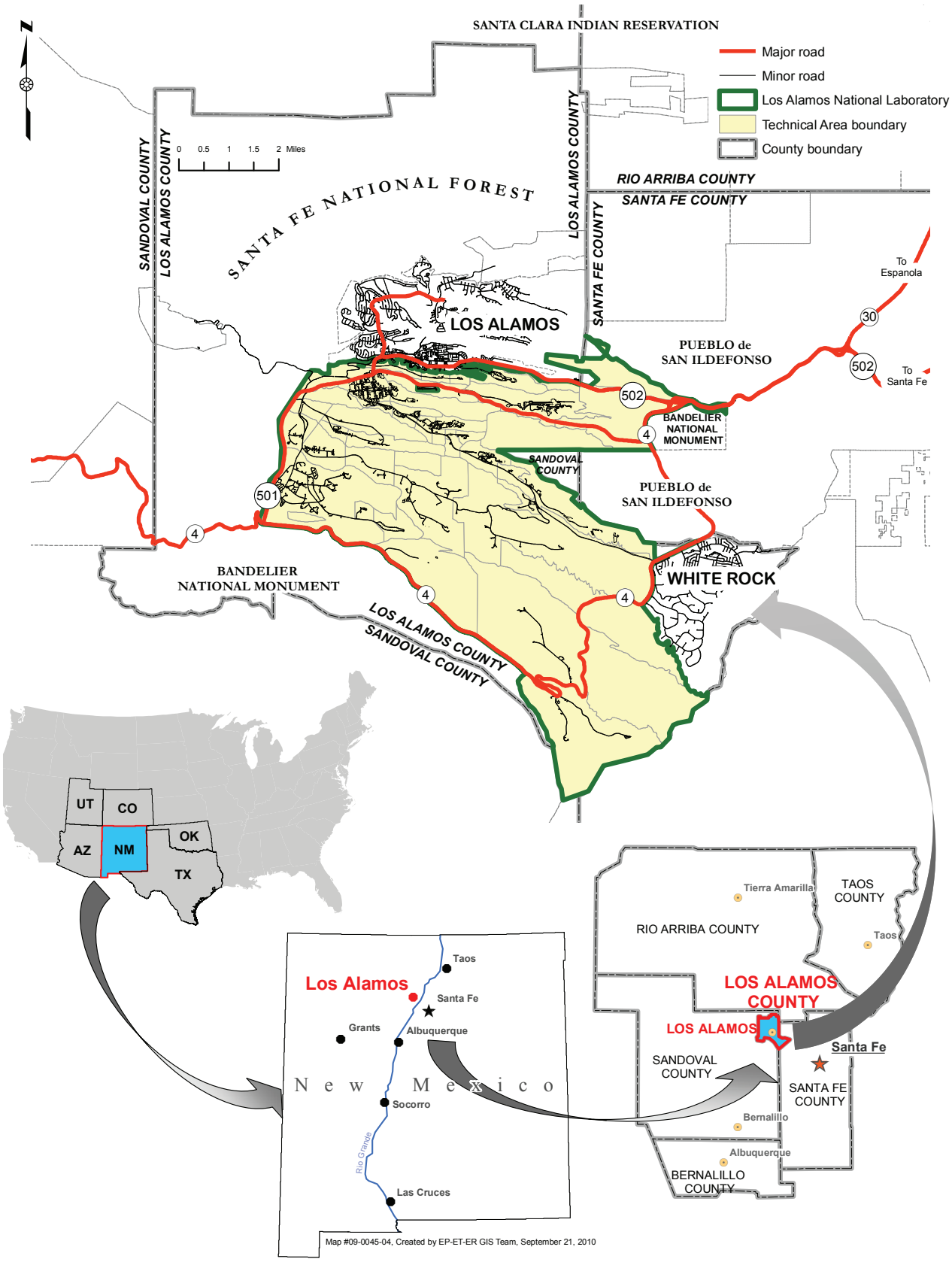


Figure 1-1. Regional location of Los Alamos National Laboratory.

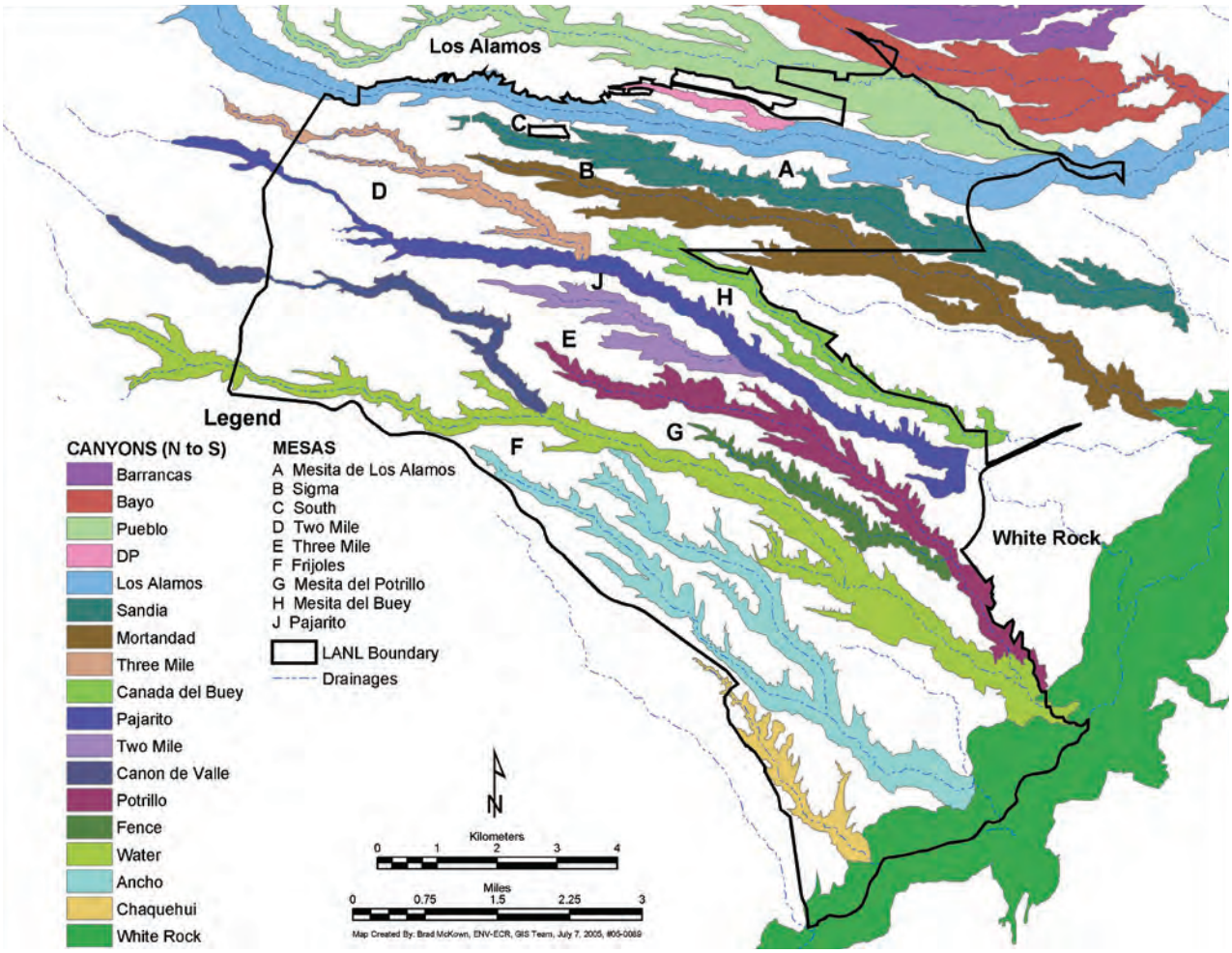


Figure 1-2. Major canyons and mesas on Laboratory land.

Groundwater in the Los Alamos area occurs in three modes: (1) water in shallow alluvium in canyons, (2) intermediate 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, which is the only aquifer in the area capable of serving as a municipal water supply. Water in the regional aquifer is in 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 regional 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-mi reach of the river in White Rock Canyon, between Otowi Bridge and the mouth of Rio de los Frijoles, receives an estimated 4,300–5,500 acre-feet of water from the regional aquifer.

3. Biological Resources

The Pajarito Plateau, including the Los Alamos area, is biologically diverse. This diversity of ecosystems is due partly to the dramatic 5,000-ft elevation gradient from the Rio Grande on the east of the plateau up to the Jemez Mountains 12 mi (20 km) to the west and partly to the many steep canyons that dissect the area. Five major vegetative cover types are found in Los Alamos County. The juniper (*Juniperus monosperma* Englem. Sarg.)-savanna community is found along the Rio Grande on the eastern border of the plateau and extends upward on the south-facing sides of canyons at elevations between 5,600 and 6,200 ft. The piñon (*Pinus edulis* Engelm.)-juniper cover type, generally between 6,200 to 6,900 ft in elevation, covers large portions of the mesa tops and north-facing slopes at the lower elevations. Ponderosa pine (Pinus ponderosa P. and C. Lawson) communities are

found in the western portion of the plateau between 6,900 and 7,500 ft in elevation. These three vegetation types predominate the plateau, each occupying roughly one-third of the Laboratory site. The mixed conifer cover type, at an elevation of 7,500 to 9,500 ft, overlaps the Ponderosa pine community in the deeper canyons and on north-facing slopes and extends from the higher mesas onto the slopes of the Jemez Mountains. The spruce (*Picea* spp.)-fir (*Abies* spp.) cover type is at higher elevations of 9,500 to 10,500 ft. Several wetlands and riparian areas enrich the diversity of plants and animals found on the plateau.

In May 2000, the Cerro Grande fire burned more than 43,000 acres of forest in and around LANL. Most of the habitat damage occurred on Forest Service property to the west and north of LANL. Approximately 7,684 acres, or 28% of the vegetation at LANL, was burned to varying degrees by the fire. However, few areas on LANL property were burned severely.

The extreme drought conditions prevalent in the Los Alamos area and all of New Mexico from 1998 through 2003 resulted directly and indirectly in the mortality of many trees. Between 2002 and 2005, more than 90% of the piñon trees greater than 10 ft tall died in the Los Alamos area. Lower levels of mortality also occurred in ponderosa and mixed conifer stands. Mixed conifers on north-facing canyon slopes at lower elevations experienced widespread mortality. These changes likely will have long-lasting impacts to vegetation community composition and distribution.

4. Cultural Resources

The Pajarito Plateau is an archaeologically rich area. Approximately 86% of DOE land in Los Alamos County has been surveyed for prehistoric and historic cultural resources, and more than 1,800 sites have been recorded. During fiscal year 2006, sites that have been excavated since the 1950s were removed from the overall site count numbers. Thus, there are fewer recorded sites than the number reported in previous years. More than 85% of the resources are Ancestral Pueblo and date from the 13th, 14th, and 15th centuries. Most of the sites are found in the piñon-juniper vegetation zone, with 80% located between 5,800 and 7,100 ft. Almost three-quarters of all cultural resources are found on mesa tops. Buildings and structures from the Manhattan Project and the early Cold War period (1943–1963) are being evaluated for eligibility for listing in the National Register of Historic Places, and more than 500 buildings have been evaluated to date. In addition, "key facilities" (facilities considered of national historic significance) dating from 1963 to the end of the Cold War in 1990 are being evaluated.

5. Climate

Los Alamos County has a temperate, semiarid mountain climate. Large differences in locally observed temperature and precipitation exist because of the 1,000-ft elevation change across the Laboratory site and the complex topography. Four distinct seasons occur in Los Alamos County. Winters are generally mild, with occasional winter storms. Spring is the windiest season. Summer is the rainy season, with occasional afternoon thunderstorms. Fall is typically dry, cool, and calm.

Daily temperatures are highly variable (a 23°F range on average). On average, winter temperatures range from 30°F to 50°F during the daytime and from 15°F to 25°F during the nighttime. The Sangre de Cristo mountains to the east of the Rio Grande Valley act as a barrier to wintertime arctic air masses that descend into the central United States, making the occurrence of local subzero temperatures rare. On average, summer temperatures range from 70°F to 88°F during the daytime and from 50°F to 59°F during the nighttime.

From 1971 to 2000, the average annual precipitation (which includes both rain and the water equivalent of frozen precipitation) was 18.95 in., and the average annual snowfall amount was 58.7 in. (Note: By convention, full decades are used to calculate climate averages [WMO 1984].) The months of July and August account for 36% of the annual precipitation and encompass the bulk of the rainy season, which typically begins in early July and ends in early September. Afternoon thunderstorms form as moist air from the Pacific Ocean and the Gulf of Mexico is convected and/or orographically lifted by the Jemez Mountains. The thunderstorms yield short, heavy downpours and an abundance of lightning. Local lightning density, among the highest in the United States, is estimated at 15 strikes per square mile per year. Lightning is most commonly observed between May and September (about 97% of the local lightning activity).

The complex topography of the Pajarito Plateau influences local wind patterns. Often a distinct diurnal cycle of winds occurs. Daytime winds measured in the Los Alamos area are predominately from the south, consistent with the typical upslope flow of heated daytime air moving up the Rio Grande valley. Nighttime winds (sunset to sunrise) on the Pajarito Plateau are lighter and more variable than daytime winds and typically from the west, resulting from a combination of prevailing winds from the west and downslope flow of cooled mountain air. Winds atop Pajarito Mountain are more representative of upper-level flows and primarily range from the northwest to the southwest, mainly because of the prevailing westerly winds.

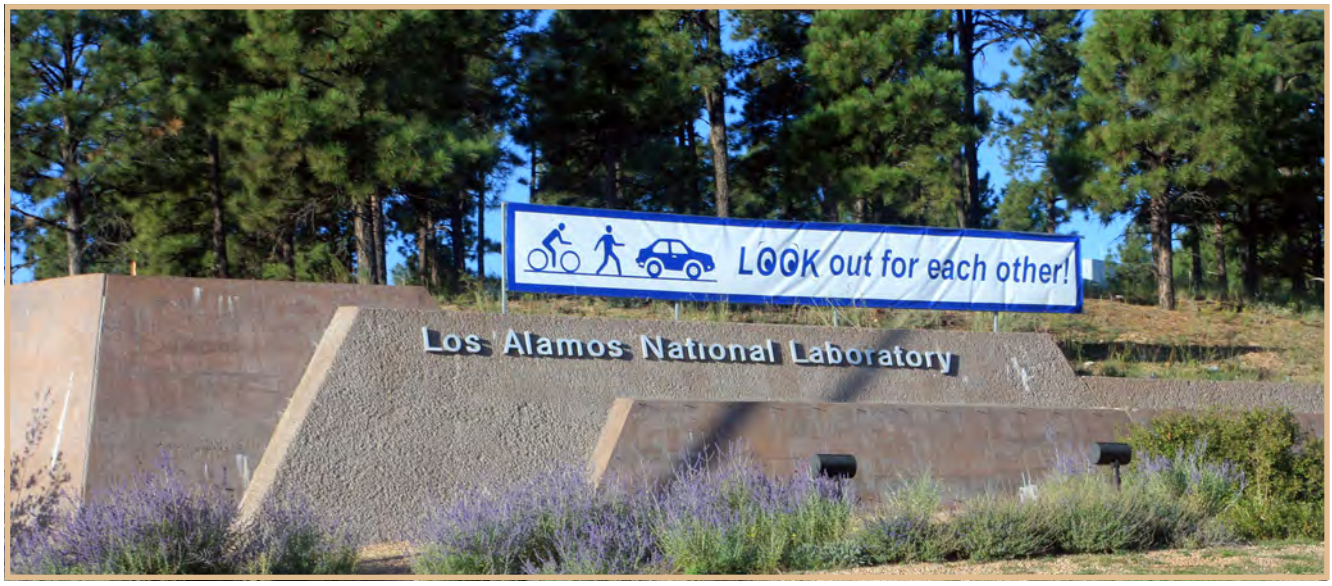
C. LABORATORY ACTIVITIES AND FACILITIES

The Laboratory is divided into technical areas (TAs) used for building sites, experimental areas, support facilities, roads, and utility rights-of-way (Appendix C and Figure 1-3). However, these uses account for only a small part of the total land area; much of the LANL land provides buffer areas for security and safety or is held in reserve for future use. The Laboratory has about 2,000 structures, with approximately 8.6 million square feet under roof, spread over an area of approximately 40 square miles.

DOE National Nuclear Security Administration (NNSA) issued a new Site-Wide Environmental Impact Statement (SWEIS) in May 2008 (DOE 2008a) and a limited Record of Decision (ROD) in September 2008 (DOE 2008b). In the SWEIS, LANL identified 15 Laboratory facilities as "Key Facilities" for the purposes of facilitating a logical and comprehensive evaluation of the potential environmental impacts of LANL operations (Table 1-1). Operations in the Key Facilities represent the majority of exposures associated with LANL operations. The facilities identified as "key" are those that house activities critical to meeting work assignments given to LANL and also:

- House operations that could potentially cause significant environmental impacts,
- Are of most interest or concern to the public based on scoping comments received, or
- Would be the facilities most subject to change as a result of programmatic decisions.

In the SWEIS, the remaining LANL facilities were identified as "Non-Key Facilities" because these facilities do not meet the above criteria. The Non-Key Facilities comprise all or the majority of 30 of LANL's 48 TAs and approximately 14,224 acres of LANL's 26,480 acres (Table 1-1). The Non-Key Facilities also currently employ about 42% of the total LANL workforce. The Non-Key Facilities include such important buildings and operations as the Nonproliferation and International Security Center (NISC), the new National Security Sciences Building (NSSB), which is now the main administration building, and the TA-46 sewage treatment facility.



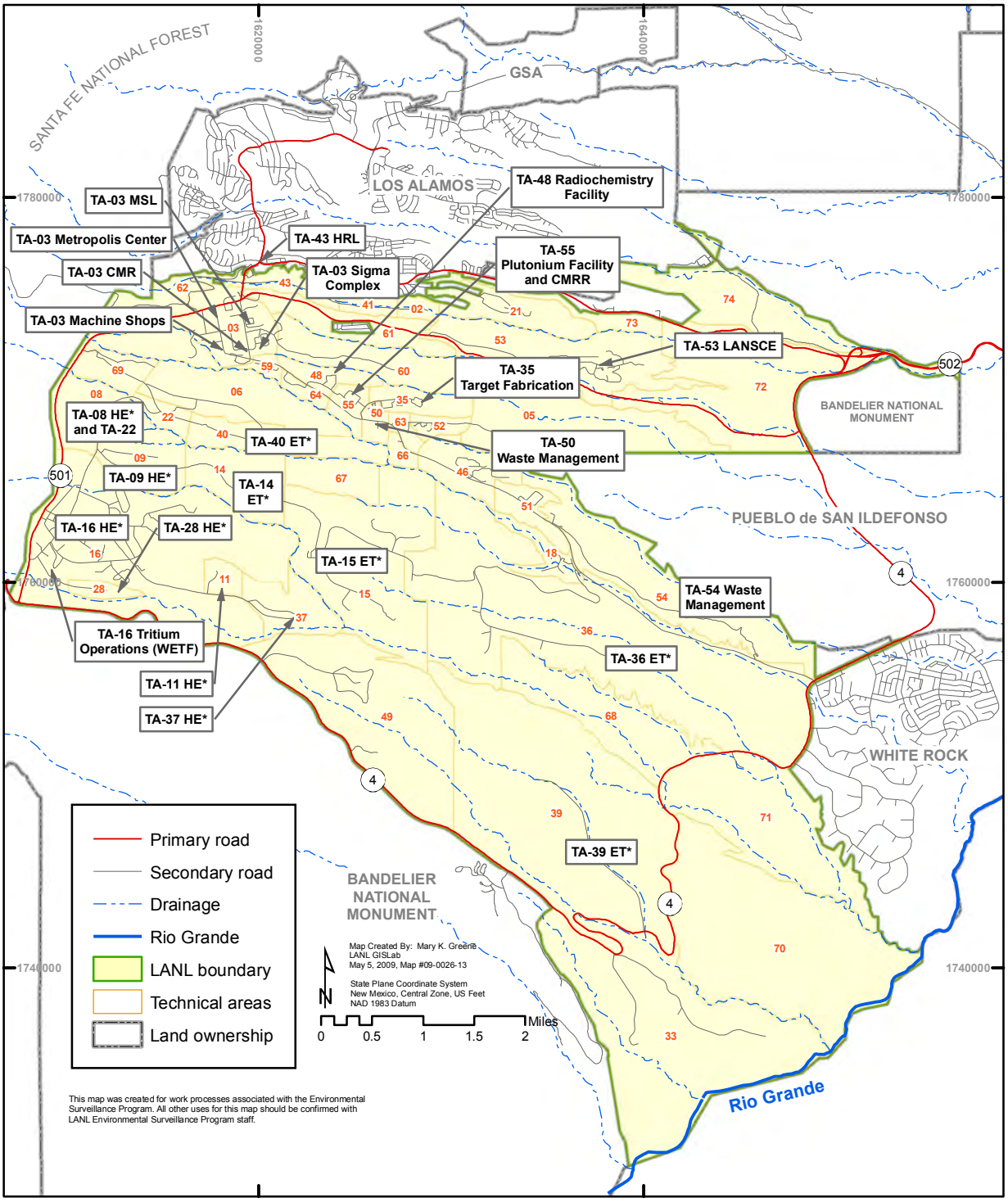


Figure 1-3. **Technical Areas and Key Facilities of Los Alamos National Laboratory in relation to surrounding landholdings (*ET = Explosive testing; HE = High explosive processing).**

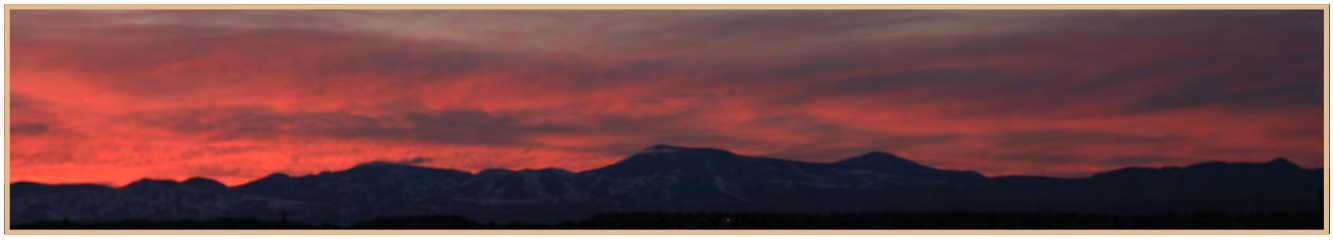


Table 1-1
Key Facilities*

Facility	Technical Areas
Plutonium Complex	TA-55
Tritium Facilities	TA-16
Chemistry and Metallurgy Research (CMR) Building	TA-03
Sigma Complex	TA-03
Materials Science Laboratory (MSL)	TA-03
Target Fabrication Facility (TFF)	TA-35
Machine Shops	TA-03
Nicholas C. Metropolis Center for Modeling and Simulation	TA-03
High-Explosives Processing	TA-08, -09, -11, -16, -22, -37
High-Explosives Testing	TA-14, -15, -36, -39, -40
Los Alamos Neutron Science Center (LANSCE)	TA-53
Biosciences Facilities (formerly Health Research Laboratory)	TA-43, -03, -16, -35, -46
Radiochemistry Facility	TA-48
Radioactive Liquid Waste Treatment Facility (RLWTF)	TA-50
Solid Radioactive and Chemical Waste Facilities	TA-50, TA-54

*Data from 2008 SWEIS.

D. MANAGEMENT OF ENVIRONMENT, SAFETY, AND HEALTH

Safety, environmental protection, and compliance with environmental, safety, and health (ES&H) laws and regulations are underlying values of all Laboratory work. The Laboratory uses ISM to create a worker-based safety and environmental compliance culture in which all workers commit to safety and environmental protection in their daily work. A seamless integration of ES&H with the work being done is fundamental to the compliance culture. ISM provides the Laboratory with a comprehensive, systematic, standards-based, performance-driven management system for setting, implementing, and sustaining safety performance and meeting environmental expectations. The term "integrated" is used to indicate that safety, protection of the environment, and compliance with ES&H laws and regulations are an integral part of how the Laboratory conducts its work. ISM is the way LANL meets the ethical commitment to avoid injury to people and the environment and the business imperative to meet the safety and environmental requirements of the contract for managing and operating the Laboratory.

Each Laboratory organization is responsible for its own environmental management and performance. Line management provides leadership and ensures ES&H performance is within the context of the Laboratory's values and mission. Laboratory managers establish and manage ES&H initiatives, determine and communicate expectations, allocate resources, assess performance, and are held accountable for safety performance.

Environmental characterization, remediation, surveillance, and waste management programs are part of the Environmental Programs (EP) Directorate. Environmental permitting, the environmental management system, pollution prevention, integrated environmental review, land transfer, the SWEIS, and other environmental risk reduction activities are managed within the Environmental Protection Division in the Environment, Safety, Health, and Quality (ESH&Q) Directorate. An organizational chart and description is available at http://www.lanl.gov/organization/. The major environmental programs and management system are described below.

1. Environmental Management System

The Laboratory is committed to protecting the environment while conducting its important national security and energy-related missions. DOE Order 450.1A, Environmental Protection Program, requires all DOE sites to "implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations and by which DOE cost-effectively meets or exceeds compliance with applicable environmental; public health; and resource protection laws, regulations, and DOE requirements." The order further states this objective must be accomplished by implementing an Environmental Management Systems (EMS) at each DOE site.

LANL has implemented a pollution-prevention-based EMS, meeting the DOE Order 450.1A requirement to have an EMS implemented by December 31, 2005.

An EMS is a systematic method for assessing mission activities, determining the environmental impacts of those activities, prioritizing improvements, and measuring results. DOE Order 450.1A defines an EMS as "a continuous cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental missions and goals." This DOE order mandates that the EMS be integrated with an existing management system already established pursuant to DOE Policy 450.4. Although it significantly exceeds DOE Order 450.1A requirements, LANL pursued and achieved registration to the ISO 14001-2004 standard in April 2006.

A key feature of the Laboratory EMS is the focus on ensuring that it is integrated with existing procedures and systems wherever possible. The intent is for the EMS to consolidate these existing programs into a systematic process for environmental performance improvement. The ISM provides an important foundation for the five core elements of the EMS:

The ISM provides an important foundation for the five core elements of the EMS:

1. Policy and Commitment
2. Planning
3. Implementation and Operation
4. Checking and Corrective Action
5. Management Review

More information about the EMS may be found at http://www.lanl.gov/environment/risk/ems.shtml.

The EMS met several milestones in 2009. Multi-disciplinary teams from each Directorate executed the EMS process. These organizations identified their activities, products, and services and their potential environmental aspects. They prioritized these aspects to determine which were significant and developed an Environmental Action Plan designed to prevent or eliminate the environmental risk associated with those aspects. A trained support person from the EMS Management Team, whose members were trained in ISO 14001:2004 systems, aided the Directorate teams.

All 15 Directorates completed the Directorate Environmental Action Plans. Together, these plans committed to nearly 600 environmental improvement and pollution prevention actions covering fiscal years 2006 and 2007. For fiscal years 2008 through 2009, an additional 424 improvements actions were implemented. In addition, new action plans were developed for implementation in 2010.

Certification to the ISO 14001-2004 standard requires extensive management review. External audits of the system have been conducted as follows:

- Kansas City Plant Pre-Audit, September 2004 (three auditors, three days)
- National Sanitation Foundation-International Strategic Registration, Ltd.(NSF-ISR, an independent third-party ISO 14001 registrar) Pre-Assessment, September 2005 (two auditors, three days)

- NSF-ISR Desk Audit, November 2005 (one auditor, two days)
- NSF-ISR Readiness Review, Phase 1 Audit, January 2006 (two auditors, three days)
- NSF-ISR Certification Audit, Phase 2 Audit, March 2006 (five auditors, five days)
- NSF-ISR Surveillance Audit 1, September 2006 (two auditors, three days)
- NSF-ISR Surveillance Audit 2, April 2007 (two auditors, three days)
- NSF-ISR Surveillance Audit 3, October 2007 (two auditors, three days)
- NSF-ISR Surveillance Audit 4, May 2008 (two auditors, three days)
- NSF-ISR Surveillance Audit 5, October 2008 (two auditors, three days)
- NSF-ISR Re-certification Audit, March 2009 (three auditors, five days)

These audits covered most of the Directorates and Divisions and all major support contractors and included interviews conducted from the Principal Associate Director level to individual staff and students chosen at random by the auditors. The auditors concluded that the Laboratory's EMS meets all the requirements of the ISO 14001-2004 standard with no major non-conformities and recommended that LANL maintain full certification. On April 13, 2006, LANL received full certification of its EMS to the ISO 14001-2004 standard. LANL was the first NNSA national laboratory and was the first University of California-operated facility to receive this distinction. In March, 2009, NSF-ISR conducted a thorough re-certification audit (as required by ISO 14001-2004) of the LANL EMS and found that all requirements for certification were met. The auditors also noted that there was significant evidence that the EMS was maturing as a management system and that significant risk reduction measures were in place and working.

NNSA and DOE recognized the success of the EMS management and the unique approach by giving the Laboratory the 2009 NNSA "Best in Class" Award and the "DOE E-Star" for the institutional improvements identified and implemented through the EMS from 2006 to 2008.

A second important component of the EMS is the institutional environmental stewardship and management support programs. These programs, described in the following sections, assist with the integration of job and work-specific evaluations and ensure natural and cultural resources are managed from a Laboratory-wide perspective.

2. Waste Management Program

Research programs that support the Laboratory's mission generate contaminated waste that must be properly managed to avoid risks to human health, the environment, or national security. Remediation of sites contaminated by past Laboratory operations also generates substantial volumes of waste. The Laboratory generates Resource Conservation and Recovery Act (RCRA) regulated waste, Toxic Substances Control Act regulated waste, low-level radioactive waste (both solid and liquid), mixed low-level waste, transuranic waste, administratively controlled waste, medical waste, New Mexico Special Waste, and sanitary solid and liquid waste. Certain wastes are treated and/or disposed of at the Laboratory, but most wastes are shipped off-site for treatment and final disposal.

The Laboratory's goal is to minimize hazardous and non-hazardous waste generation as much as is technically and economically feasible, as discussed in Section 3, *Pollution Prevention Program*, below. The Laboratory also strives to conduct waste management operations in a manner that maintains excellence in safety, compliance, environment, health, and waste management operations. This goal is accomplished through the following program tenets:

- Ensuring a safe and healthy workplace;
- Minimizing adverse impact to the general public;
- Minimizing adverse impact to the environment; and
- Ensuring compliance with all applicable laws, standards, and regulations governing environment, safety, and health.

LANL manages all waste management and disposal operations, except sanitary solid and liquid wastes, under its Environmental Programs Directorate. TA-54, Area G, managed by the Waste Disposition Project, is the Laboratory's primary solid radioactive and hazardous waste handling site. Thousands of drums of packaged transuranic waste are securely stored at this site awaiting transport to the DOE's Waste Isolation Pilot Plant (WIPP) near Carlsbad, NM. The site also receives, processes, and disposes of approximately 4,000 m^3 of low–level radioactive waste per year. In the past, wastes were often buried in or released to pits or trenches around the Laboratory; several of these areas, known as Material Disposal Areas (MDAs), have been remediated, and the remainder are either being investigated or undergoing remediation as discussed in Section 4, *Environmental Protection Programs,* below.

The Radioactive Liquid Waste Program manages the RLWTF at TA-50. The RLWTF treats approximately 1.6 million gal/year of radioactive liquid waste.

The Water Quality and RCRA Group in the Environmental Protection Division provides guidance and support to Laboratory waste generators on compliance with all waste handling requirements. Within the EP Directorate, both the Waste Disposition Project and the Waste and Environmental Services Division provide direct support to waste generators on specific aspects of waste packaging, waste acceptance criteria, and transportation of hazardous and radioactive wastes for proper treatment and disposal.

The Waste Disposition Project also operates the "Green is Clean Program" to reduce low-level radioactive waste generation through a waste segregation and verification program. Generators segregate clean waste from radioactive-contaminated waste and ship it to TA-54, Area G, for verification through a very sensitive radioactive measurement system.

3. Pollution Prevention Program

The Pollution Prevention (P2) Program implements waste minimization, pollution prevention, sustainable design, and conservation projects to enhance operational efficiency, reduce life-cycle costs of programs or projects, and reduce risks to the environment. Reducing waste directly contributes to the efficient performance of the Laboratory's national security, energy, and science missions. Specific P2 activities include the following:

- Collecting data and reporting on DOE P2 goals;
- Forecasting waste volume to identify P2 opportunities;
- Conducting P2 opportunity assessments for customer divisions;
- Providing technical support for pollution prevention;
- Funding specific waste reduction projects through the LANL Generator Set-Aside Fund Program;
- Supporting affirmative procurement efforts;
- Conducting an annual LANL P2 awards program to recognize achievements;
- Supporting sustainable design for the construction of new buildings; and
- Communicating P2 issues to the Laboratory community.

Pollution Prevention Projects in fiscal year 2009 yielded $6 million in savings to the Laboratory. The P2 Program received an overall performance rating of "Good" for fiscal year 2009. The P2 Program collectively avoided the generation of 3 cubic meters of transuranic waste; recycled or reduced 16.5 cubic meters of mixed low level waste; avoided 116,188 kg hazardous waste; reduced, reused or recycled 10,581 metric tons of solid waste; avoided 385 cubic meters of low level waste; eliminated 2,000,000 gallons of water use; diverted 241,000 liters of liquid waste from the Radioactive Liquid Waste Treatment Facility; eliminated 25,000 liters of high explosive waste water discharge; and avoided hundreds of labor hours.

The Pollution Prevention Program measures reductions in routine waste as part of prevention performance tracking and measurement per DOE guidance. Routine waste includes waste from ongoing processes and does not include waste from spills, clean-up, demolition and decommissioning, construction, or any material that is recycled. The rationale is that prevention measures are most successfully applied to ongoing processes rather than one-time or unplanned activities. Non-routine waste from clean up, demolition, and construction are generally larger than routine waste. However, the Pollution Prevention Program works with all waste generators to reduce unnecessary waste, routine or non-routine. Figures 1-4 and 1-5 show routine waste generation from 2004 through 2009. Waste generation, as a whole, does not always reflect the amount of prevention occurring at the site since reductions in one area may be offset by new waste-generating processes coming on-line. LANL continues to document significant waste reductions, even with new processes contributing new waste to the system. Note that radioactive and mixed waste is reported in volume and hazardous waste is reported in weight.

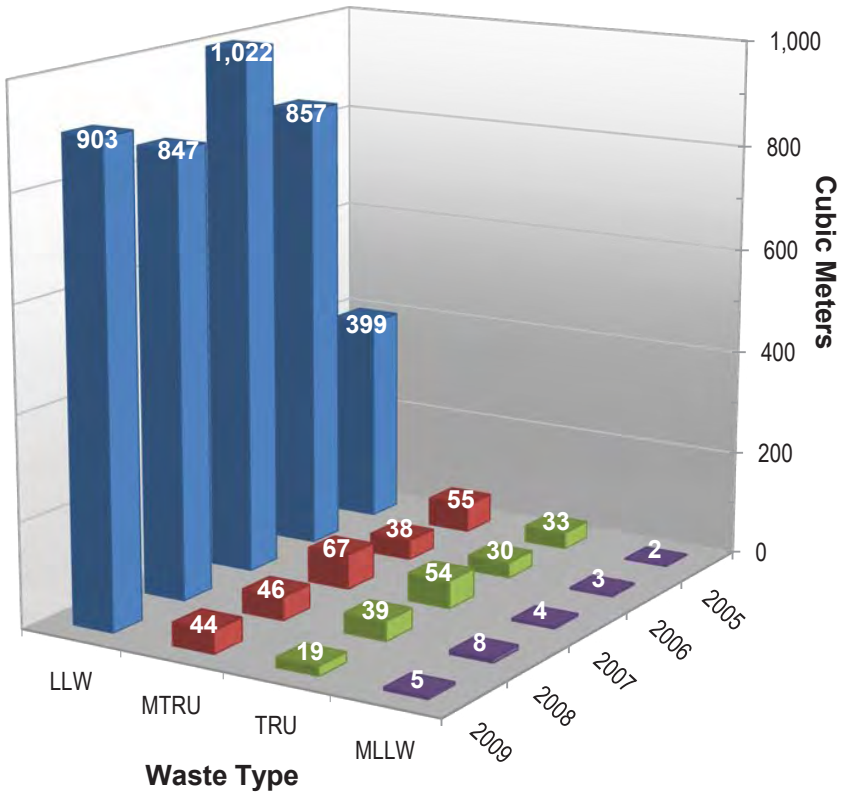


Figure 1-4. Cubic meters of low-level radioactive (LLW), mixed transuranic (MTRU), transuranic (TRU), and mixed low-level radioactive (MLLW) wastes generated at LANL for the past 5 years.

"Green purchasing" is mandated by an executive order and calls for considering environmental factors in purchasing decisions in addition to traditional factors such as performance, price, health, and safety. Green purchasing, also known as affirmative procurement, is procurement of products or services considered to be environmentally preferable, meaning those products that have a comparatively smaller negative effect on human health and the environment. The aim is to eliminate waste, prevent pollution, and improve the quality of the environment. In fiscal year 2009, the Laboratory continued to ensure that new contracts for office supplies and other goods and services included a strong emphasis on green product offerings.

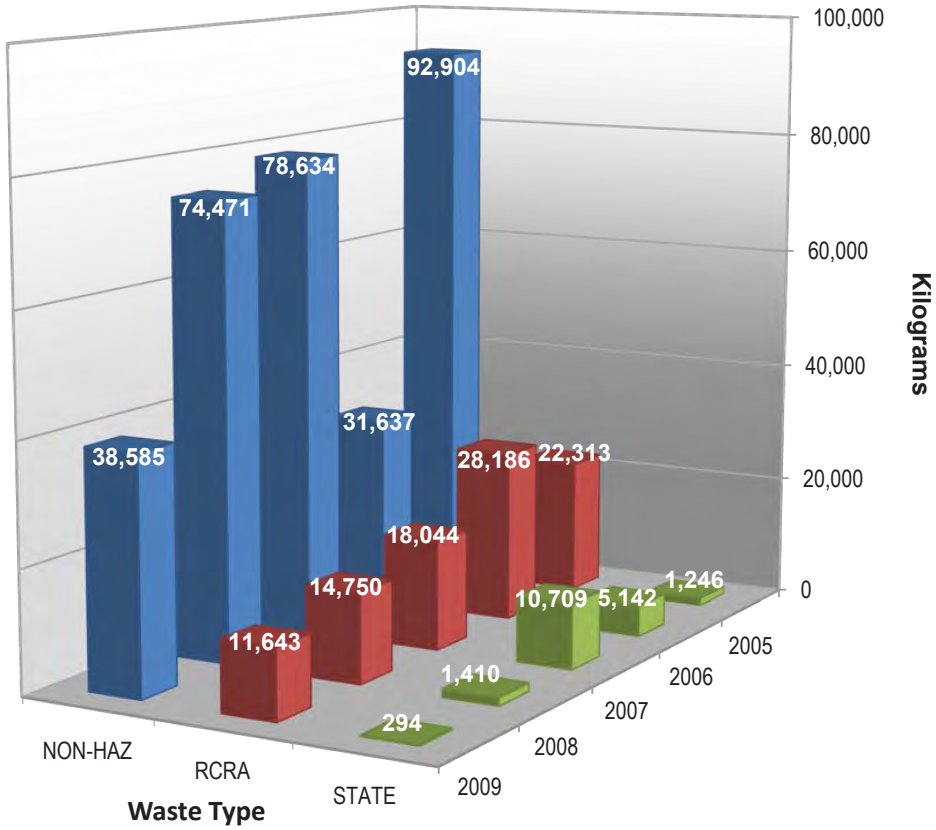


Figure 1-5. Kilograms of non-hazardous waste, RCRA-regulated waste, and NMED-regulated wastes generated at LANL for the past 5 years.

The Laboratory's P2 Program won four NNSA Pollution Prevention Awards for projects completed in 2009. The awards are based on an NNSA-wide competition and recognize major contributions in pollution prevention, recycling, and procurement. The awards affirm the importance and benefits of integrating pollution prevention into all NNSA sites' operations through environmental management systems. The actual award ceremony will be held in 2010. The NNSA Pollution Prevention Awards are summarized below.

- **RCRA-less Oxidation (NNSA Best in Class Award):** LANL developed the RCRA-less Oxidation approach to replace toxic RCRA-listed salts with non-toxic reagents for actinide separation schemes. RCRA-less Oxidation enables a 140-fold decrease in cost for waste treatment and disposal relative to other, standard oxidation methods. The process generates low level radioactive waste rather than mixed low-level radioactive hazardous waste. There is a three-fold decrease in cost of raw starting materials because silver salts are more expensive than their copper analogues.

- **Radiological Laboratory/Utility/Office Building (RLUOB) Integrated Planning, Design, Procurement, and Construction (NNSA Best in Class Award):** LANL uses the LEED® third-party rating system to document high performance sustainable design considerations and measure the level of sustainability that the RLUOB building achieves. Green design and implementation elements include sustainable site selection and development adjacent to programmatic facilities it will serve, construction with highly reflective roofing material to minimize the heat island effect, water efficiency, optimized energy performance, an indoor air quality management plan, and reduced environmental impact of materials and resources. Through September 2009, approximately 85% (by weight) of RLUOB construction waste including concrete, metal, corrugated cardboard, wood, and asphalt were recycled or reused and thereby diverted from disposal in landfills.

- **LANL's Electronic Recycling Program (NNSA Environmental Stewardship Award):** In the past, LANL disposed of computers by removing the hard drives and shredding and disposing of them through an out-of-state electronic recycler. The computer shell was then was released for sale to the public. LANL was concerned about management of materials sold to the public, especially in light of rising concerns about electronics recycling in third-world countries and associated pollution and public health issues. In addition, new memory device security requirements greatly expanded the types of electronic memory devices to include digital cameras, two-way radios, cell phones, and pagers, copiers, faxes, printers, PDAs, iPods, phones, thumb drives, as well as circuit boards, computers, and laptops. Property management staff improved the electronics disposal process to enhance security and closed the loop on all of LANL's salvaged memory devices, ensure proper cradle-to-grave management of LANL property through a zero-waste system and reduce the operation's overall carbon footprint. In 2009, LANL shipped 93,554 lbs of e-waste to a company at Terrell, Texas, where the electronics are crushed and recycled. The estimated savings for one year is $172,000. All of LANL's e-waste is recycled appropriately through this process.
- **Alternative Fuel Use at LANL (NNSA Environmental Stewardship Award):** In fiscal year 2009, a third of the LANL fleet could use E-85 fuel, an alcohol fuel mixture that typically contains up to 85% denatured fuel ethanol. At the end of 2009, one-half of LANL's fleet of vehicles was flex-fuel and 75% of the security officers' fleet in Los Alamos was powered by E-85. Since no local vendors have E-85 fuel available, LANL procured a mobile E-85 fuel transport truck that meets drivers of flex-fuel vehicles at a specified location for fueling. By using alternative fuels, LANL is meeting the intent of Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, which led to DOE Order 430.2B.

4. Environmental Restoration Programs

The environmental restoration and cleanup work at LANL is organized into several projects that have responsibility for different aspects of environmental restoration:

- Corrective Actions Program (includes investigations and remediations in canyons)
- TA-21 Closure Project
- TA-54 Closure Project

The goal of these programs is to ensure that residual contaminants from past Laboratory operations do not threaten human or environmental health and safety. To achieve this goal, the Laboratory is investigating and, as necessary, remediating sites contaminated by past Laboratory operations. In calendar year 2009, fieldwork at several sites was either implemented, ongoing, or completed. Much of the work under these projects is subject to the requirements in the New Mexico Environment Department's (NMED's) Compliance Order on Consent (Consent Order), described in Chapter 2, Section B.1h. Most environmental sample analyses (78%) were for characterization or assessment of sites being investigated or cleaned up at LANL (Table 1-2). Chapter 9 summarizes the cleanup work conducted or completed in calendar year 2009.

After sites have been remediated, long-term monitoring may be required as part of the chosen remedy solution. Such monitoring will eventually become part of the existing environmental surveillance programs and will fulfill DOE requirements for a long-term environmental stewardship program.

Table 1-2
Approximate Numbers of Environmental Samples, Locations, and Analytes Collected in 2009

Sample Type or Media	Locations	Samples	Analytes or Measurements
Ambient Air*	65	2,969	9,792
Stack Monitoring	28	2,761	22,266
Biota	79	168	5,242
Soil	80	156	8,028
Sediment	60	69	8,743
Foodstuffs	22	34	3,246
Groundwater	200	1,605	62,153
NPDES Outfalls	14	168	2,176
Surface Water Base Flow	30	123	16,394
Surface Water Storm Runoff	22	83	9,749
Neutron Radiation	47	188	188
Gamma Radiation	89	356	356
Environmental Restoration	2,849	5,551	766,499
Subsurface Vapor Monitoring	65	1,381	104,186
Totals:	**3,650**	**15,640**	**1,119,308**

Note: Not all the data counted in the table above are reported in this document. Totals include duplicate samples but do not include additional samples and results from extensive quality assurance/quality control program, which are normally 10% to 20% more but can be over 60% more, depending on the media.

* Does not include particulate (in air) measurements made by four Tapered Element Oscillating Microbalance instruments that calculated particulate concentrations every half hour.

5. Compliance and Surveillance Programs

LANL's environmental compliance and surveillance programs identify possible environmental hazards and impacts by regularly collecting samples and comparing results with previous results and applicable regulatory standards. The Laboratory routinely collects samples of air particles and gases, water, soil, sediment, foodstuffs, and associated biota from over 3,650 locations (Table 1-2).

All monitoring data collected at LANL is available through the RACER Data Analysis Tool (http://racernm.com/). This tool was developed to provide public access to the same data that NMED and LANL use in making remediation and other environmental management decisions.

In 2008, LANL and the local DOE office re-initiated the effort to pursue a natural resources damages assessment (NRDA) for LANL. The goal of the NRDA is to assess and recover monetary damages for injuries to natural resources (including air, surface water, groundwater, soils, and biota) that have resulted from the release of hazardous substances to the environment from the area of LANL. In 2009, the Trustee Council determined that the pre-assessment screen criteria have been met and it is appropriate to pursue a full scale assessment. See Chapter 2 of this document for more information.

Monitoring can detect and identify environmental impacts from hazardous and radioactive materials and data from monitoring can be used to help with mitigation of any impacts. To this end, each pathway by which an individual could be exposed is monitored. The sensitivity of environmental surveillance measurements allows for the detection of contaminants during cleanup or normal operations. Additional monitoring may be conducted in places where there is an increased potential for environmental releases. In some cases, immediate actions are warranted because of monitoring results. The various environmental monitoring programs are discussed below.

a. Air Quality Monitoring

The Laboratory maintains a rigorous ambient air surveillance and air quality compliance program for the emissions of both radionuclide and nonradionuclide air pollutants. The air monitoring and compliance efforts consist of three main parts: compliance and permitting, stack monitoring, and ambient air monitoring (AIRNET).

The Laboratory also works with and assists neighboring communities and pueblos in performing ambient air, direct penetrating radiation, and meteorological monitoring.

i. Compliance and Permitting

The Laboratory operates under a number of air emissions permits issued by the NMED and approvals for construction of new facilities or operations by the US Environmental Protection Agency (EPA). These permits and approvals require pollution control devices, stack emissions monitoring, and routine reporting.

LANS is authorized to operate applicable air emission sources at LANL per the terms and conditions as defined in Operating Permit No. P100 M2. As part of the Title V Operating Permit program, the Laboratory reports emissions from sources included in the Operating Permit twice a year. In 2008, the Laboratory submitted its new Title V permit application for a five-year renewal; the new permit was issued in 2009.

In addition, the Laboratory maintains compliance with Title VI of the Clean Air Act, which regulates the use of ozone-depleting substances, such as halons and refrigerants. The Laboratory maintains records on all work that involves refrigerants and the purchase, usage, and disposal of refrigerants.

To ensure compliance with the National Emission Standard for Hazardous Air Pollutants (NESHAP) for asbestos, the Laboratory conducted internal inspections of job sites and asbestos packaging approximately monthly. During 2009, the Laboratory had 17 major renovation or demolition projects that involved removal of asbestos. LANL also reports emissions from chemical use associated with research and permitted beryllium activities.

Chapter 2 of this report describes in greater detail these permits and the status of compliance; this information is also available online at http://www.lanl.gov/environment/air/.

ii. Stack Monitoring

As described in greater detail in Chapters 2 and 4, LANL rigorously controls and monitors stack emissions of radioactivity, as required by the Clean Air Act. Members of the Rad-NESHAP team at LANL evaluate these operations to determine potential impacts of the stack emissions on the public and the environment. This team continuously sampled 26 stacks at LANL for the emission of radioactive material to the ambient air. LANL categorizes its radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous activation products, (3) tritium, and (4) gaseous mixed activation products (GMAP).

During 2009, the off-site dose impact from LANL stack emissions was about 5.5% of the Clean Air Act standard for radionuclide emissions.

iii. Ambient Air Monitoring

The Laboratory operates an extensive network of ambient air quality monitoring stations (AIRNET) to detect other possible radioactive emissions (see Chapter 4). The network includes stations located on site, in adjacent communities, and in regional locations. These stations are operated to ensure that air quality meets EPA and DOE standards. These data are published in this report (see Chapter 4) and online at http://www.lanl.gov/environment/air/. During 2009, the AIRNET system did not detect any radionuclide concentrations of concern.

b. Water Resources Monitoring

The water resources monitoring and compliance efforts consist of three main parts: compliance and permitting, groundwater monitoring, and surface water monitoring.

i. Compliance and Permitting

The Laboratory's Water Quality and RCRA Group is responsible for all compliance and permitting functions related to the state Water Quality Act and federal Clean Water Act requirements. The group provides institutional expertise and implementation assistance for obtaining regulatory permits and maintaining compliance with all permit requirements. These functions include sampling, processing, and analyzing water and wastewater from treatment facilities; institutional coordination, integration, and communication of all wastewater resource-related monitoring and reporting activities; submitting permit applications, notices of intent to discharge, analytical data, and compliance documentation; interpretation of compliance with state and federal water quality laws and regulations; development of institutional standards and policy regarding water and wastewater with line organizations; and interaction with regulatory agencies, stakeholders, the public, and Native American pueblos on water quality or water resource management issues.

ii. Groundwater Monitoring

The LANL Water Stewardship Program manages and protects groundwater and surface water resources (see Chapters 5 and 6). The Laboratory conducts several activities to comply with the requirements of DOE orders, state and federal regulations, and the Consent Order.

Groundwater resource management and protection efforts at the Laboratory focus on (1) the regional aquifer underlying the plateau, (2) the shallow perched groundwater found within canyon alluvium, and (3) the perched groundwater at intermediate depths above the regional aquifer. The objectives of the Laboratory's groundwater programs are to determine compliance with liquid waste discharge requirements and to evaluate any impact from Laboratory activities on groundwater resources. This program includes environmental monitoring, resource management, aquifer protection, and hydrogeologic investigations.

The Los Alamos County water supply system contains no detected LANL-derived contaminants. At present, the major thrust of the water-monitoring program, being developed under the Consent Order with NMED, is directed toward estimating the prospective risk from contamination that may enter the drinking water in the future. One such activity is modeling to estimate the possibility of contaminants migrating from the surface through the vadose zone to the aquifer. Data show that plutonium, uranium, cesium, and strontium are tightly bound to the soil matrix and so will not migrate in measurable amounts. Tritium is more mobile, but due to dilution and long travel times to the regional aquifer compared with its approximately 12-year radioactive half-life, the activity of tritium in the regional aquifer is far below the drinking water standard. Thus, migration of radionuclides is not likely to be a problem, so attention is focused on migration of chemicals such as perchlorate, chromium, solvents, and high explosive residues.

LANL has drilled numerous monitoring wells over the past several years, and several more wells were drilled in 2009. These new wells will provide a better picture of the location and movement of contamination in the groundwater. Details of the new wells are provided in Chapter 2.

iii. Surface Water Monitoring

LANL's surface water protection efforts focus on monitoring surface water and stream sediment in northern New Mexico. The objectives of the surface water program are to address water pollution control compliance, environmental surveillance, watershed management, surface and ground water protection, drinking water quality protection, pesticide protection obligations, and public assurance needs. Samplers at more than 290 sites are set to collect samples when sufficient water is present during storm runoff events. The Laboratory analyzes samples for radionuclides, high explosives, metals, a wide range of organic compounds, and general chemistry.

c. Biological Monitoring

The LANL biological resources program focuses on assisting Laboratory projects and programs to comply with federal and state laws and regulations, DOE Orders, and LANL directives related to biological resources. LANL adopted a Biological Resources Management Plan in 2007. This document, along with LANL's 2005 revision of its Threatened and Endangered Species Habitat Management Plan, provides guidance for biological resources protection at LANL. The presence of federally listed species is monitored annually. In addition, the biological resources program is currently conducting an inventory of riparian habitats at LANL and is continuing a project to monitor state-listed species such as the Gray Vireo and Jemez Mountains Salamander.

LANL's Emergency Management and Response Division manages wildland fire, including fuels monitoring and treatment on LANL property. One of the lasting results of past wildfires in and around LANL has been a significant increase in a regional, multi-agency approach to managing wildland fire. In September 2007, the Laboratory adopted the Wildland Fire Management Plan, which provides a strategic program to manage risk associated with wildland fires (LANL 2007).

d. Soil, Foodstuffs, and Non-foodstuff Biota Monitoring

The Laboratory collects surface soil, foodstuffs, and non-foodstuffs biota from the Laboratory, perimeter communities (Los Alamos, White Rock, and surrounding pueblos), and regional (background) areas to determine whether Laboratory operations impact human health via the food chain and the environment. The Laboratory conducts these programs to comply with the requirements of DOE Orders and state and federal regulations. Samples of the various media are collected on a three-year rotating schedule and analyzed for radionuclides, heavy metals, and organic chemicals to determine concentrations and distribution in soil and potential uptake by plants, animals, and humans. Radiation doses to humans and biota (see Chapter 3) and changes in concentrations over time are also measured and analyzed. These data are published in Chapters 7 and 8 of this report and other Laboratory publications.

e. Radiation Monitoring

Gamma and neutron radiation is monitored by the direct penetrating radiation monitoring network (DPRNET) described in Chapter 4.

The largest source of direct radiation is TA-54, Area G, which is monitored at 33 DPRNET stations, all of which measure above-background intensities of neutron radiation. As discussed in Chapter 3, the all-pathway maximally exposed individual (MEI) is at the northern boundary of TA-54 and results primarily from neutrons. The neutron radiation is being reduced by removing the sources from Area G.

Though high radiation levels are not expected from TA-21 during the cleanup at that site, several new DPRNET stations were installed in 2006 along DP Road and State Road 502, between the potential sources at TA-21 and the public areas to the north and west.

Though not required for compliance purposes, the Laboratory operates 11 Neighborhood Environmental Monitoring Network (NEWNET) stations that measure gamma radiation levels at 15-minute intervals and post these data to the NEWNET website in near real time (http://newnet.lanl.gov/). Stations are located near the Laboratory boundary and in the nearby communities of Los Alamos, Pueblo de San Ildefonso, and Santa Clara Pueblo. The stations at East Gate and Mortandad Canyon are used to check the dose from LANSCE emissions. During 2009, the dose measured by NEWNET was 0.0 ±0.3 mrem. The data from these stations are available in real time on the NEWNET website and are not discussed further in this report.

f. Cultural Resources Protection

The Laboratory manages the diverse cultural resources according to the requirements of the National Historic Preservation Act and other federal laws and regulations concerned with cultural resources protection. Cultural resources include archaeological sites and associated artifacts, historic buildings and associated artifacts, and traditional cultural places of importance to Native American and other ethnic groups. Section 106 of the act requires federal agencies to take into account the effects of projects on historic properties and to allow review and comment by the State Historic Preservation Office and the Advisory Council on Historic Preservation. The Section 106 regulations outline a project review process that is conducted on a project-by-project basis.

The Laboratory has adopted a Cultural Resources Management Plan (LANL 2005b) as an institutional comprehensive plan that defines the responsibilities, requirements, and methods for managing its cultural properties. The plan provides an overview of the cultural resources program, establishes a set of procedures for effective compliance with applicable historic preservation laws, addresses land-use conflicts and opportunities, ensures public awareness of DOE's cultural heritage stewardship actions at LANL, and provides a 10-year road map that summarizes and prioritizes the steps necessary to manage these resources.

E. RISK AND HAZARD REDUCTION

The Laboratory is committed to reducing hazards and the associated risk to people and the environment. In some cases the risk is directly related to dose, which results from actual exposure to a radiological or chemical hazard. In this case, the risk is reduced by keeping the dose as low as reasonably achievable (ALARA). In other cases the risk depends on the probability of exposure in the future. For example, buried hazardous material may have little or no exposure under current conditions but may have an increased probability of exposure if the material is brought to the surface.

1. Estimation of Risk

Current risk is the risk of harm that might result from present-day conditions, whereas prospective risk is defined by the EPA as "the future risks of a stressor not yet released into the environment or of future conditions resulting from an existing stressor." The stressor or hazard could be a radionuclide or a chemical for which the potential risk is evaluated based on a reasonable exposure scenario.

An "acceptable" risk is determined by target levels defined by the regulatory authorities (EPA, NMED or DOE). These "acceptable" risks are less than a 10^{-5} (1 in 100,000) probability of cancer; a hazard index equal to 1.0 or less for noncancer-causing chemicals; and a dose of 15 mrem/yr or less for radionuclides. In keeping with the policy of maintaining all dose and risk as low as reasonably achievable, the Laboratory strives to reduce risk/dose to below these target levels whenever possible. For the MEI reported in Chapter 3 of this report, the calculated cancer risk from the estimated dose in 2009 was approximately 3×10^{-7} (a 3 in 10,000,000 chance of cancer).

To analyze risk, LANL uses environmental data, computer evaluation tools, and computer models. To evaluate potential risk based on material inventory buried or stored at a site, the Laboratory uses models such as the residual radioactivity (RESRAD) model (http://web.ead.anl.gov/resrad/), Hotspot (http://www.llnl.gov/nhi/hotspot/), and CAP88 (http://www.epa.gov/radiation/assessment/CAP88/index.html).

Prospective risk is also used in the evaluation of remediation and corrective measure options. Probabilistic models account for uncertainties. Prospective risk methods can also identify the additional data needed to determine the optimal decision, thus guiding data collection operations.

2. Examples of Risk Reduction

The following are examples of where the Laboratory is working to reduce risks.

a. TA-54, Area G, and MDA G

The transuranic waste disposition program expedites the disposal of legacy transuranic waste to WIPP in Carlsbad, NM. Area G stores radioactively contaminated waste and other contaminated materials in aboveground storage. MDA G is a subsurface disposal site containing potentially hazardous and radioactive

wastes from operational activities and from environmental restoration. Most of the waste will eventually be transported to permanent storage at WIPP in southern New Mexico.

As discussed in Chapter 3, the dose to the all-pathway MEI was about 1 mrem/yr in 2009. The primary method used to reduce both the current and prospective risk at Area G is to steadily reduce the inventory of transuranic waste by transporting drums of radioactive material to WIPP. Of the approximately 100,000 plutonium equivalent curies (PE-Ci) of radioactive materials in secure above-ground storage at Area G, the Laboratory shipped approximately 15,000 PE-Ci in 2,000 drums to WIPP in 2009. Additionally, the Laboratory disposed of approximately 100 drums of radioactive sealed sources, recovered by the Off-site Source Recovery Program, at WIPP.

b. TA-21

TA-21 is the site of the Laboratory's original plutonium processing facility, a tritium processing and handling facility, and several MDAs. The inventories of hazardous and radioactive material at the MDAs are not well characterized because there are few records of waste disposal during the 1940s and the Manhattan Project. MDAs V and U have been remediated; MDAs A and T have or will undergo corrective measures evaluations to determine the appropriate corrective actions; and MDA B is scheduled to be remediated. In addition, the other sites at TA-21 are being characterized or remediated as part of the DP Site Aggregate Area investigation.

c. Groundwater

As discussed in Chapter 5, Groundwater Monitoring, Laboratory-derived impacts to groundwater have been detected in some monitoring wells. At present, there is no measurable LANL-derived contamination in the Los Alamos County drinking water system, but there may be a prospective risk because of the potential for contamination to migrate to the drinking water supply wells. For the past several years, efforts have been underway to evaluate groundwater quality and augment the current monitoring network to ensure monitoring activities will detect contamination in groundwater before it can affect the drinking water. These investigations will help determine the actions to reduce the prospective risk.

d. Environmental Characterization and Restoration

The objective of the environmental investigation and cleanup activities at the Laboratory is to identify and characterize the nature of the contamination, the location and extent of the contamination, whether it requires remediation, and what type of remediation is appropriate. Over the past few years, the Laboratory has been conducting corrective action activities under the Consent Order.

In the past several years, the Laboratory has determined where contamination is present and in many cases has reduced the legacy contamination. Where contamination is present, the risk is quantified to determine whether it is unacceptable with respect to human health and the environment. Chapter 9 provides information about environmental investigation and cleanup activities in 2009.

F. REFERENCES

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2. Compliance Summary

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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 non-radioactive hazardous and/or radioactive materials. Laboratory policy implements US Department of Energy (DOE) requirements by directing employees to protect the environment and comply with all applicable federal and state environmental regulations. Federal and state environmental laws address: (1) handling, transporting, releasing, and disposing of contaminants and wastes; (2) protecting ecological, archaeological, historic, atmospheric, soil, and water resources; and (3) conducting environmental impact analyses. Regulations provide specific requirements and standards to ensure maintenance of environmental quality. The US Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) are the principal administrative authorities for these laws. Los Alamos National Security (LANS), LLC, operates LANL for the National Nuclear Security Administration (NNSA), an agency of DOE, and is a co-permittee, with DOE and/or NNSA, on all EPA- or NMED-administered permits. LANL/LANS and its subcontractors are also subject to DOE-administered requirements for control of radionuclides.

Table 2-1 presents the environmental permits or approvals the Laboratory operated under in 2009 and the specific operations and/or sites affected. Table 2-2 lists the various environmental inspections and audits conducted at the Laboratory during 2009. The following sections summarize the Laboratory's regulatory compliance performance during 2009.

B. COMPLIANCE STATUS

The Laboratory continues to meet requirements under the Clean Water Act (CWA). The year 2009 was the second complete year the Laboratory operated under the current National Pollutant Discharge Elimination System (NPDES) permit for industrial and sanitary waste water discharges (effective August 1, 2007). During 2009, none of the 76 samples collected from the Sanitary Wastewater Systems (SWWS) Plant's outfall exceeded CWA effluent limits. Only seven of the 1,361 samples collected from industrial outfalls exceeded effluent limits: three chlorine exceedances, two pH exceedances, one total suspended solids (TSS) exceedence, and one PCB exceedence. The overall inspection compliance rate for NPDES-permitted construction sites in 2009 was 99.2%, but the rate was 100% during the summer precipitation season.

The Laboratory was issued a renewed Clean Air Act (CAA) Title V Operating Permit on August 7, 2009. The new permit includes updates to information and language found in the previous permit. The permit is valid for a term of five years. The Laboratory continues to operate well below all CAA permit limits for emissions to the air.

Table 2-1
Environmental Permits or Approvals under which the Laboratory Operated during 2009

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
RCRA[a] Permit	Hazardous Waste Facility Permit: Permitted hazardous waste storage units: Technical Areas (TA)-50 and TA-54	November 1989	November 1999*	NMED[b]
	40 CFR 265 Standards: Interim Status hazardous waste storage and treatment facilities: TAs-3, -14, -16, -36, -39, -50, -54, and -55. Permit applications submitted to NMED.	Post-1980 hazardous waste units; Post-1991 mixed waste units	Inclusion in Hazardous Waste Facility Permit or closure	NMED
HSWA[c]	RCRA corrective activities	March 1990	December 1999*	NMED
Consent Order	Legacy and contaminated waste site investigations, corrective actions, and monitoring; revised to establish new notification and reporting requirements for groundwater monitoring data	March 1, 2005; revised June 18, 2008	September 20, 2015	NMED
CWA[d]/NPDES[e]	Outfall permit for the discharge of industrial and sanitary liquid effluents	August 1, 2007	July 31, 2012	EPA[f]
	MSGP[g] for the discharge of storm water from industrial activities	September 29, 2008	September 29, 2013	EPA
	Federal Facility Compliance Agreement for storm water discharges from Solid Waste Management Units (SWMUs)	February 5, 2005	Upon issuance of the Individual Permit (issued April 1, 2009)	EPA
	Construction General Permits (17) for the discharge of storm water from construction activities	June 30, 2008	July 31, 2011	EPA
CWA Sections 404/401	COE[h] Nationwide Permits (six)	NA	NA	COE/NMED
Groundwater Discharge Plan, TA-46 SWWS Plant[i]	Discharge to groundwater	July 20, 1992 Renewed January 7, 1998	January 7, 2003*	NMED
Groundwater Discharge Plan, TA-50, Radioactive Liquid-Waste Treatment Facility	Discharge to groundwater	Submitted August 20, 1996	Approval pending	NMED
Groundwater Discharge Plan, Domestic Septic Systems	Discharge to groundwater	Submitted April 27, 2006	Approval pending	NMED

Table 2-1 (continued)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
Air Quality Operating Permit (20.2.70 NMAC[j])	LANL air emissions Renewal 1	August 7, 2009	August 7, 2014	NMED
Air Quality Construction Permits (20.2.72 NMAC)	Portable rock crusher	June 16, 1999	None	NMED
	Retired and removed from operating permit	June 15, 2006		
	Permit number will remain active to track exempt sources at LANL			
	TA-3 Power Plant	September 27, 2000	None	NMED
	Permit revision	November 26, 2003		
	Permit modification 1, Revision 1	July 30, 2004		
	Permit modification 1, Revision 2	March 5, 2009		
	1600-kW Generator at TA-33	October 10, 2002	None	NMED
	Permit revision	May 28, 2008	None	NMED
	Two 20-kW Generators and one 225-kW generator at TA-33	August 8, 2007	None	NMED
	Asphalt Plant at TA-60	October 29, 2002	None	NMED
	Permit revision	September 12, 2006	None	NMED
	Data disintegrator	October 22, 2003	None	NMED
	Chemistry and Metallurgy Research Replacement (CMRR), Radiological Laboratory, Utility, Office Building	September 16, 2005	None	NMED
Air Quality (NESHAP[k])	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	February 11, 2000	None	NMED

[a] Resource Conservation and Recovery Act
[b] New Mexico Environment Department
[c] Hazardous and Solid Waste Amendments
[d] Clean Water Act
[e] National Pollutant Discharge Elimination System
[f] Environmental Protection Agency
[g] Multi-Sector General Permit
[h] US Army Corps of Engineers
[I] Sanitary Wastewater Systems Plant
[j] New Mexico Administrative Code
[k] National Emission Standards for Hazardous Air Pollutants

* Permit was administratively continued for all of 2009.
NA = Not applicable

Table 2-2
Environmental Inspections and Audits Conducted at the Laboratory during 2009

Date	Purpose	Performing Agency
07/13/09–07/15/09	NPDES Industrial Point Source Permit compliance evaluation Inspection	EPA
06/15/09–06/22/09	Hazardous waste compliance inspection	NMED
01/21/09–12/10/09	Hazardous waste compliance inspection	NMED
04/07/09–04/08/09	Toxic Substances Control Act PCB* Facility Compliance inspection	EPA
09/30/09	Title V Operating Permit compliance inspection	NMED

Note: No Federal Insecticide, Fungicide, and Rodenticide Act; Section 401/404; Construction General Permit; or Groundwater Discharge Plan compliance inspections were conducted in 2009.

* Polychlorinated biphenyls

The Laboratory continued to conduct corrective actions in accordance with the March 2005 Compliance Order on Consent (Consent Order). The NMED issued LANS and DOE a Notice of Violation (NOV) identifying two alleged violations noted during the 2009 RCRA compliance inspection, though a penalty was not assessed for these findings because the violations were adequately addressed during the inspection.

Self-inspections of RCRA hazardous and mixed waste compliance found a nonconformance rate of 3.07% (compared with 2.82% in 2008).

1. Resource Conservation and Recovery Act

a. Introduction

Laboratory operations produce a wide variety of hazardous wastes as a research facility. Wastes are generated primarily from research and development activities, processing and recovery operations, decontamination and decommissioning projects, and environmental restoration activities. Most of these waste streams are in small quantities compared with industrial facilities of comparable size because of the relatively diverse activities and the many research projects at the Laboratory.

RCRA, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, establishes a comprehensive program to regulate hazardous wastes from generation to ultimate disposal. The EPA has authorized the State of New Mexico to implement the requirements of the program, which it does through the New Mexico Hazardous Waste Act and regulations found in the New Mexico Administrative Code (NMAC) Title 20, Chapter 4, Part 1, as revised October 1, 2003.

The federal and state laws regulate management of hazardous wastes based on a combination of the facility's status, the quantities of waste generated, and the types of waste management conducted by the facility. Certain operations require a hazardous waste facility permit, often called a RCRA permit. The LANL hazardous waste facility permit was initially granted in 1989 for storage and treatment operations. It expired in 1999 but was administratively continued beyond the expiration date as allowed by 20.4.1.900 NMAC.

The Laboratory has submitted various permit applications for NMED review since 1996 to renew the hazardous waste facility permit. Permit modification packages have also been submitted to revise and update the waste management conditions and facilities contained in the original permit.

b. RCRA Permitting Activities

In 2007, NMED issued a draft for public comment on the renewal of the LANL hazardous waste facility permit. NMED received extensive comments from the Northern New Mexico Citizens' Advisory Board, the Embudo Valley Environment Monitoring Group, the Southwest Research and Information Center, the Natural Resources Defense Council, the Concerned Citizens for Nuclear Safety, Nuclear Watch New Mexico, the Pueblos de San Ildefonso and Santa Clara, the EPA, several private citizens, and the Laboratory. These comments were extensive and addressed many subjects contained in the draft permit including emergency

procedures, information availability, seismic considerations, financial assurance, open burning operations, and hazardous waste management unit decontamination, among others. All commenters who requested a hearing were invited to participate in NMED-mediated permit negotiations to resolve comments.

The negotiations were started in August 2008 and extended through 2009. The negotiations included information presentations, discussions and comment resolution that supported the development of a second revised draft permit. NMED issued the revised draft permit on July 6, 2009. Another public comment period for review of this draft remained open through the end of 2009. A public hearing regarding the draft permit was scheduled for early 2010.

On June 30, 2009, the Laboratory submitted a Class 1 permit modification transmittal for changes to the Contingency Plan in the original hazardous waste facility permit. The changes involved updating the list of emergency coordinators with new names, addresses, and phone numbers.

On September 30, 2009, the Laboratory submitted a Class 1 permit modification transmittal for additional changes to the Contingency Plan. These changes included updates for organization names and editorial revisions.

No hazardous waste management units at the Laboratory underwent full closure activities in 2009. Dome 226 was removed from the Pad 1 storage unit at TA-54 Area G in September of 2009 with notification to NMED. Storage activities will otherwise continue at the pad. In April and May 2009, the Laboratory submitted to NMED the new closure plans for all the hazardous waste management units that will be included in the renewed hazardous waste facility permit.

c. Other RCRA Activities

The compliance assurance program performed Laboratory self-assessments to determine whether hazardous waste and mixed waste are managed to meet the requirements of federal and state regulations, DOE orders, and Laboratory policy. The program communicated findings from these self-assessments to waste generators, waste-management coordinators, and waste managers who help line managers implement appropriate actions to ensure continual improvement in LANL's hazardous waste program. In 2009, the Laboratory completed 1,467 self-assessments with a nonconformance rate of 3.07%.

d. RCRA Compliance Inspection

From June 15, 2009, to June 22, 2009, NMED conducted a hazardous waste compliance inspection at the Laboratory (see Table 2-2). The Laboratory received two violations from this inspection. From December 1, 2009 to December 10, 2009, NMED conducted a hazardous waste compliance inspection at the Laboratory. The Laboratory received three potential findings from this inspection.

e. Site Treatment Plan

In October 1995, the State of New Mexico issued a Federal Facility Compliance Order to the DOE and the University of California, requiring compliance with the Site Treatment Plan (STP). On June 1, 2006, Los Alamos National Security, LLC (LANS) replaced UC as the operating contractor at LANL, and LANS assumed responsibility for compliance with the order. The plan documents the use of off-site facilities for treating and disposing of mixed waste generated at LANL and stored for more than one year. In 2009, the Laboratory shipped approximately 217 m^3 of STP-covered low-level mixed waste and approximately 300 m^3 of covered mixed transuranic waste for treatment and disposal.

f. Solid Waste Disposal

LANL sends sanitary solid waste (trash) and construction and demolition debris for transfer through the Los Alamos County Eco-Station on East Jemez Road. The DOE owns the property and leases it to Los Alamos County under a special-use permit. Los Alamos County operates this transfer station and is responsible for obtaining all related permits for this activity from the state. The transfer station is registered with the NMED Solid Waste Bureau. Laboratory trash sent to the transfer station in 2009 included 2,191 metric tons of trash and 554 metric tons of construction and demolition debris. Through LANL's recycling efforts in 2009, 3,242 metric tons of material was recycled and did not go to a landfill.

g. Hazardous Waste Report

The Hazardous Waste Report covers hazardous and mixed waste generation, treatment, and storage activities performed at LANL during calendar year 2009 as required by RCRA, under 40 CFR §262.41, Biennial Report. In 2009, the Laboratory generated about 357,000 kg of RCRA hazardous waste, approximately 66,135 kg of which was generated by corrective action activities at the Laboratory. The waste was recorded for more than 10,000 waste movements, treatment, or storage actions resulting in 471 Waste Generation and Management forms in the Hazardous Waste Report. The entire report is available on the Web at http://www.lanl.gov/environment/waste/docs/reports/2009_biennial_hwr_LA-UR-10-01462.pdf.

h. Compliance Order on Consent (Consent Order)

The Consent Order is an enforcement document that prescribes the requirements for corrective action at the Laboratory. The purposes of the Consent Order are (1) to define the nature and extent of releases of contaminants at, or from, the facility; (2) to identify and evaluate, where needed, alternatives for corrective measures to remediate contaminants in the environment and prevent or mitigate the migration of contaminants at, or from, the facility; and (3) to implement such corrective measures. The Consent Order supersedes the corrective action requirements previously specified in Module VIII of the Laboratory's Hazardous Waste Facility Permit and applies to Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) subject to RCRA and HSWA requirements, but not to sites that are regulated by DOE under the Atomic Energy Act, such as those containing or releasing radionuclides. The Consent Order does not apply to those SWMUs and AOCs that received "no further action" decisions from EPA when it had primary regulatory authority. A description of the Consent Order work done in 2009 is presented in Chapter 9 of this report.

In 2009, the Laboratory submitted 181 deliverables (plans and reports) required by the Consent Order on time to NMED (see Tables 9-1 and 9-2 in Chapter 9 of this report).

Figure 2-1 shows each aggregate area, as defined by the Consent Order, and indicates the status of LANL work in these aggregate areas as (1) scheduled activities complete, (2) scheduled activities in progress, or (3) scheduled activities pending. For those aggregate areas presented as scheduled activities complete in Figure 2-1, there are currently no scheduled field sampling campaigns, investigation reports, or corrective measures activities (as of June 2010). Aggregate areas listed as scheduled activities in progress include sites or areas where field sampling campaigns or corrective measure activities are currently being conducted, or investigation reports are being prepared or finalized. Aggregate areas listed as scheduled activities pending include sites or areas where field sampling campaigns have not yet started. Scheduled activities for four aggregate areas are complete, are in progress at nine aggregate areas, and are pending for 13 aggregate areas as of June 2010.

i. Notices of Violation

In October 2009, the NMED Hazardous Waste Bureau issued LANS and DOE an NOV identifying two alleged violations noted during the 2009 RCRA compliance inspection. A penalty was not assessed for these findings because it was determined that the violations were adequately addressed during the inspection, and no further action was required.

In May 2009, the NMED Hazardous Waste Bureau issued a demand for payment of stipulated penalties for the LANL report entitled Periodic Monitoring Report for Vapor-Sampling Activities at Material Disposal Area T. Penalties were assessed by NMED because the report did not contain all the monitoring data required by NMED and, therefore, was not in substantial compliance with the Consent Order. DOE and LANS paid stipulated penalties to NMED of $126,000 to settle the issue.

In May 2009, the NMED Hazardous Waste Bureau issued an NOV to DOE and LANS for failing to implement the requirements in the LANL report entitled Work Plan to Plug and Abandon Mortandad Canyon Wells Test Well 8 and MCOBT-4.4. The NOV was issued because DOE and LANS did not plug and abandon well MCOBT-4.4 by the date specified in the work plan. A settlement was reached and DOE paid NMED $1,300,000 to settle this issue.

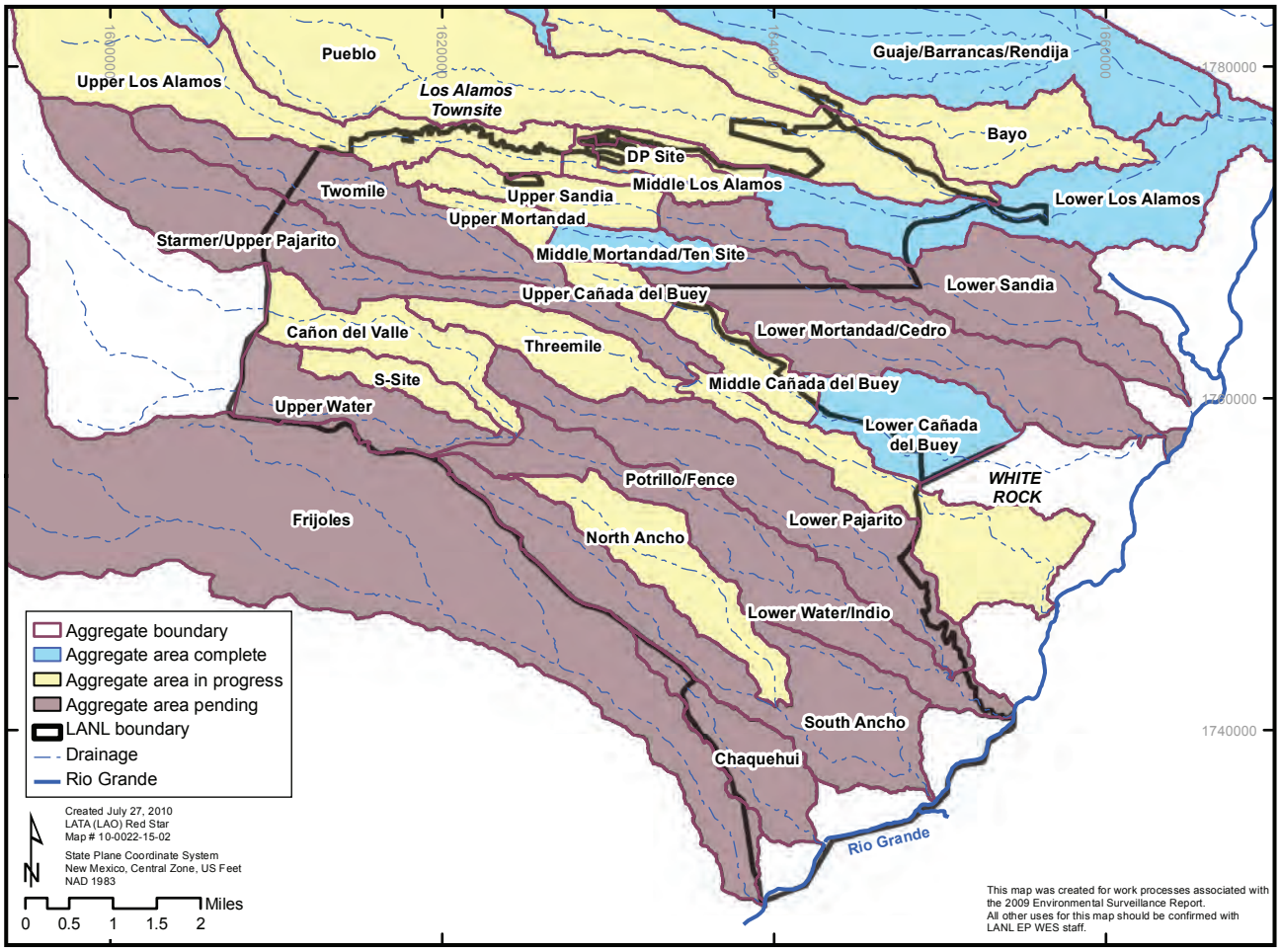

Figure 2-1. Aggregate areas as defined for the NMED Consent Order and their status. Status is shown as aggregrate area activities complete, activities in progress, or activities pending.

j. Other RCRA Non-compliances

The following waste storage or transportation violations were found during waste processing operations at LANL:

- Hazardous waste transferred from an accumulation area into storage at TA-54 was returned to the accumulation area and then back to TA-54 due to characterization issues.
- At TA-50-69, a waste drum failed a receipt inspection because of a small hole in the bottom of the drum. The drum was overpacked and processed through the facility.
- During repackaging processes at TA-54, Area G, an 85 gallon overpack drum was found to have a non-hazardous waste label while the drum within the overpack contained a hazardous waste label. The correct label was placed on the new container after repackaging.

There were no actual or potential hazards to the environment and human health outside the facility, and no material was lost or had to be recovered resulting from any of these incidents. None of these incidents required other reporting to the NMED under the LANL Hazardous Waste Facility Permit.

2. Comprehensive Environmental Response, Compensation, and Liability Act

a. Land Transfer

No properties were conveyed under Public Law 105-119 in 2009. The Environmental Baseline Survey Reports for A-13, the LASO Site; Tracts B-3, the Little Otowi Site; and A-10, DP Canyon were transmitted to and accepted by LASO in fiscal year 2009. These reports satisfy the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 120(h) requirements for environmental disclosure in federal real property transfers.

b. Natural Resource Damage Assessment

Under a memorandum of agreement established in 2008, the DOE and several other federal, state, and tribal entities in the region continued to work towards completing a natural resources damages assessment (NRDA) for LANL. Participating entities include the DOE, the Department of Interior, the Department of Agriculture, the State of New Mexico, and the Pueblo de San Ildefonso (collectively known as Trustees). The governing regulations include the CWA, the Oil Pollution Act of 1990, the DOE Organization Act, CERCLA, and the New Mexico Natural Resources Trustee Act.

The Trustees may assess and recover monetary damages for injuries to natural resources (including air, surface water, groundwater, soils, and biota) that have resulted from the release of hazardous substances to the environment from the area of LANL. Damages may include the cost of restoring the injured resources to their baseline condition (i.e., the condition that would have existed but for the release) as well as the value of interim losses pending restoration. Damages are used to restore, rehabilitate, replace, or acquire the equivalent of services provided by injured natural resources.

Using Department of Interior guidance for cooperative implementation of NRDA, the LANL Natural Resource Trustee Council completed a pre-assessment screen in November 2009. The pre-assessment screen is the initial step in the NRDA process and provides a rapid review of readily available information on hazardous substance releases and the potential impacts of those releases on natural resources. The pre-assessment screen has been used to determine whether there is a reasonable probability of making a successful claim before efforts are expended in carrying out a full-scale assessment. The Trustee Council determined that the pre-assessment screen criteria have been met and it is appropriate to pursue a full-scale assessment. In December 2009, the Trustee Council began developing a statement of work for a DOE contract that will be used to develop an assessment plan for the full-scale assessment.

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

a. Introduction

The Laboratory is required to comply with the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 and Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management.

b. Compliance Activities

For 2009, the Laboratory submitted reports to fulfill its requirements under EPCRA, as shown in Table 2-3 and described below.

i. Emergency Planning Notification

Title III, Sections 302–303, of EPCRA require 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 (1) if any changes at the Laboratory might affect the local emergency plan or (2) if the Laboratory's emergency planning coordinator changes. No updates to this notification were made in 2009.

Table 2-3
Compliance with Emergency Planning and Community Right-to-Know Act during 2009

Statute	Brief Description	Compliance
EPCRA Sections 302–303 Planning Notification	Requires emergency planning notification to state and local emergency planning committees.	No changes to the notification have been made since the July 30, 1999, notification and an update in 2000.
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.	No leaks, spills, or other releases of chemicals into the environment required EPCRA Section 304 reporting during 2009.
EPCRA Sections 311–312 Material Safety Data Sheets 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 20 hazardous materials stored at LANL over specified quantities in 2009 required submittal of a hazardous chemical inventory to the State Emergency Response Commission and the Los Alamos County Fire and Police Department.
EPCRA Section 313 Annual Toxic Release Inventory	Requires all federal facilities to report total annual releases of listed toxic chemicals used in quantities above reportable thresholds.	Laboratory use of lead exceeded the reporting thresholds in 2009, requiring submittal of Toxic Chemical Release Inventory Reporting Forms (Form Rs) to the EPA and the State Emergency Response Commission.

ii. Emergency Release Notification

Title III, Section 304, of EPCRA requires facilities to provide emergency release notification of leaks, spills, and other releases of listed chemicals into the environment if these chemicals exceed specified reporting quantities. 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 chemicals into the environment required EPCRA Section 304 reporting during 2009.

iii. Material Safety Data Sheet/Chemical Inventory Reporting

Title III, Sections 311–312, of EPCRA require facilities to provide an annual inventory of the quantity and location of hazardous chemicals above specified thresholds present at the facility. The inventory includes hazard information and the storage location for each chemical. The Laboratory submitted a report to the State Emergency Response Commission and the Los Alamos County Fire and Police Departments listing 20 chemicals and explosives at the Laboratory stored on site in quantities that exceeded reporting threshold limits during 2009.

iv. Toxic Release Inventory Reporting

Executive Order 13423 requires all federal facilities to comply with Title III, Section 313, of EPCRA. This section requires reporting of total annual releases to the environment of listed toxic chemicals that exceed activity thresholds. Beginning with reporting year 2000, new and lower chemical-activity thresholds were put in place for certain persistent, bioaccumulative, and toxic chemicals and chemical categories. The thresholds for these chemicals range from 0.1 g to 100 lb. Until this change went into effect, the lowest threshold was 10,000 lb. LANL operations exceeded the threshold for use of lead in 2009 and therefore was required to report the uses and releases of this chemical. The largest use of reportable lead is at the on-site firing range where security personnel conduct firearms training. Table 2-4 summarizes the reported releases in 2009.

Table 2-4
Summary of 2009 Reported Releases under EPCRA Section 313

	Lead (lb)
Air Emissions	5.42
Water Discharges	0.065
On-Site Land Disposal	5.001
Off-Site Waste Transfers	9,779

4. Toxic Substances Control Act

Because the Laboratory's activities are research and development (R&D) rather than the manufacture of commercial chemicals, the Laboratory's main concerns under the Toxic Substances Control Act (TSCA) are the regulations covering polychlorinated biphenyls (PCBs) and the import/export of R&D chemical substances. The PCB regulations govern substances including, but not limited to, dielectric fluids, contaminated solvents, oils, waste oils, heat-transfer fluids, hydraulic fluids, slurries, soil, and materials contaminated by spills.

During 2009, the Laboratory shipped 263 containers of PCB waste off site for disposal or recycling. The quantities of waste disposed of included 1,941 lb (880.5 kg) of capacitors and 2,605 lb (1,181.6 kg) of fluorescent light ballasts. The Laboratory manages all wastes in accordance with 40 Code of Federal Regulations (CFR) 761 manifesting, record keeping, and disposal requirements. PCB wastes go to EPA-permitted disposal and treatment facilities. Light ballasts go off-site for recycling. The primary compliance document related to 40 CFR 761.180 is the annual PCB document log that the Laboratory maintains on file for possible inspection by EPA Region 6. The renewal request for the Area G PCB disposal authorization was withdrawn in 2006. During 2009, EPA did not perform a PCB site inspection. Approximately 23 TSCA reviews were conducted on imports and exports of chemical substances for the Laboratory's Property Management Group Customs Office. One TSCA Section 12b export notification letter was sent to EPA for the export of a TSCA-regulated substance to the Federal Republic of Germany.

5. Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates the manufacturing of pesticides and protection of workers who use these chemicals. Sections of this act that apply to the Laboratory include requirements for certification of workers who apply pesticides. The New Mexico Department of Agriculture has the primary responsibility to enforce pesticide use under the act. The New Mexico Pesticide Control Act applies to the licensing and certification of pesticide workers, record keeping, equipment inspection, as well as application, storage, and disposal of pesticides.

The New Mexico Department of Agriculture did not conduct assessments or inspections of the Laboratory's pesticide application program in 2009. The Laboratory conducted four quarterly inspections of the pesticide storage area in 2009 and found that the storage area was maintained in accordance with FIFRA regulations.

Table 2-5 shows the amounts of pesticides and herbicides the Laboratory used in 2009.

Table 2-5
Herbicides and Pesticides Used at LANL in 2009

Herbicides	Amount
Velpar L (Liquid)	127.5 gal
Roundup (PRO liquid)	12 oz
Insecticides	**Amount**
Advion ANT Bait granular	16.75 oz
Advion ANT Bait (Gel)	7 oz
Prescription Treatment (PT) P.I. Contact	2 oz
Prescription Treatment (PT) Wasp Freeze	24 oz
Maxforce Ant Bait (granular)	6 oz
Tempo 20 WP	6 oz
Tempo WP Ultra	15 oz
Fertilizers	**Amount**
16-8-8 all season	100 lbs
18-5-9 w/herbicide	500 lbs
Color Marker	**Amount**
Blazon (Liquid)	5 gal
Water Treatment Chemicals	**Amount**
Fresh Airs	34.4 lbs
Garrat-Callahan 314T	3,285 lbs
Garrat-Callahan 315	5.5 gal
Garrat-Callahan 316	20 packs
Sump Buddy	99.5 lbs

6. Clean Air Act

Through the federal Clean Air Act Amendments and NMAC 20.2.70 Operating Permits, LANS is authorized to operate applicable air emission sources at LANL. The Laboratory was issued Operating Permit No. P100 in April 2004. The term of this permit was five years, so an application to renew the permit was submitted to NMED in April 2008. The renewed permit, P100R1, was issued in August 2009. This permit provides the terms and conditions that must be followed in order to operate the applicable air emission sources. The operating permit conditions are a collection of existing source-specific permit conditions that address operation, record keeping, monitoring, and reporting. By complying with the conditions of the Title V Operating Permit, the Laboratory is deemed to be in compliance with all applicable air requirements existing at the date of permit issuance.

As part of the Title V Operating Permit program, LANL reports the emissions from sources included in the Operating Permit to NMED twice a year. These sources include multiple boilers and electric generators, a power plant, a combustion turbine generator, a data disintegrator, two carpenter shops, a degreaser, and an asphalt plant. LANL also reports emissions from chemical use associated with R&D and permitted beryllium activities.

The Title V Operating Permit requires the Laboratory to submit an Annual Compliance Certification to NMED. In the 2009 Compliance Certification, the Laboratory reported one permit deviation. The deviation involved a new permit condition in the renewed Title-V Operating Permit. The condition required the use of a data logger to monitor the differential pressure across the baghouse filters and the time period the rotary dryer drum operates on the asphalt plant. The data logger was in the process of being installed when the permit was issued in August 2009. Due to the need for custom chart paper and availability of electricians to install the unit, the data logger was not fully installed and operational until September 2009.

LANL demonstrated full compliance with all other applicable air permit terms and conditions and met all required reporting deadlines during 2009.

In 2009, LANL requested and received a revision to New Source Review (NSR) permit 2195B. The revision replaced a combustion turbine monitoring requirement to perform periodic emission calculations with an annual emissions test using a portable analyzer. This permit revision was issued on March 5, 2009.

In 2009, LANL provided the first greenhouse gas emissions report to NMED, as required by NMAC 20.2.87. The 2008 emissions of CO2 (reported in 2009) were approximately 57,430 metric tons of carbon dioxide equivalents from the combustion of fossil fuels. For the 2009 reporting year, LANL will include methane emissions to the annual report. For 2010 and beyond, all listed greenhouse gasses will be reported. The State of New Mexico and the DOE have set aggressive goals to reduce greenhouse gas emissions; the data submitted in the annual emission reports will be used to track progress made towards these goals.

Under the Title V Operating Permit program, LANL is considered a major source of pollutants, based on the potential to emit NOX, CO, and volatile organic compounds (VOCs). In 2009, the TA-3 power plant and boilers located across the Laboratory were the major contributors of NOX, CO, and particulate matter (PM). R&D activities were responsible for most of the VOC and hazardous air pollutant emissions. Table 2-6 summarizes these data.

Table 2-6
Calculated Emissions of Regulated Air Pollutants Reported to NMED in 2009

	Pollutants[a], tons					
Emission Units	**NO_x**	**SO_x**	**PM**	**CO**	**VOC**	**HAPs**
Asphalt Plant	0.03	0.003	0.02	1.01	0.005	0.005
TA-3 Power Plant (3 Boilers)	14.2	0.15	1.9	9.8	1.35	0.46
TA-3 Power Plant (Combustion Turbine)	0.35	0.02	0.05		0.02	0.01
Regulated Boilers	5.8	0.04	0.5	3.9	0.33	0.11
R&D Chemical Use	NA[b]	NA	NA	NA	10.4	4.4
Degreaser	NA	NA	NA	NA	0.02	0.02
Data Disintegrator	NA	NA	0.05	NA	NA	NA
Carpenter Shops	NA	NA	0.06	NA	NA	NA
Stationary Standby Generators[c]	5.1	0.17	0.22	1.2	0.22	0.002
Miscellaneous Small Boilers[c]	19.7	0.12	1.50	16.6	1.10	0.37
TA-33 Generators (4 units)	1.39	0.18	0.06	0.93	0.04	<0.001
TOTAL	46.57	0.68	4.36	33.51	13.49	5.38

[a] NOx = nitrogen oxides; SOx = Sulfur oxides; PM = particulate matter; CO = carbon monoxide; VOC = volatile organic compounds; HAPs = hazardous air pollutants.
[b] NA = Not applicable.

LANL staff calculates air emissions using emission factors from source tests, manufacturer's data, and EPA documents. Calculated emissions are based on actual production rates, fuel usage, and/or material throughput. To satisfy requirements found in NMAC 20.2.73, Notice of Intent and Emissions Inventory Requirements, and the Title V Operating Permit, LANL submits an annual Emissions Inventory Report and semi-annual Emissions Reports, respectively, to NMED. Figure 2-2 depicts a five-year history of criteria pollutant emissions. Emissions from 2005 through 2009 are very similar and remain relatively constant.

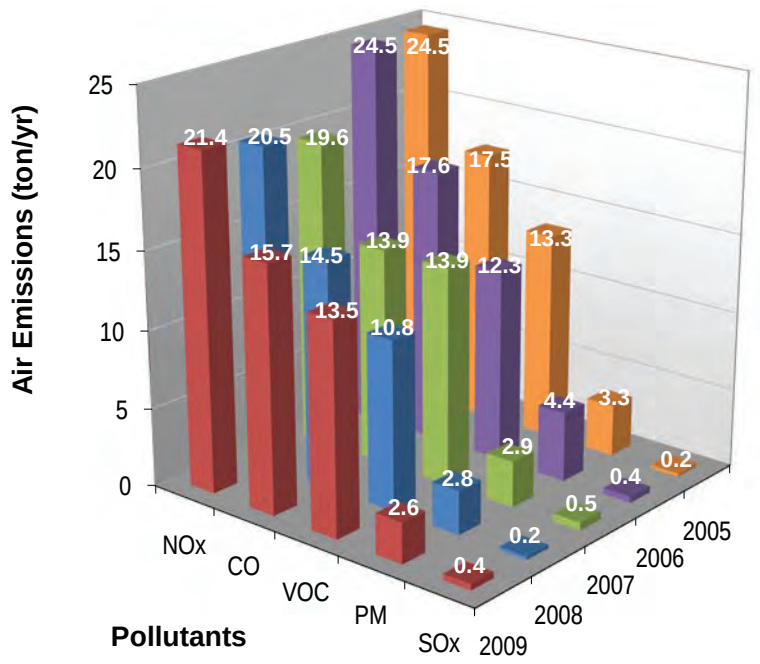

Figure 2-2. **LANL criteria pollutant emissions from 2005 through 2009 for annual emissions inventory reporting. Totals from the emissions inventory report do not include small boilers or standby generators.**

a. New Mexico Air Quality Control Act

i. Permits

LANL reviews plans for new and modified projects, activities, and operations to identify all applicable air quality requirements including the need to apply for construction permits or to submit notifications to NMED. During 2009, the Laboratory received an NSR air quality permit revision for the combustion turbine located at TA-3. No NSR permit applications were submitted in 2009. The Title V Operating Permit was renewed and issued by NMED in August 2009. The Laboratory operated under the existing Title V permit P100-M2 until the new permit was issued. LANL submitted two exemption notifications to NMED during 2009. The exemptions were for small boilers and small generators. During 2009, LANL operated under the air permits listed in Table 2-1.

ii. Open Burning

LANL may perform open burning under 20.2.60 NMAC (Open Burning) or 20.2.65 NMAC (Smoke Management) to thin vegetation and reduce the threat of fire. LANL did not perform any open burning during 2009.

iii. Asbestos

The National Emission Standard for Hazardous Air Pollutants (NESHAP) for Asbestos requires that LANL provide advance notice to NMED for large renovation jobs that involve asbestos and for 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. In 2009, 17 large renovation and demolition projects were completed. NMED was provided advance notice on each of these projects. These projects, combined with other smaller activities, generated approximately 73 m^3 of asbestos waste that was properly packaged and disposed of at approved landfills.

To ensure compliance, the Laboratory conducted internal inspections of job sites and asbestos packaging approximately monthly.

b. Federal Clean Air Act.

i. Ozone-Depleting Substances

Title VI of the CAA contains specific sections that establish regulations and requirements for ozone-depleting substances (ODS), such as halons and refrigerants. The main sections applicable to the Laboratory prohibit individuals from knowingly venting or otherwise releasing into the environment any refrigerant or refrigerant substitute during maintenance, repair, service, or disposal of halon fire-suppression systems and air-conditioning or refrigeration equipment. All technicians who work on refrigerant systems must be EPA-certified and must use certified recovery equipment. The Laboratory is required to maintain records on all work that involves refrigerants and the purchase, usage, and disposal of refrigerants. The Laboratory's standards for refrigeration work are covered under Criterion 408, "EPA Compliance for Refrigeration Equipment," of the LANL Operations and Maintenance Manual.

The Laboratory continued eliminating the use of Class I and Class II ODS. Class I and Class II ODS are the refrigerants that have high ozone-depleting potentials. In 2008, the Laboratory removed approximately 817 pounds of Class II ODS from the active inventory.

ii. Radionuclides

Under the NESHAP regulations, which regulate the air emissions of radionuclides other than radon from facilities owned or operated by the DOE, the EPA limits to 10 mrem/yr the effective dose equivalent of airborne releases of radioactive material from a DOE facility, such as LANL, to any member of the public. The 2009 annual dose to the maximally exposed individual (MEI) (as calculated using EPA-approved methods) was 0.55 mrem. The location of the highest dose was the East Gate area near the eastern edge of Los Alamos County. Emissions of radioactive gases from the Los Alamos Neutron Science Center (LANSCE) accelerator facility contributed over half of this dose; the remainder came from other Laboratory stack emissions and environmental cleanup work. See Chapter 4 for more information about these emissions.

7. Clean Water Act

a. NPDES Industrial Point Source Outfall Self-Monitoring Program

The primary goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The act established the requirements for NPDES permits for point-source effluent discharges to the nation's waters. The NPDES outfall permit establishes specific chemical, physical, and biological criteria that the Laboratory's effluent must meet before it is discharged.

LANS and DOE/NNSA are co-permittees of the NPDES permit covering Laboratory operations. EPA Region 6 in Dallas, Texas, issues and enforces the permit. NMED certifies the EPA-issued permit and performs some compliance-evaluation inspections and monitoring for the EPA. During 2009, the Laboratory's industrial point-source NPDES permit contained 15 permitted outfalls that include one sanitary outfall and 14 industrial outfalls (Table 2-7). To facilitate full compliance with the requirements in the current permit, the Laboratory is planning to eliminate outfalls and to add additional treatment technologies. The Laboratory's NPDES permit is available online at http://www.lanl.gov/environment/h2o/permits.shtml?1.

Table 2-7
Volume of Effluent Discharge from NPDES Permitted Outfalls in 2009

Outfall Number	TA-Bldg	Description	Watershed (Canyon)	2009 Discharge (gal.)
02A129	21-357	TA-21 Steam Plant	Los Alamos	0
03A048	53-963/978	LANSCE Cooling Tower	Los Alamos	17,448,500
051	50-1	TA-50 Radioactive Liquid Waste Treatment Facility	Mortandad	1144,565
03A021	3-29	CMR Building Air Washers	Mortandad	0
03A022	3-2238	Sigma Cooling Tower	Mortandad	589,298
03A160	35-124	National High Magnetic Field Laboratory Cooling Tower	Mortandad	101,496
03A181	55-6	Plutonium Facility Cooling Tower	Mortandad	1,208,507
13S	46-347	Sanitary Wastewater Treatment Plant	Sandia	85,289,000
001	3-22	Power Plant (includes treated effluent from Outfall 13S)	Sandia	85,351,581
03A027	3-2327	Strategic Computing Complex Cooling Tower	Sandia	16,146,800
03A113	53-293/952	LANSCE Cooling Tower	Sandia	342,085
03A199	3-1837	Laboratory Data Communications Center	Sandia	10,079,880
03A130	11-30	TA-11 Cooling Tower	Water	3,021
03A185	15-312	DARHT Cooling Tower	Water	876,318
05A055	16-1508	High Explosives Wastewater Treatment Facility	Water	0
			2009 Total:	**133,292,051**

The Laboratory's current NPDES outfall permit requires weekly, monthly, quarterly, and yearly sampling to demonstrate compliance with effluent quality limits. The Laboratory reports analytical results to EPA and NMED at the end of the monitoring period for each respective outfall category. During 2009, none of the 76 samples collected from the SWWS Plant's outfall exceeded effluent limits; however, seven of the 1,361 samples collected from industrial outfalls exceeded effluent limits (described below). Monitoring data obtained from sampling at NPDES permitted outfalls are in Supplemental Data Table S2-1 and S2-2 (on included compact disc) and available online at http://racernm.com/.

The following is a summary of the corrective actions the Laboratory has taken during 2009 to address the NPDES outfall permit noncompliance cited above.

- **TA-50 RLWTF Outfall 051.** On February 4, 2009, during a discharge, a pH measurement of 5.7 standard units (su) was outside the acceptable range of 6.0–9.0 su. The pH meter at the sample sink (used as a final pH check of effluent tank contents prior to starting the discharge pump) had not been calibrated in approximately six weeks. The pH reading from this meter was 6.38 su, which met operational requirements for start of the discharge pump. While the discharge was in progress, a grab sample was collected to be analyzed for pH and total residual chlorine (using properly calibrated instruments) for NPDES compliance reporting. The pH of the compliance sample was 5.7 su. pH measurements must now be taken with the meter used for compliance monitoring which is calibrated at a minimum once each week. The procedure revision changes acceptable pH limits to 6.9 to 8.1 for treated water prior to discharge.
- **TA-3 LDCC Outfall 03A199.** During a discharge on February 4, 2009, pH was measured at 8.9 su, which is outside the acceptable range of 6.6 to 8.8 su for Outfall 03A199. Investigations revealed that a plugged strainer on the conductivity meter resulted in the cooling tower not blowing down as anticipated. The strainer was cleaned and the cooling tower returned to normal operation.

- **TA-35 HMFL Outfall 03A160.** During a discharge on March 31, 2009, total suspended solids (TSS) were measured at 97.7 mg/L, exceeding the monthly average limit of 30 mg/L. The cooling tower had not been used in March and dirt/sediment partially clogged the flow meter at the end of the blowdown pipe. A back-up operator at the Facility initiated the blowdown so quarterly compliance samples could be collected. The Lead Operator will be present when the cooling tower blowdown is initiated.

- **TA-3 SCC Outfall 03A027.** On May 20, 2009, a total residual chlorine (TRC) concentration of 1,510 µg/L exceeded the NPDES daily maximum limit of 11 µg/L. During maintenance of the cooling tower water treatment system, the system was set to the "No Blowdown" mode and the valve that introduces the chlorine neutralizer into the blowdown was placed in the closed position. After the maintenance was performed, the system was set back to the "Blowdown" mode. However the neutralizer valve was left in the closed position. An additional checklist has been implemented allowing facility personnel to verify that all components of the water treatment system are placed back in normal operation after routine maintenance has been performed.

- **TA-15 DARHT Outfall 03A185.** On November 3, 2009, a TRC concentration of >2,200 µg/L exceeded the NPDES daily maximum limit of 11 µg/L. The check valve on the chlorine neutralizer pump became stuck in the nearly closed position, not allowing sufficient neutralizer to mix with the blowdown. The check valve was cleaned and verification performed that it was working properly. The neutralizer pump, tubing, and valves will be inspected for crystallization each week and cleaned as necessary.

- **TA-3 Power Plant Outfall 001.** On December 17, 2009, a PCB concentration of 0.0131 µg/L was measured during compliance sampling. This result exceeded the monthly average permit limit of 0.009 µg/L. As part of the on-going investigation for the source of the elevated level of PCBs, corrective actions have included plugging the drains in the basement, discontinuing use of one basement sump, sealing caulked areas in basement, cleaning of tank sumps, and additional sampling (results pending).

- **TA-15 DARHT Outfall 03A185.** On December 28, 2009, a TRC concentration of 240 µg/L exceeded the NPDES daily maximum limit of 11 µg/L. The make-up valve on the north cooling tower cell was stuck in the open position (frozen) causing potable water to constantly enter the cooling tower. This resulted in the over-flowing condition. Excess potable water flows through a drain directly to Outfall 03A185 without being dechlorinated. The heat tape around the make-up valve failed because the solenoid controlling the blowdown valve was clogged with solids found in the cooling tower basin. The blowdown valve remained in the open position, draining the tower, which caused the heat tape to fail. The cooling tower has been placed on a yearly cleaning schedule to keep down the amount of solids in the basin.

b. NPDES Sanitary Sewage Sludge Management Program

The Laboratory's TA-46 SWWS Plant is an extended-aeration, activated-sludge sanitary wastewater treatment plant. The activated-sludge treatment process requires periodic disposing of excess sludge (waste-activated sludge) from the plant's clarifiers to synthetically lined drying beds. After air-drying for a minimum of 90 days to reduce pathogens, the dry sludge is characterized and disposed of as a New Mexico Special Waste. During 2009, the SWWS Plant generated approximately 25.8 dry tons (51,561 dry lbs) of sewage sludge. All of this sludge was disposed of as a New Mexico Special Waste at a landfill authorized to accept this material..

c. NPDES Industrial Point Source Permit Compliance Evaluation Inspection

A Compliance Evaluation Inspection was performed from July 13 to 15, 2009. The inspection consisted of separate evaluations for the sanitary and industrial outfalls. The Laboratory received a rating of four for the industrial outfalls evaluation and a rating of four for the sanitary outfall evaluation. A rating of five indicates very reliable self-monitoring programs, three is for satisfactory, and one is for very unreliable programs.

d. NPDES Storm Water Construction General Permit Program

The NPDES Construction General Permit (CGP) Program regulates storm water discharges from construction activities disturbing one or more acres, including those construction activities that are part of a larger common plan of development collectively disturbing one or more acres.

LANL and the general contractor apply individually for NPDES CGP coverage and are co-permittees at most construction sites. Compliance with the NPDES CGP includes developing and implementing a Storm Water Pollution Prevention Plan (SWPPP) before soil disturbance can begin and conducting site inspections once soil disturbance has commenced. A SWPPP describes the project activities, site conditions, best management practices (erosion control measures), and permanent control measures required for reducing pollution in storm water discharges and protecting endangered or threatened species and critical habitat. Compliance with the NPDES CGP is demonstrated through periodic inspections that document the condition of the site and also identify corrective actions required to keep pollutants from moving off the construction site. Data collected from these inspections are tabulated weekly, monthly, and annually in the form of Site Inspection Compliance Reports.

During 2009, the Laboratory implemented and maintained 52 construction site SWPPPs and addendums to SWPPPs and performed 471 storm water inspections. The Laboratory uses a geographic information system to manage project information and generate status reports that facilitate reporting under the Director's Portfolio Reviews. The overall CGP inspection compliance record in 2009 was 99.2%. During the summer months, when most high-intensity precipitation events occur, all 467 of the inspections were compliant.

The LANL storm water team continued to use relatively new methods to assist with storm water compliance. Improvements in accounting for non-uniform distribution of precipitation were made by using a network of rain gages in association with the Thiessen polygon method. This method associated 13 precipitation gauges across the Laboratory with LANL construction projects to ensure refined data were used for triggering storm water inspections. The gauges were equipped with 5-minute tipping buckets connected to existing stations with data loggers. The team incorporated solutions for preventing non-compliances in its Quality Improvement Performance Report. To further reduce future CGP non-compliances and to increase awareness of CGP requirements, the storm water team briefed subcontractors on CGP requirements at pre-bid and pre-construction meetings. Storm water requirements were put into subcontract requirements, so each bidder who responds to or bids on a subcontract for a Laboratory project is given project-specific environmental requirements. The team also gave presentations to multiple LANL organizations to increase awareness of CGP requirements and continued to hold a standing weekly meeting with LANL Project Management personnel to review the storm water compliance status of projects.

e. NPDES Industrial Storm Water Program

The NPDES Industrial Storm Water Permit Program regulates storm water discharges from identified regulated industrial activities (including SWMUs) and their associated facilities. These activities include metal fabrication; hazardous waste treatment, storage, and disposal; landfill operations; vehicle and equipment maintenance; recycling activities; electricity generation; warehousing activities; and asphalt manufacturing.

LANS and the DOE are co-permittees under the EPA 2008 NPDES Storm Water Multi-Sector General Permit for Industrial Activities (MSGP-2008). MSGP-2008 requires the development and implementation of site-specific SWPPPs, which must include identifying potential pollutants and activities and installing erosion control measures. Permit requirements also include monitoring storm water discharges from permitted sites. In 2009, LANL implemented and maintained 15 SWPPPs under the MSGP-2008 requirements, covering 19 facilities. Compliance with the requirements for these sites is achieved primarily by implementing the following activities:

- Identifying potential contaminants and activities that may impact surface water quality and identifying and providing structural and nonstructural controls to limit the impact of those contaminants.
- Developing and implementing facility-specific SWPPPs.

- Monitoring storm water runoff at facility gauging stations and stand-alone samplers for industrial sector-specific benchmark parameters, impaired water constituents, and effluent limitations, and visually inspecting storm water runoff to assess color; odor; floating, settled, or suspended solids; foam; oil sheen; and other indicators of storm water pollution.

f. Federal Facility Compliance Agreement/Administrative Order

In February 2005, DOE and EPA Region 6 entered into the FFCA with the purpose of establishing an interim compliance program for the regulation of storm water discharges from listed sites and to allow adequate time to submit an Individual Storm Water Permit Application. The March 2005 Individual Storm Water Permit application was intended to separate the sites regulated under the MSGP into an Individual Storm Water Permit (IP) focused primarily on imposing more stringent requirements for storm water discharge from Sites.

The IP was issued in February 2009 and became effective on April 1, 2009 (NPDES Permit No. NM0030759). The IP was subsequently appealed by a coalition of regional citizens' groups. Since that time, the final conditions of the IP continue to be negotiated under a proposed settlement agreement between LANS, DOE, EPA and the citizens' groups. As a result of the permit appeal negotiations, it is expected that issuance of a modified IP will have requirements different from the original 2009 permit.

In 2009, the Laboratory completed the following tasks:

1. Completed the annual modification of the SWPPP for SWMU/AOCs that describes watershed-scale monitoring, site-specific monitoring, and the erosion control program at SWMU/AOCs;
2. Continued negotiations with EPA and NMED on the development of an individual permit for storm water discharges from SWMUs/AOCs;
3. Completed the following fieldwork:
   - Installed 52 new site-specific samplers for IP sampling;
   - Maintained 60 gage stations for storm event sampling;
   - Collected 85 filtered and unfiltered storm water samples;
   - Installed 150 new erosion control measures at IP sites;
   - Conducted 1012 inspections at IP sites;
   - Completed maintenance of control measures at 25 IP sites;
   - Conducted Annual Comprehensive Site Compliance Evaluation inspections.

Qualified personnel, as required under the MSGP, conducted the Annual Comprehensive Site Compliance Evaluation inspections to assess the presence of existing industrial materials, leaks and spills, off-site tracking of sediment, tracking/blowing of industrial materials, and evidence of pollutants entering into receiving waters. The annual inspections also included an evaluation of the existing structural control measures at each site and corrective actions when needed.

The Laboratory completed supplemental information submittals in support of the Individual Permit application for storm water discharges from certain SWMUs/AOCs. EPA issued a draft permit in early 2008 for public comment. The final Individual Permit was issued in April 2009.

g. Aboveground Storage Tank Compliance Program

The Laboratory's Aboveground Storage Tank (AST) Compliance Program is responsible for ensuring compliance with the requirements established by EPA (Clean Water Act 40 CFR, Part 112) and NMED's Petroleum Storage Tank Bureau (PSTB) Regulations (20.5 NMAC). During 2009, the Laboratory was in full compliance with both EPA and NMED requirements.

Spill Prevention Control and Countermeasures (SPCC) Plans fulfill the federal requirements for the AST Compliance Program, as required by the CWA (40 CFR, Part 112, Oil Pollution Prevention Regulations). Comprehensive SPCC Plans are developed to meet EPA requirements that regulate water pollution from oil spills.

EPA proposed additional extensions to compliance deadlines for meeting new regulatory requirements under the federal Clean Water Act (40 CFR, Part 112). Proposed new regulations will require the Laboratory to modify and implement its SPCC Plans by November 10, 2010. Primary modifications address AST storage capacity, inspection frequency, integrity testing requirements, and equipment. The Laboratory completed 18 out of 20 modifications to existing and new SPCC Plans and implementation of those modifications is in process. Updates to two remaining SPCC Plans will be completed in early 2010.

The Laboratory continues to maintain and operate ASTs in compliance with 20.5 NMAC of the NMED-PSTB Regulations. The Laboratory paid annual AST registration fees of $100 per AST. The Laboratory has three tank systems that are operational pursuant to 20.5 NMAC. The remaining four tanks systems are under temporary closure status pursuant to 20.5 NMAC.

During 2009, the Laboratory continued to work on removing and decommissioning ASTs that are no longer in service. Three AST systems were officially closed out with NMED-PSTB pursuant to 20.5 NMAC. These AST system were located at TA-53-645 (near LANSCE), TA 53-1071(a, b, and c), and TA-3-316.

On February 21, 2002, the Laboratory notified EPA, NMED, and the National Response Center of a discharge of approximately 48,000 gallons of diesel fuel released into the environment from a tank at TA-21-57. Soil removal and sampling were performed in accordance with Laboratory, state, and federal regulatory requirements to determine the extent of the leak. In 2009, the Laboratory completed additional characterization work at the site. A Tier 1 Assessment will be conducted in 2010 pursuant to 20.5 NMAC of the NMED-PSTB regulations. Additional corrective actions will be recommended pursuant to the Tier 1 Assessment findings.

h. Dredge and Fill Permit Program

Section 404 of the Clean Water Act requires the Laboratory to obtain permits from the US Army Corps of Engineers to perform work within perennial, intermittent, or ephemeral watercourses. Section 401 of the Clean Water Act requires states to certify that Section 404 permits issued by the Corps of Engineers 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 may include additional permit requirements to meet state stream standards for individual Laboratory projects. In addition, the Laboratory must comply with 10 CFR 1022, which specifies how DOE sites comply with Executive Order 11988, Floodplain Management, and Executive Order 11990, *Protection of Wetlands*.

During 2009, six Section 404/401 permits were issued to the Laboratory:

- Removal of Abandoned Sewer Line, North Ancho Canyon (Nationwide Permit No. 18, Minor Discharges)
- Installation of a Carbon Filtration System at SWSC Spring, Cañon de Valle (Nationwide Permit No. 18, Minor Discharges)
- Upgrades to the Existing Carbon Filtration System at Martin Spring, Martin Spring Canyon (Nationwide Permit No. 18, Minor Discharges)
- Installation of a Pilot Permeable Reactive Barrier, Cañon de Valle (Nationwide Permit No. 3, Maintenance)
- Installation of a Carbon Filtration System at Burning Ground Spring, Cañon de Valle (Nationwide Permit No. 18, Minor Discharges)
- Installation of Three Cross Vane Structures to Control Sediment Transport, Pueblo Canyon (Nationwide Permit No. 18, Minor Discharges)

During 2009, one Section 404/401 permit was issued to the NNSA, Los Alamos Site Office:

- Installation of Grade Control Structures in DP and Pueblo Canyons to Control Sediment Transport (Nationwide Permit No. 43, Stormwater Management Facilities)

In addition, LANL reviewed 608 excavation permits and 61 project profiles for potential impacts to watercourses, floodplains, or wetlands. No Floodplain/Wetland Assessments were prepared in 2009. No violations of the DOE Floodplains/Wetlands Environmental Review Requirements were recorded. NMED and the Corps of Engineers did not inspect any sites permitted under the Section 404/401 regulations during 2009.

8. Safe Drinking Water Act

Los Alamos County, as owner and operator of the Los Alamos water supply system, is responsible for compliance with the requirements of the federal Safe Drinking Water Act (SDWA) and the New Mexico Drinking Water Regulations (NMEIB 2007). The SDWA requires Los Alamos County to collect samples from various points in the water distribution systems at the Laboratory, Los Alamos County, and Bandelier National Monument to demonstrate compliance with SDWA maximum contaminant levels (MCLs). EPA has established MCLs for microbiological organisms, organic and inorganic constituents, and radioactivity in drinking water. The State of New Mexico has adopted these standards in the New Mexico Drinking Water Regulations. EPA has authorized NMED to administer and enforce federal drinking water regulations and standards in New Mexico. Information on the quality of the drinking water from the Los Alamos County water supply system is in the County's annual Consumer Confidence Report, available online at http://www.losalamosnm.us/.

In 2009, the Laboratory conducted additional confirmation monitoring of the Los Alamos County water supply system for quality assurance purposes. The data are available in Chapter 5 of this report and at the online RACER Data Analysis Tool (http://racernm.com/). Drinking water supplied by Los Alamos County has not been impacted by any LANL contaminants.

9. Groundwater

a. Groundwater Protection Regulations

New Mexico Water Quality Control Commission (NMWQCC) regulations control liquid discharges onto or below the ground surface to protect all groundwater in New Mexico. Under the regulations, when required by NMED, a facility must submit a groundwater discharge plan and obtain NMED approval (or approval from the New Mexico Oil Conservation Division for energy/mineral-extraction activities). Subsequent discharges must be consistent with the terms and conditions of the discharge plan. In 2009, the Laboratory had one approved groundwater discharge plan and two groundwater discharge plans pending NMED approval (see Table 2-1).

i. TA-46 SWWS Plant Discharge Plan DP-857

On July 20, 1992, the Laboratory was issued a discharge permit for the TA-46 SWWS Plant. The permit was renewed on January 7, 1998. The permit requires quarterly sampling of the SWWS Plant's effluent, NPDES Outfalls 001 and 03A027, and Cañada del Buey alluvial groundwater well CDBO-6 to demonstrate compliance with NMWQCC groundwater standards. The Laboratory reports the analytical results to the NMED quarterly. During 2009, none of samples collected exceeded NMWQCC groundwater standards. Monitoring data are available online at the RACER Data Analysis Tool (http://racernm.com/). On August 27, 2002, the Laboratory submitted a renewal application for the TA-46 SWWS Plant's discharge permit, and NMED approval was pending at the end of 2009.

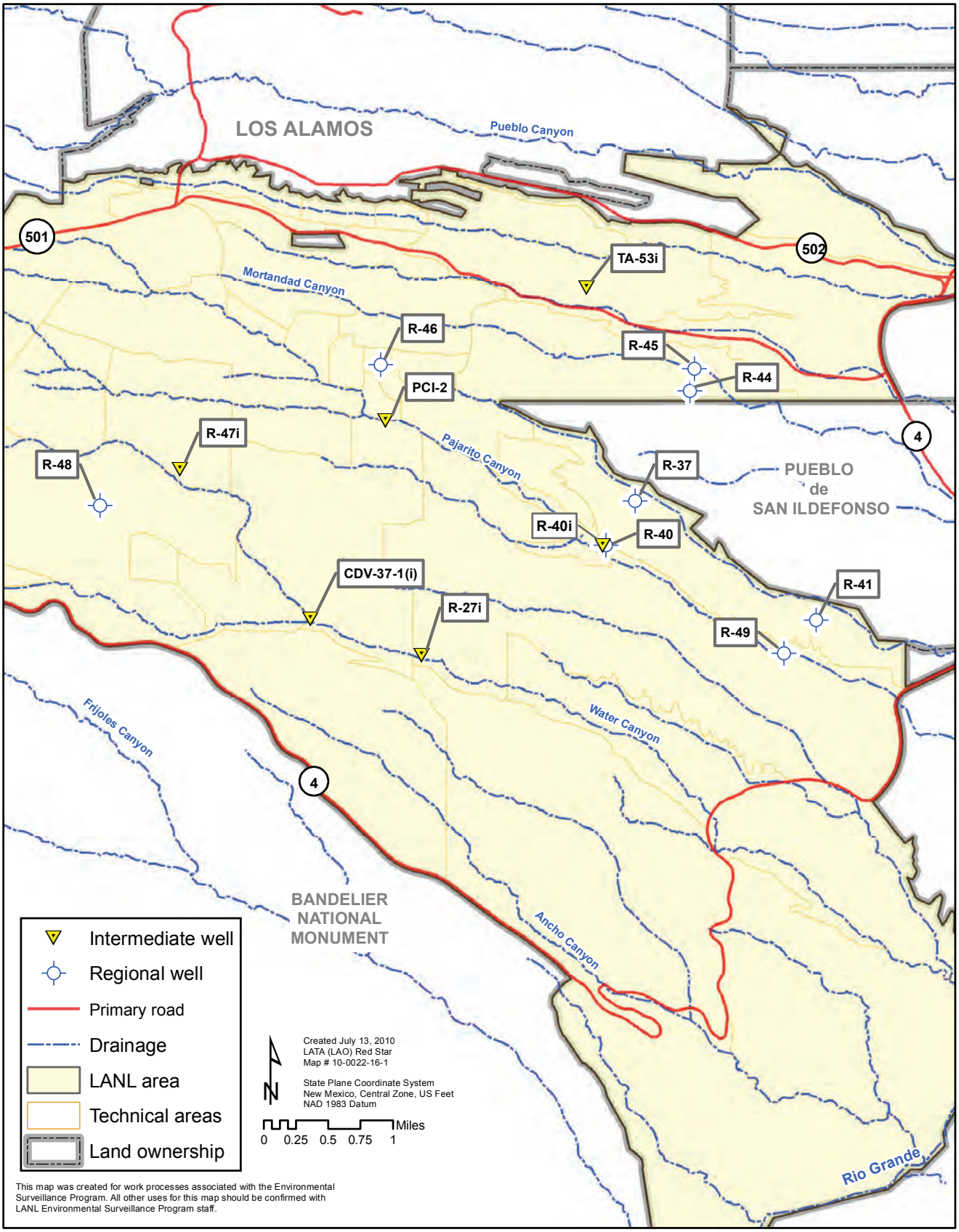

Figure 2-3. Characterization wells in the intermediate and regional aquifers installed during 2009.

ii. TA-50 RLWTF Discharge Plan DP-1132

On August 20, 1996, at the NMED's request, the Laboratory submitted a discharge plan application for the RLWTF at TA-50; NMED approval was pending at the end of 2009. Since 1999, the Laboratory has conducted voluntary quarterly sampling of the RLWTF's effluent and alluvial groundwater monitoring wells MCO-3, MCO-4B, MCO-6, and MCO-7 in Mortandad Canyon for nitrate (as N), fluoride, and total dissolved solids (TDS). The Laboratory reports the analytical results to the NMED quarterly. During 2009, none of the quarterly discharge plan samples exceeded NMWQCC groundwater standards with the exception of two effluent results in October and November 2009; nitrate (as nitrogen) concentrations in two samples—11.8 mg/L and 11.2 mg/L—exceeded the NMWQCC groundwater standard of 10 mg/L. Monitoring data are available online at the RACER Data Analysis Tool (http://racernm.com/).

iii. Septic Tanks Discharge Plan

On April 27, 2006, at the NMED's request, the Laboratory submitted a discharge plan application for the discharge of domestic wastewater from 21 septic systems. These septic systems (a combined septic tank and leach field) are located in remote areas of the Laboratory where access to the SWWS Plant's collection system is not practicable. The Laboratory regularly pumps and maintains these tanks. The NMED has declared the Laboratory's application to be administratively complete, but approval was still pending at the end of 2009.

b. Groundwater Monitoring Activities

The Laboratory performed significant groundwater compliance work in 2009 pursuant to the Consent Order. These activities included groundwater monitoring, groundwater investigations, and groundwater well construction.

Sample analytical and other groundwater data can be reviewed online on the RACER Data Analysis Tool (http://racernm.com/). Periodic monitoring reports and water-level and well construction data can be found on the Laboratory's Environment Website at http://www.lanl.gov/environment/h2o/reports.shtml.

In 2009, LANL installed six perched-intermediate monitoring wells and eight regional monitoring wells (Table 2-8). Figure 2-3 shows the locations of the new wells; maps of all monitoring well locations can be found in Chapter 5. Intermediate well TA-53i was installed south of Los Alamos Canyon to assess the southern extent of perched water identified in the canyon bottom. Regional wells R-44 and R-45 were installed as part of the ongoing chromium contamination investigation. Regional well R-46 was installed in support of the MDA C investigation. Six wells were installed to supplement the groundwater monitoring network around TA-54. Wells R-37, R-40, R-41, and R-49 were installed in the regional aquifer. Wells PCI-2 and R-40i were installed in the intermediate depth perched zone. Four wells were installed to monitor groundwater associated with historical TA-16 activities. Wells R-27i, CdV-37-1i, and R-47i were installed to intermediate depths. Well R-48 was installed to the regional aquifer by advancing the previously drilled CdV-16-3(i) borehole.

10. DOE Order 435.1 Radioactive Waste Management

Institutional Requirements

DOE Order 435.1 "Radioactive Waste Management" and the associated DOE Manual 435.1-1 give requirements for management and handling of radioactive waste. In 2005, LANL submitted a compliance plan to DOE which was approved in 2007. Since 2007, major operational facilities at LANL that contain or manage radioactive waste must prepare a Radioactive Waste Management Basis (RWMB) for the generating facility. LANL submits compliance reporting for the RWMB to the local DOE office for approval. Any facility at LANL that generates radioactive waste must comply with three internal requirement documents that cover waste acceptance criteria, the radioactive waste certification requirements, and off-site shipment of chemical, hazardous, or radioactive waste. At the end of 2009, 11 organizations had prepared and submitted RWMBs for approval by DOE and seven had been approved. Four approvals were granted by DOE and three extensions for radioactive waste stored over one year were approved.

Table 2-8
Wells and Boreholes Installed in 2009

Type[a]	Identifier	Watershed (Canyon)	Total Completed depth[b] (ft bgs)	Screened interval(s) (ft bgs)	Initial Water level (ft bgs)	Comments
I	TA-53i	Los Alamos	620.8	600.0–610.0	599.8	Monitors for potential southward migration of contaminants from sources in Los Alamos Canyon
R	R-37	Pajarito	1068.8	929.3–950.0 1026.0–1046.6	909.6 1009.6	Monitors groundwater downgradient of MDA H at TA-54
R	R-40	Pajarito	895	751.6–785.0 849.3–870.0	761.3 852.0	Monitors TA-54 and potential sources in Pajarito Canyon
I	R-40i	Pajarito	674.6	649.7–669.0	640.4	Monitors TA-54 and potential sources in Pajarito Canyon
I	PCI-2	Pajarito	533.3	512.0–522.0	508.0	Intermediate depth well adjacent to regional aquifer well R-17. Provides baseline data for areas upgradient of TA-54
R	R-44	Mortandad	1016.0	895.0–905.0 985.3–995.2	878.0 879.0	Monitors for nature and extent of contaminants from sources in Sandia Canyon
R	R-45	Mortandad	1016.0	880.0–890.0 974.9–994.9	868.2 868.3	Monitors for nature and extent of contaminants from sources in Sandia Canyon
R	R-46	Mortandad	1382.2	1340.0–1360.7	1327.9	Monitors groundwater quality downgradient of MDA C at TA-50
R	R-41	Pajarito	997.1	928.0–937.7 965.3–975.0	Dry 960.4	Monitors groundwater northeast of MDA G at TA-54
R	R-49	Pajarito	949.3	845.0–855.0 905.6–926.4	809.9 833.3	Monitors groundwater south of MDA G at TA-54
R	R-48	Water	1542.4	1500.0–1520.6	1352.7	Deepening and completion of borehole CdV-16-3(i) at TA-16. Monitors historical TA-16 sources
I	R-47i	Water	865.5	840.0–860.6	832.2	Originally intended to be a regional aquifer well, but completed as an intermediate aquifer well. Provides data in support of 260 Outfall CME.
I	R-27i	Water	630.2	619.0–629.0	616.4	Intermediate depth well adjacent to regional aquifer well R-27. Monitors groundwater downgradient of historical TA-16 sources
I	CdV-37-1i	Water	657.8	632.0–652.5	627.9	Sited to monitor intermediate depth groundwater at the confluence of Water Canyon and Canon de Valle downgradient from historical TA-16 sources

[a] Perched intermediate aquifer well; R = regional aquifer well.
[b] Total depth refers to the completed well; bgs = below ground surface.

The Laboratory has required registration of on-site radioactive waste storage and staging areas since July 24, 2007. The on-site Waste Certification Program also calls for self-assessments to ensure radioactive waste is managed in accordance with the approved RWMB and DOE requirements. Registration, facility self-inspections, and surveillance of radioactive staging and storage areas ensure LANL radioactive waste management practices are consistent with the requirements in DOE Order 435.1. The WCP assures compliance from the generators through storage and transport to the receiving facility. In calendar year 2009, 142 inspections were conducted and 17 findings were documented.

11. National Environmental Policy Act

Under the National Environmental Policy Act (NEPA) (42 U.S.C. 4331 et seq.), federal agencies such as DOE/NNSA must consider the environmental impacts of proposed projects and ensure public participation as part of the decision-making process. The Laboratory's Environmental Stewardship Group devotes considerable resources to assist NNSA in compliance with NEPA, pursuant to DOE Order 451.1B. Proposed projects and actions at LANL are reviewed to determine potential resource impacts and the appropriate coverage under NEPA, and these recommendations are provided to NNSA. The NEPA analysis in the new LANL Site-Wide Environmental Impact Statement (SWEIS) was prepared in 2007.

The DOE NEPA implementing regulations (10 CFR Part 1021.330[d]) require a SWEIS to be reviewed at least every five years and a Supplemental Analysis be performed to examine whether the SWEIS still adequately covers site operations. In August 2005, a memo was issued to LANL from DOE/NNSA to prepare a new SWEIS. The final SWEIS was issued in May 2008 (DOE 2008a). A limited Record of Decision (ROD) was issued in September 2008 (DOE 2008b) in which DOE decided to implement the No Action Alternative with the addition of some elements of the Expanded Operations Alternative.

The second ROD for the 2008 SWEIS was issued in July 2009. The ROD was based on the information and analyses contained in the SWEIS and other factors, including comments received on the SWEIS, costs, technical and security considerations, and the missions of NNSA. The following elements of the Expanded Operations Alternative were approved:

- Complete the environmental remediation and closure of TA-18 Pajarito Site;
- Complete the environmental remediation and closure of TA-21 (also referred to as the Delta Prime or DP Site);
- Refurbish the Plutonium Facility Complex at TA-55;
- Construct and operate a new Radioactive Liquid Waste Treatment Facility Complex in TA-50 and operate a zero liquid discharge facility in TA-52 as an auxiliary action;
- Install additional processors and equipment to further expand the capabilities and operation level of the Nicholas C. Metropolis for Modeling and Simulation in TA-3; and
- Construct and operate a new Science and Engineering Complex at TA-62.

The first Supplement Analysis to the 2008 SWEIS was issued in October 2009. This analysis was prepared to determine if the 2008 SWEIS adequately bounded off-site transportation of low specific activity and low level waste by a combination of truck and rail to EnergySolutions in Clive, Utah. DOE/NNSA concluded that the proposed shipment of waste to EnergySolutions by truck and rail are bounded by 2008 SWEIS transportation analysis.

12. Endangered Species Act

The Endangered Species Act requires federal agencies to protect populations and habitats of federally listed threatened or endangered species. The Laboratory contains potential habitat for two federally endangered species (Southwestern willow flycatcher, *Empidonax traillii extimus*, and black-footed ferret, *Mustela nigripes*), one federally threatened species (Mexican spotted owl, *Strix occidentalis lucida*), and two candidate species (yellow-billed cuckoo, *Coccyzus americanus*, and New Mexico meadow jumping mouse, *Zapus hudsonius luteus*).

The Southwestern willow flycatcher, black-footed ferret, and New Mexico meadow jumping mouse have not been observed on Laboratory property. In addition, several federal species of concern and state-listed species potentially occur within LANL (Table 2-9).

The Laboratory meets its requirements for threatened and endangered species protection through implementation of its Threatened and Endangered Species Habitat Management Plan and review of excavation permit requests and project profiles. During 2009, LANL reviewed 612 excavation permits, 115 project profiles, and seven storm water pollution prevention plans for potential impacts to threatened or endangered species. The Laboratory conducted annual surveys for the Mexican spotted owl, Southwestern willow flycatcher, Jemez Mountains salamander, and grey vireo.

Table 2-9
Threatened, Endangered, and Other Sensitive Species Occurring or Potentially Occurring at LANL

Scientific Name	Common Name	Protected Status[a]	Potential to Occur[b]
Empidonax traillii extimus	Southwestern Willow Flycatcher	E	Moderate
Mustela nigripes	Black-footed Ferret	E	Low
Strix occidentalis lucida	Mexican Spotted Owl	T	High
Coccyzus americanus	Yellow-billed Cuckoo	C, NMS	Moderate
Zapus hudsonius luteus	New Mexico meadow jumping mouse	C, NMS	Moderate
Haliaeetus leucocepahlus	Bald Eagle	NMT, S1	High
Gila pandora	Rio Grande Chub	NMS	Moderate
Plethodon neomexicanus	Jemez Mountains Salamander	NME, FSOC	High
Falco peregrinus anatum	American Peregrine Falcon	NMT, FSOC	High
Falco peregrinus tundrius	Arctic Peregrine Falcon	NMT, FSOC	Moderate
Accipiter gentiles	Northern Goshawk	NMS, FSOC	High
Lanius ludovicianus	Loggerhead Shrike	NMS	High
Vireo vicinior	Gray Vireo	NMT	Moderate
Plegadis chihi	White-faced Ibis	S1	Moderate
Myotis ciliolabrum melanorhinus	Western Small-footed Myotis Bat	NMS	High
Myotis volans interior	Long-legged Bat	NMS	High
Euderma maculatum	Spotted Bat	NMT	High
Plecotus townsendii pallescens	Townsend's Pale Big-eared Bat	NMS, FSOC	High
Nyctinomops macrotis	Big Free-tailed Bat	NMS	High
Myotis thysanodes thysanodes	Fringed Bat	NMS	High
Myotis yumanensis yumanensis	Yuma Bat	NMS	High
Myotis evotis evotis	Long-eared Bat	NMS	High
Bassariscus astutus	Ringtail	NMS	High
Vulpes vulpes	Red Fox	NMS	Moderate
Ochotona princeps nigrescens	Goat Peak Pika	NMS, FSOC	Low
Lilium philadelphicum var. andinum	Wood Lily	NME	High
Cypripedium calceolus var. pubescens	Greater Yellow Lady's Slipper	NME	Moderate
Speyeria Nokomis nitocris	New Mexico Silverspot Butterfly	FSOC	Moderate

[a] E = Federal Endangered; T = Federal Threatened; C = Federal Candidate Species; NMS = New Mexico Sensitive Taxa (informal); S1 = Heritage New Mexico: Critically Imperiled in New Mexico; NMT = New Mexico Threatened; NME = New Mexico Endangered; FSOC = Federal Species of Concern.

[b] Low = No known habitat exists on LANL; Moderate = Habitat exists, though the species has not been recorded recently; High = Habitat exists, and the species occurs at LANL.

13. Migratory Bird Treaty Act

Under the provisions of the Migratory Bird Treaty Act, it is unlawful "by any means or manner to pursue, hunt, take, capture [or] kill" any migratory birds except as permitted by regulations issued by the US Fish and Wildlife Service. In the project review process, LANL biologists provided specific comments for projects with the potential to impact migratory birds, their eggs, or nestlings if, for example, a project proposed an electrical power line or a project disturbed vegetation during the bird nesting season.

14. Cultural Resources

The goal of the National Historic Preservation Act (NHPA) of 1990 is to have federal agencies act as responsible stewards of the nation's resources when their actions affect historic properties. NHPA Section 106 requires federal agencies to take into account the effects projects may have on historic properties and to allow for comment by the Advisory Council on Historic Preservation. Section 106 regulations outline a project review process conducted on a project-by-project basis.

In 2009, the Laboratory conducted 40 projects that required some field verification of previous cultural surveys. Twenty-one new archaeological sites and seven new historical buildings were identified in 2009. Five historic buildings were determined eligible for the National Register of Historic Places.

The Laboratory began the eighth year of a multiyear program that included archaeological excavation in support of the Land Conveyance and Transfer Project. The DOE/NNSA is in the process of conveying to Los Alamos County approximately 2,000 acres of Laboratory lands. Thirty-nine archaeological sites were excavated during the 2002 to 2005 field seasons, with more than 200,000 artifacts and 2,000 samples collected. During 2009, the remaining artifacts stored at LANL were transferred for curation to the Museum of New Mexico. Together, these sites provide new insights into past activities on the Pajarito Plateau from 5000 B.C. to A.D. 1943. From a compliance perspective, these excavations resolve the anticipated adverse effects to archaeological sites from the future development of lands to be acquired by Los Alamos County. These sites are also ancestral places to the local Pueblo populations, and, as such, representatives from the Pueblos de San Ildefonso and Santa Clara acted as tribal consultants and monitors on the project. During fiscal year 2008, the final report was completed and submitted to the New Mexico State Historic Preservation Office in fulfillment of the Data Recovery Plan and the Programmatic Agreement between the DOE Los Alamos Site Office, the Advisory Council on Historic Preservation, and the State Historic Preservation Office.

In support of LANL's 2009 decontamination and decommissioning program, square footage reduction, and Laboratory consolidation, the Laboratory conducted historic building assessments and other documentation work related to three proposed projects as required under the provisions of the NHPA. Buildings included in these projects are located at TAs-8, -11, -15, -16, -22, -33, -37, -41, -46, and -49. This work included field visits to historic properties (including interior and exterior inspections), digital and archival photography, and architectural documentation (using standard LANL building recording forms). Additional documentation included the production of location maps for each of the evaluated projects. Historical research was also conducted using source materials from the LANL archives and records center, historical photography, the Laboratory's public reading room, and previously conducted oral interviews.

The Laboratory continues to consult with the Pueblos with respect to identifying and protecting traditional cultural properties, human remains, and sacred objects in compliance with the NHPA and Native American Graves Protection and Repatriation Act (NAGPRA). This work included ongoing consultations with the Pueblo de San Ildefonso regarding culturally affiliated human remains discovered in TA-36.

C. UNPLANNED RELEASES

1. Air Releases

No unplanned air releases occurred during 2009.

2. Liquid Releases

No unplanned releases of radioactive liquids occurred on Laboratory lands in 2009. There were 28 unplanned releases of non-radioactive liquids in 2009:

- Approximately 1,800 gallons of potable water into Los Alamos Canyon.
- Approximately 100,000 gallons of potable water into Twomile Canyon.
- Approximately 3 gallons of diesel fuel at the Pajarito Laydown Yard.
- Approximately 600,000 gallons of potable water into Twomile Canyon.
- Approximately 200 gallons of re-use water from an excavation.
- Approximately 5,000 gallons of potable water into Sandia Canyon.
- Approximately 14,000 gallons of potable water into DP Canyon.
- Approximately 24,000 gallons of potable water into Sandia Canyon.
- Approximately 1 gallon of Roof Guard mixed with storm water to a storm drain into Mortandad Canyon.
- Approximately 1 gallon of propylene glycol in storm water into a storm drain to Mortandad Canyon.
- Approximately 4 gallons of Roof Guard mixed with storm water into a storm drain to Twomile Canyon.
- Approximately 75 gallons of hydraulic fluid at TA-60 from a crane.
- Approximately 500 gallons of R-28 purge water.
- Approximately 20,000 gallons of potable water into Pajarito Canyon.
- Approximately 4,320 gallons of steam condensate into Sandia Canyon.
- Approximately 15,000 gallons of R-47 drilling fluid.
- Groundwater from R-20 Screen #1 communicated to Screen #2.
- Approximately 200,000 gallons of steam condensate into upper Twomile Canyon.
- Approximately 300 gallons of potable water to Pajarito Canyon.
- Approximately 1,000 gallons of potable water into Water Canyon.
- Approximately 20,000 gallons of R-37 well development drilling fluid.
- Packer systems in some wells may have become under inflated causing communication between perched aquifers and the regional aquifer.
- Approximately 2,800 gallons per day of steam condensate into Twomile Canyon.
- Approximately 6,500 gallons of potable water into Sandia Canyon.
- Approximately 10,000 gallons of potable water into Water Canyon.
- Approximately 3,600 gallons per day of steam condensate into Sandia Canyon.
- Approximately 25,000 gallons of potable water into DP Canyon.
- Approximately 6,000 gallons of potable water into Los Alamos Canyon.

The Laboratory investigated all unplanned releases of liquids as required by the NMWQCC Regulations 20.6.2.1203 NMAC. Upon cleanup, the NMED and the DOE Oversight Bureau inspected the unplanned release sites to ensure adequate cleanup. In 2009, the Laboratory was in the process of administratively closing all releases for 2009 with the NMED and the DOE Oversight Bureau and anticipates these unplanned release investigations will be closed out after final inspections.

D. REFERENCES

DOE 1996: "Dual-Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement Mitigation Action Plan," United States Department of Energy report USDOE/EIS-0228 (January 1996).

DOE 2008a: US Department of Energy, "Final Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico," DOE/EIS-0380 (May 16, 2008).

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LANL 2006: "Interim Measures Work Plan for Chromium Contamination in Groundwater," Los Alamos National Laboratory document LA-UR-06-1961, Los Alamos, New Mexico. (LANL 2006, 091987) (March 2006).

NMEIB 2007: New Mexico Environmental Improvement Board, State of New Mexico, "Drinking Water Regulations" (as amended through April 2007), found at 20.7.10 NMAC.

3. Radiological and Nonradiological Dose Assessment

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A. INTRODUCTION

This chapter presents the results of the calculation of radiological dose and non-radiological risk to the public and biota from Los Alamos National Laboratory (LANL or the Laboratory) operations in 2009 and reports whether the doses are below specified limits. This chapter also provides a measure of the significance of environmental radioactivity in the context of its potential risk to humans and biota. In this respect, the human dose assessment provides a different perspective from the biota dose assessment. The calculated human dose is received near the publicly accessible Laboratory boundaries, whereas the calculated biota dose is potentially received throughout the interior of Laboratory property, usually at locations rarely visited by humans. In addition, the potential risks from non-radiological materials detected during 2009 and previous years' sampling activities are summarized.

As defined by US Department of Energy (DOE) Standard 1153-2002 (DOE 2002), biota are divided into plants and animals. Plants receive the highest radiation dose because they grow and remain in one location. Most animals range over an area, which usually minimizes their dose. Humans receive the lowest radiation dose because they limit their time in areas with residual contamination and do not typically eat the vegetation or drink the water in these areas. Therefore, locations with no significant human radiation dose may have a higher biota radiation dose.

B. RADIOLOGICAL DOSE ASSESSMENT FOR HUMANS

1. Overview of Radiological Dose Equivalents

Radiological dose equivalents presented are calculated using standard methods specified in guidance documents (DOE 1988a, 1988b, 1991; EPA 1988, 1993, 1997, 1999; ICRP 1996; NRC 1977). The effective dose equivalent, referred to here as "dose," is calculated using radiation weighting factors and tissue weighting factors to adjust for the various types of radiation and the various tissues in the body. The final result, measured in millirem (mrem), is a measure of the overall dose to an individual, whether from external radiation or contact with radioactive material. For example, from a human health risk perspective, 1 mrem of direct gamma radiation is effectively equivalent to 1 mrem from inhalation of plutonium. In addition, the dose results within this chapter reflect potential dose to hypothetical people and biota and are not to be construed as a dose assessment for any specific individual or organism.

Federal government standards limit the dose that the public may receive from Laboratory operations. The DOE dose limit to a member of the public is 100 mrem/yr (DOE 1993) received from all pathways (i.e., all ways in which a person can be exposed to radiation, such as inhalation, ingestion, and direct radiation). Furthermore, doses to members of the public must be reduced to low levels consistent with a documented "as low as reasonably achievable" (ALARA) process (LANL 2008b) and generally should not exceed a dose constraint of one-quarter of the primary dose limit, or 25 mrem/yr (DOE 1999). The dose received from airborne emissions of radionuclides is further restricted by the US Environmental Protection Agency (EPA) dose standard of 10 mrem/yr (EPA 1986), also known as the National Emission Standards for Emissions of Radionuclides Other than Radon from DOE (Rad-NESHAP) dose limit. These doses are in addition to exposures from natural background, consumer products, and medical sources. Doses from community drinking water supplies are limited in accordance with the

Clean Water Act, either by established maximum contaminant levels (MCLs) for some radionuclides or by dose rate (4 mrem/yr for man-made radionuclides) (EPA 2000).

2. Public Dose Calculations

a. Scope

The objective of our public dose calculations is to report incremental (above-background) doses resulting from LANL operations. Therefore, we do not include dose contributions from radionuclides present in our natural environment or from radioactive fallout.

Annual radiation doses to the public are evaluated for three principal exposure pathways: inhalation, ingestion, and direct (or external) radiation. We calculate doses for the following cases:

1. The entire population within 80 km of the Laboratory
2. The maximally exposed individual (MEI) not on LANL property; for the airborne pathway dose only and compared with the EPA RAD-NESHAP dose limit of 10 mrem/yr
3. The MEI not on LANL property; for the all-pathways dose and compared with the DOE Order 5400.5 dose limit of 100 mrem/yr
4. Residents in Los Alamos and White Rock

b. General Considerations

As discussed in Section B.4, below, the dose rate from naturally occurring radioactivity is approximately 450 mrem/yr. Additional man-made sources of radiation, such as medical/dental uses of radiation and building products such as stone walls, raise the total background dose to about 700 mrem/yr on average (NCRP 1975, 1987a, 1987b, 2009). It is extremely difficult to measure doses from LANL that are less than 0.1% (one one-thousandth) of natural doses. As the dose rates become smaller, the estimates become less certain and less significant. Generally, we conclude that a dose rate less than 0.1 mrem/yr is essentially zero and cannot be distinguished from natural background radiation.

We begin with environmental measurements of radionuclides in air, water, soil, foodstuffs, sediment, and non-foodstuffs biota. We compare the concentrations of these radionuclides in the various media to pre-determined radionuclide-specific screening levels that are equivalent to 0.1 mrem/yr for specific exposure pathways such as ingestion of drinking water, ingestion of foodstuffs, and residing on contaminated soil (LANL 2003). If the concentrations do not exceed the screening levels, no further assessment is required and the doses are assumed to be essentially zero. If the concentrations do exceed the screening levels, further dose assessment is required and specific numerical dose values are reported in this chapter (LANL 2008a).

i. Direct Radiation Exposure

The Laboratory monitors direct radiation from gamma photons or neutrons at about 100 locations in and around LANL (see Chapter 4, Section C). Direct radiation doses above natural background are measured near Technical Area (TA) -54, but there are no other Laboratory sources of external radiation that can be measured at off-site areas.

To receive a measurable dose, a member of the public must be within a few hundred meters of the source of external radiation. At distances more than one kilometer, the decrease in radiation dose rate with increasing distance from the radiation source (inverse-square law), combined with scattering and attenuation or shielding in the air, reduces the dose to much less than 0.1 mrem/yr, which cannot be distinguished from natural background radiation. This means the only significant above-background doses from direct radiation are measured near TA-54 (see Section B.3.b of this chapter).

To estimate the dose to the public near TA-54, we multiply the measurements of neutron dose by an occupancy factor of 1/16 (NCRP 1976). The direct radiation measurements reported in Chapter 4 apply to an individual who is at a particular location continuously (i.e., 24 hours/day and 365 days/yr). We followed standard guidance and assumed continuous occupancy for residences and places of business. For all other locations, we multiplied the measured dose by the 1/16 occupancy factor.

ii. Airborne Radioactivity (Inhalation Pathway)

At distances of more than a few hundred meters from LANL sources, the dose to the public is almost entirely from airborne radioactive material. Whenever possible, we use the direct measurements of airborne radioactivity concentrations measured by the Ambient Air Sampling Network (AIRNET) and reported in Chapter 4, Section A. Where local concentrations are too small to measure, we calculate the doses using the CAP88 model (PC Version 3.0) (EPA 2007a), an atmospheric dispersion and dose calculation computer code that combines stack radionuclide emissions information with meteorological data to estimate where the released radioactive material may have gone and the dose from that radioactive material.

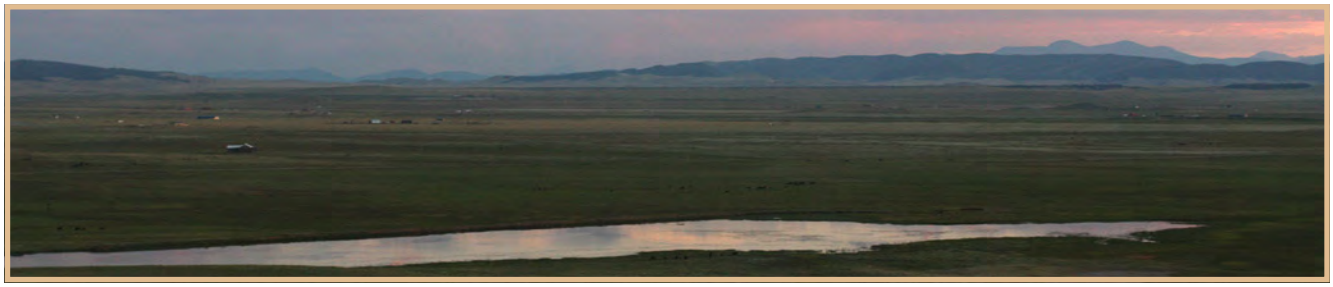
In particular, some of the radionuclide emissions from the Los Alamos Neutron Science Center (LANSCE) are not measured by AIRNET. These emissions are measured at the stacks (see Chapter 4, Section B), and the resulting doses are calculated with CAP88. These doses decrease substantially with distance from the stack because the radioactive half-lives are short (mostly 20 minutes or less).

iii. Water (Ingestion Pathway)

The majority of radionuclides detected in groundwater samples collected from known or potential drinking water sources (i.e., Los Alamos County drinking water supply wells, Buckman wells, and natural springs) in 2009 resulted from the presence of natural radioactivity in these sources. These radionuclides include natural uranium and its decay products, such as radium-226. Except for tritium, radionuclides attributable to Laboratory operations are not found in recognized drinking water sources. The highest concentration of tritium detected in a Los Alamos County drinking water supply well was 17 pCi/L in a sample collected from the Otowi-1 well located in Pueblo Canyon and is within the range of tritium concentrations found in rain water (16 to 35 pCi/L) (Holloway 1993). This concentration is far below the EPA MCL of 20,000 pCi/L and results in a dose of much less than 0.1 mrem/yr if this water were to be ingested for an entire year (assumes 730 L ingested for the year). However, Los Alamos County has not used this well as a drinking water source for several years. Tritium was also detected in water samples from Basalt Spring on Pueblo de San Ildefonso land at levels up to 67 pCi/L, somewhat above the highest level expected in rain water. The dose from ingesting this water for an entire year (730 L) would also be much less than 0.1 mrem/yr.

Surface water samples were obtained in 2009 from three locations along the Rio Grande. Radionuclide analysis of these samples indicated the presence of radium-226, radium-228, thorium-228, thorium-230, thorium-232, tritium, uranium-234, uranium-235/236, and uranium-238. The highest concentrations of radium-226, the thorium isotopes, and tritium were measured in samples taken from a location above LANL at Otowi Bridge, indicating non-LANL and naturally-occurring sources for these radionuclides. The maximum uranium isotope concentrations measured downriver from Otowi Bridge were between 1% and 13% of the maximum concentrations measured upriver, thus indicating minimal contribution from LANL operations. In no case did any concentration exceed the 0.1 mrem/yr screening levels specified in LANL (2003), which would trigger a dose assessment.

In conclusion, these water ingestion doses are very small relative to the 4-mrem/yr EPA community drinking water dose limit.



iv. Soil (Direct Exposure Pathway)

We report measurements of radionuclide concentrations in surface soil in Chapter 7. As described in Chapter 7, Section C.1, soil samples are collected on the perimeter of the Laboratory and at regional and on-site locations on a triennial basis (every three years). Routine soil samples were previously collected in 2006 and were collected again in 2009. No regional samples have had radionuclide concentrations detected above the regional statistical reference levels (RSRLs). RSRLs represent background radionuclide concentrations plus three standard deviations in media, such as soil, sediment, and crops, collected or harvested in regional areas far from the influence of the Laboratory averaged over a period of five years.

However, radionuclide concentrations measured in soil samples from 2009 were above the RSRL at some perimeter and LANL locations. For example, plutonium-239/240 was above the RSRL at perimeter locations near TA-8 (GT Site) and the east and west sides of the Los Alamos County airport. Tritium was above the RSRL at the Tsankawi/PM-1 perimeter location. Several on site LANL locations had transuranic and uranium soil concentrations in samples above the RSRL, including locations at TA-21's DP Site and TA-54. Screening of the perimeter soil concentrations indicate that annual doses from the soil exposure pathway would result in less than 0.1 mrem/yr to a member of the public residing in these areas.

Only six sample results, from locations on site in and around TA-54 and the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility, exceeded the 0.1 mrem/yr screening criteria: two for transuranic radionuclides, one for tritium, and three for uranium-238. However, because these locations are not accessible to the public, no public dose impact through the soil exposure pathway would result.

In addition, soil samples were collected along the north side of East Jemez Road and analyzed for transuranic radionuclides and cesium-137 for a special monitoring study in order to eventually determine airborne emissions from historical operations at TA-1 and TA-21, DP West. These sampling locations are all on site, but some are accessible to the public. Most of the plutonium-239/240 results were above the RSRL, but all were below the 0.1 mrem/yr screening criteria.

A study was also performed where soil samples were collected from alfalfa fields irrigated with Rio Grande river water upstream and downstream of LANL. None of the analysis results exceeded the RSRL values, and none of these results exceeded the 0.1 mrem/yr screening values.

In summary, we conclude that the LANL contribution to the dose from soil around the perimeter of the Laboratory and off site is less than 0.1 mrem/yr, and the majority of the anthropogenic radionuclides detected are primarily due to worldwide fallout and historical operations at the Laboratory.

v. Food (Ingestion Pathway)

We report measurements of the radioactive content of food, mostly crops, fish, and native vegetation, in Chapter 8. The food is collected on a triennial basis, rotating with the collection of soils. This year, we focused our analysis on of road-killed deer from Pueblo de San Ildefonso and LANL, alfalfa forage irrigated from Rio Grande river water upstream and downstream of LANL, and crawfish sampled from the Rio Grande water upstream and downstream of LANL. While humans do not directly consume alfalfa forage, it does represent a means of transferring potential contaminants from irrigation water, soil, and the air to cattle and then on to humans, so it will be considered a foodstuff for purposes of this analysis.

None of the deer muscle and bone radionuclide concentrations exceeded the 0.1 mrem/yr screening levels. Consumption of these deer would, therefore, not result in a dose to the public above 0.1 mrem/year. The uranium-234 and uranium-238 concentrations in alfalfa forage at certain locations did exceed the 0.1 mrem/yr screening level. However, these concentrations were all well below the RSRL value and the ratios of uranium-234 to uranium-238 at these locations were indicative of naturally occurring uranium in river water being used for irrigation purposes. None of the crawfish from either the upstream or downstream reaches had radionuclide concentrations that exceeded the 0.1 mrem/yr screening levels. Therefore, consumption of crawfish either

upstream or downstream of LANL at an assumed ingestion rate of 10 pounds per year would result in less than 0.1 mrem/yr to a member of the public.

In conclusion, the food ingestion doses are very small relative to the all-pathways dose limit of 100 mrem/yr and the 25-mrem/yr dose constraint.

vi. Release of Items and Real Property

The Laboratory releases miscellaneous surplus items of salvageable office and scientific equipment to the general public, following Laboratory requirements for release of such items (LANL 2009). All items destined for release from known or potentially contaminated areas are screened for radioactive contamination in accordance with the procedures of LANL's Health Physics Operations Group. Any items with surface contamination or dose levels above the authorized release limits for uncontrolled use are not released to the public. Items from a known or potentially contaminated area that cannot be completely surveyed are also not released. The authorized release limits for items (LANL 2009) are the limits in Figure IV-1 of DOE requirements (DOE 1993, DOE 1995). In 2009, no items were released to the public with contamination or dose levels approaching the authorized release limits. Therefore, the dose to the public from this pathway is negligible.

The transfer of real property (land) from DOE to the public is allowed if the modeled dose is no greater than the authorized release limit of 15 mrem/yr and the modeled dose is ALARA. Several environmental ALARA analyses were performed in 2009, specifically for the future conveyance and transfer of land tracts A-13 (old DOE Los Alamos Area office location), B-3 (TA-74-4), C-1 (portion of State Route 4 in White Rock), C-2 (White Rock "Y" interchange), C-3 (portion of State Route 502 west of interchange), and C-4 (portion of State Route 4 south of interchange and north of White Rock). All calculated doses were found to be below the authorized release limit of 15 mrem/year. However, the calculated dose for land tract C-2 was above the 3 mrem/year quantitative ALARA analysis threshold. Therefore, a quantitative analysis was performed for land tract C-2. The analysis indicated that the cost of further remediation for this land tract far exceeded the benefit, and, therefore, no further remediation action was recommended.

3. Dose Calculations and Results

a. Collective dose to the population within 80 Kilometers

We used the local population distribution to calculate the dose from 2009 Laboratory operations to the population within 80 km (50 miles) of LANL. Approximately 280,000 persons live within an 80-km radius of the Laboratory. We used New Mexico county population estimates provided by the University of New Mexico Bureau of Business and Economic Research (available at http://www.unm.edu/~bber/).

The collective dose from Laboratory operations is the sum of the estimated doses for each member of the public within an 80-km radius of LANL. For example, if two persons each receive 3 mrem, the collective dose is 6 person-mrem. This collective dose results from airborne radioactive emissions. Other potential sources, such as direct radiation, are essentially zero. We calculated the collective dose by modeling the transport of radioactive air emissions using CAP88.

The 2009 collective population dose that may be attributable to Laboratory operations to persons living within 80 km of the Laboratory is 0.57 person-rem, which is less than the collective dose of 0.79 person-rem reported for 2008. Tritium contributed 9% of the dose, and short-lived air activation products such as carbon-11 from LANSCE contributed 88% of the dose. The decrease in the 2009 collective population dose compared with 2005 (2.46 person-rem) is primarily attributable to the repair of a leak at LANSCE in December 2005 and to an additional delay line installed at LANSCE in 2005. LANSCE has historically been the major contributor to the collective population dose. Collective population doses for the past 16 years have generally declined from a high of 4 person-rem in 1994 to less than 1 person-rem in 2009 (Figure 3-1). It is expected that future collective population doses will be less than 1 person-rem. No observable health effects in the local population are expected from this dose.

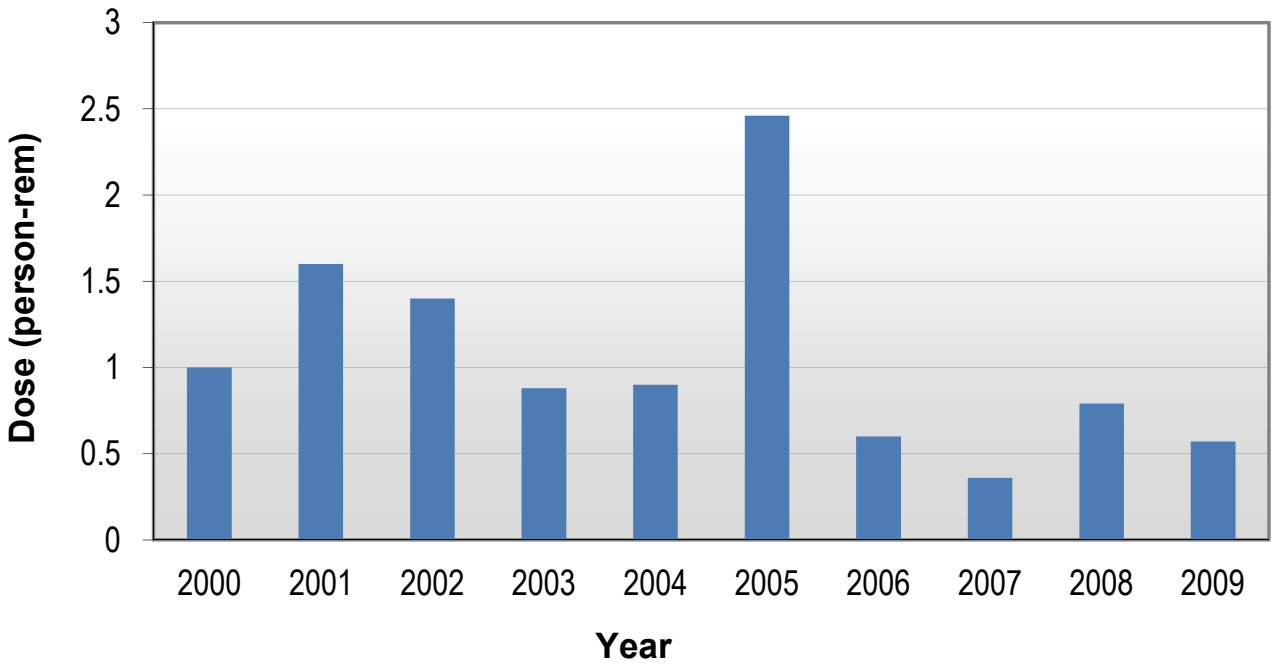


Figure 3-1. Annual collective dose (person-rem) to the population within 80 km of LANL over the past 10 years.

b. Dose to the Maximally Exposed Individual

The MEI is a hypothetical member of the public who, while not on DOE/LANL property, receives the greatest dose from LANL operations. For most of the past 15 years, the airborne pathway (RAD-NESHAP) MEI location has been at 2470 East Road, usually referred to as "East Gate." East Gate has normally been the location of greatest exposure because of its proximity to LANSCE and the prevailing wind direction. During LANSCE operations, short-lived positron emitters, such as carbon-11, nitrogen-13, and oxygen-15, are released from the stacks and diffuse from the buildings. These emitters release photon radiation as they decay, producing a potential radiation dose.

i. Airborne Pathway (RAD-NESHAP) MEI Dose

Because the LANSCE emissions after 2005 have been reduced to such low levels, the location of the MEI for 2009 was not as readily apparent as in the past and required more detailed evaluation, as follows.

We modeled the dose at East Gate from LANSCE and from the other LANL stacks using CAP88. The CAP88-modeled individual doses (Fuehne 2010) were 0.267 mrem/yr from LANSCE and 0.249 mrem/yr from other LANL stacks. We added 0.039 mrem/yr calculated from the airborne radionuclide concentrations measured at the East Gate AIRNET station, though this dose includes tritium, which was also in the CAP88 modeled doses (thus, tritium dose is conservatively included twice). Therefore, the total dose at East Gate was approximately 0.55 mrem/yr (Figure 3-2).

To ensure the East Gate location is the location with the highest potential dose (the actual MEI), we estimated the potential dose at two other locations that had relatively high AIRNET doses: station 32 at the Los Alamos County Landfill office and station 66 near the former Los Alamos Inn on Trinity Drive. Though the dose from LANSCE emissions is a significant contributor at the East Gate location, it is much less so at the other possible MEI locations. For each location, we determined the LANSCE facility (stack 53000702) annual gaseous mixed activation products (GMAP) emissions dose contribution and added the dose contribution from the AIRNET-measured radionuclides. The sums of these contributions at stations 32 and 66 were lower than the corresponding sum at East Gate. Therefore, the East Gate site was determined to be the MEI. See Section III of Fuehne (2010) for the details of how the MEI calculations were performed.

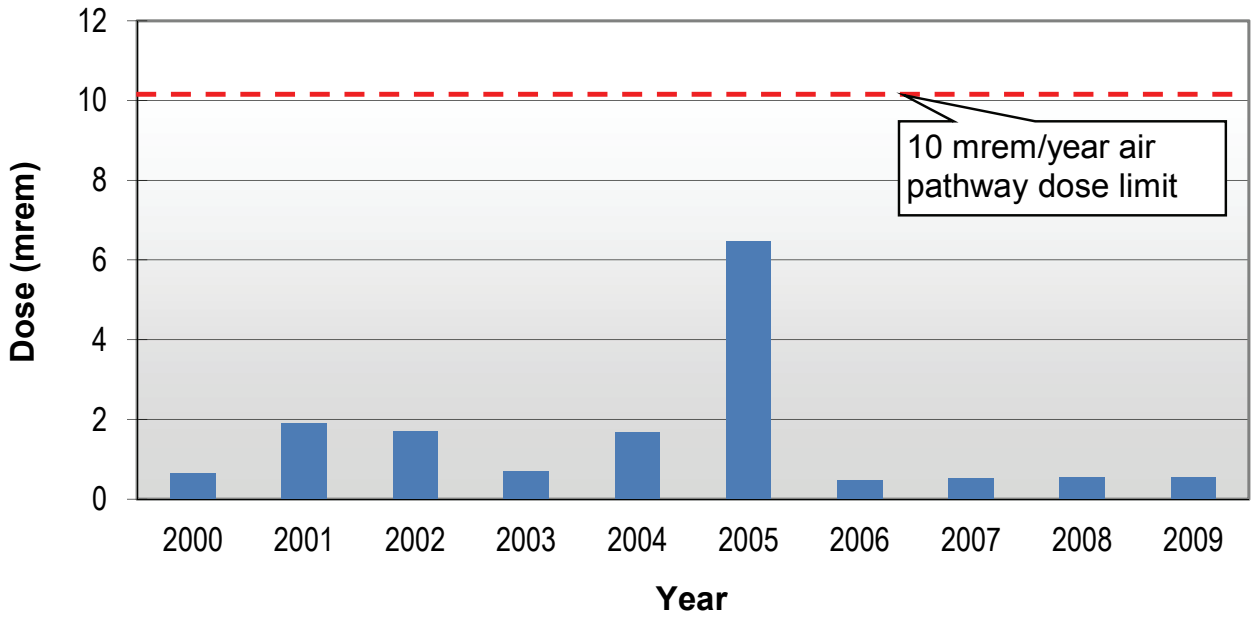


Figure 3-2. Annual airborne pathway (RAD-NESHAP) dose (mrem) to the MEI over the past 10 years.

ii. All-Pathways MEI Dose

The location evaluated in 2009 as the potential all-pathways MEI is the Laboratory boundary near the Pueblo de San Ildefonso sacred area north of TA-54, Area G. Transuranic waste at Area G awaiting shipment to the Waste Isolation Pilot Plant (WIPP) emits neutrons. The measured neutron dose at the boundary was 17 mrem/yr. After subtracting a 2-mrem/yr neutron background dose and applying the standard occupancy factor of 1/16 (NCRP 1976), the individual neutron dose is 15 mrem/16 = 0.9 mrem/yr. The gamma dose is calculated to be less than 0.01 mrem and is not included because it cannot be distinguished from the much larger gamma background measured at this and other nearby monitoring locations. To estimate the contributions from airborne radionuclides at this location, we used CAP88 to model the dose contribution from the LANL stacks as 0.02 mrem/16 = 0.001 mrem/yr. We added the dose derived from measurements at the highest-dose AIRNET station along the northern boundary of Area G (0.36 mrem/yr) close to where the neutron dose was measured and applied the occupancy factor of 1/16 to obtain a dose of 0.02 mrem/yr. This resulted in a total dose at this location of approximately 1 mrem/yr, which is greater than the airborne pathway MEI dose at East Gate.

iii. Dose Summary

The airborne pathway MEI dose of 0.55 mrem/yr at East Gate is below the 10 mrem/yr EPA airborne emissions dose limit for the public (EPA 1986), and, based on previous studies, we conclude it causes no observable health effects (BEIR 2006). The all-pathways MEI dose of 1 mrem/yr at the Laboratory boundary of the Pueblo de San Ildefonso sacred area north of Area G is below the 100 mrem/yr DOE limit for all pathways and the 25 mrem/yr dose constraint (DOE 1993, DOE 1999), and, again, we conclude it causes no observable health effects.

In most past years, LANSCE has been the major contributor to the MEI airborne pathway dose. Future operations of the facility and associated emissions are expected to stay consistent with 2009 levels. The 2009 and 2008 MEIs were located at East Gate and were primarily due to short-lived air activation emissions from LANSCE. The 2007 airborne pathway MEI was located on DP Road and was primarily due to the re-suspension of plutonium-239 in soil from Material Disposal Area (MDA) B. With increased remediation activities at MDA B and TA-21 DP West and East during 2010 and into the future, it is possible that the airborne pathway MEI may once again be located on DP Road in 2010 and in future years until completion of these projects.

c. Doses in Los Alamos and White Rock

We used background-corrected AIRNET data (reported in Chapter 4, Section A) and the factors in EPA guidance (EPA 1986) to calculate an annual dose at each of the two perimeter AIRNET stations that represent the Los Alamos resident and the White Rock resident. To these doses, we added the contributions from LANSCE and other stack emissions, calculated using CAP88 for two representative locations: 5 km northwest of LANSCE in Los Alamos and 6.8 km southeast of LANSCE in White Rock.

i. Los Alamos

During 2009, the Laboratory contributions to the dose at an average Los Alamos residence were 0.002 mrem/yr from tritium, 0.005 mrem/yr from transuranic radionuclides, 0.019 mrem/yr from uranium, and 0.008 mrem/yr from LANSCE. Other radionuclides contributed about 0.001 mrem/yr. This results in a total dose to an average Los Alamos resident of approximately 0.035 mrem/yr.

ii. White Rock

During 2009, the Laboratory contributions to the dose at an average White Rock residence were 0.008 mrem/yr from tritium, 0.001 mrem/yr from transuranic radionuclides, 0.008 mrem/yr from uranium, and 0.008 mrem/yr from LANSCE. Other radionuclides contributed less than 0.001 mrem/yr. This results in a total dose to an average White Rock resident of approximately 0.025 mrem/yr.

iii. Dose Summary

The contributions from direct radiation, food, water, and soil are discussed in Section B.2, above, in this chapter; each contribution is considered to be essentially a zero dose (i.e., <0.1 mrem/yr). In summary, the total annual dose in 2009 to an average White Rock/Los Alamos resident from all pathways was about 0.025 to 0.035 mrem and is well below the all-pathways dose limit of 100 mrem/yr and the 25 mrem/yr dose constraint. No observable health effects are expected from this dose.

4. Estimation of Radiation Dose Equivalents for Naturally Occurring Radiation

In this section, we discuss the potential LANL dose contribution relative to natural radiation and radioactive materials in the environment (NCRP 1975, 1987a, 1987b).

External radiation comes from two sources that are approximately equal: cosmic radiation from space and terrestrial gamma radiation from naturally occurring radionuclides. Doses due to cosmic radiation range from 50 mrem/yr at lower elevations near the Rio Grande to about 90 mrem/yr in the higher elevations west of Los Alamos (Bouville and Lowder 1988). In addition, background doses from terrestrial radiation range from about 50 to 150 mrem/yr.

The largest dose from radioactive material is from the inhalation of naturally occurring radon and its decay products. Nationwide, the average dose from radon is about 200 to 300 mrem/yr (NCRP 1987b.) In Los Alamos County, the average residential radon concentration results in a dose of 270 mrem/yr and is within the range of the national average (personal communication, J.J. Whicker 2010). An additional 40 mrem/yr results from naturally occurring radioactive materials in the body, primarily potassium-40, which is present in all food and living cells.

In addition, members of the US population receive an average dose of 300 mrem/yr from medical and dental uses of radiation. Compared to estimates used in previous years, this is a significant increase and is attributable to new information about the average medical dose received by members of the US population (NCRP 2009). About 10 mrem/yr comes from man-made products, such as stone or adobe walls, and less than 1 mrem/yr comes from global fallout from nuclear weapons tests. Therefore, the average total annual dose from sources other than LANL is approximately 700 mrem. Figure 3-3 compares the natural radiation background (and other sources) in Los Alamos to the average background dose in the United States. The estimated LANL-attributable 2009 all-pathways MEI dose, 1 mrem/yr, is about 0.1% of the average US dose.

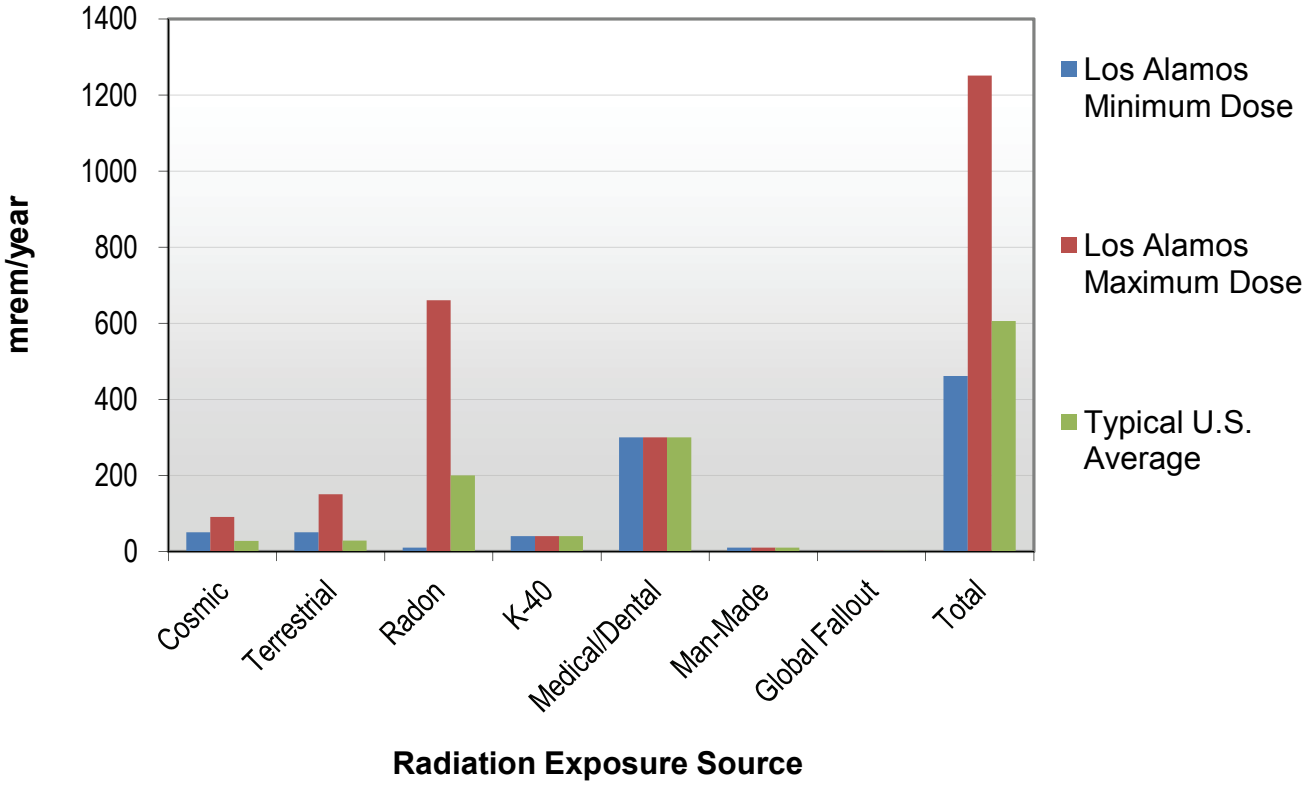


Figure 3-3. **Los Alamos County radiation background compared with average US background. Los Alamos County-specific background doses have not been determined for potassium-40, medical/dental exposures, man-made radiation, and global fallout and are assumed to be the same as the US average in this figure.**

5. Effect to an Individual from Laboratory Operations

Health effects from radiation exposure have been observed in humans at doses in excess of 10 rem (10,000 mrem), and as low as 1 rem (1,000 mrem) for the in utero fetus (BEIR 2006). However, doses to the public from LANL operations are much smaller (Table 3-1). Therefore, the doses presented in this chapter are not expected to cause observable health effects. .

Table 3-1
LANL Radiological Dose for Calendar Year 2009

Pathway	Dose to Maximally Exposed Individual mrem/yr	% of DOE 100 mrem/yr Limit	Estimated Population Dose person-rem	Population within 80 km	Estimated Background Radiation Population Dose person-rem
Air	0.55[a]	0.55%	0.57	NA[b]	NA
Water	<0.1	<0.1%	0	NA	NA
Other Pathways (foodstuffs, soils, etc.)	<0.1	<0.1%	0	NA	NA
All Pathways	1[c]	1%	0.57	~280,000	~220,000[d]

[a] RAD-NESHAP MEI dose measured at 2470 East Road (East Gate).

[b] NA = Not applicable. Pathway-specific populations are not specified, and pathway-specific background doses have not been determined, as allowed by DOE guidance.

[c] All-pathways MEI dose at the boundary of the Pueblo de San Ildefonso sacred area north of Area G.

[d] Based on 270 mrem/yr from inhalation of radon and its decay products, 70 mrem/yr from cosmic radiation, 100 mrem/yr from terrestrial radiation, 40 mrem/yr from potassium-40, 300 mrem/yr from medical and dental uses of radiation, and 10 mrem/yr from man-made products (see Section B.4).

C. BIOTA DOSE ASSESSMENT

1. Biota Dose Assessment Approach

a. Overview

The biota dose assessment methods are described in detail in the DOE Standard 1153-2002 (DOE 2002) and in the computer program RESRAD-BIOTA (http://web.ead.anl.gov/resrad/home2/biota.cfm). Because the calculations apply to all types of biota and all types of ecosystems, the DOE methods are general in nature and allow specific parameters to be adjusted according to local conditions. The site-specific methods used at LANL are specified in the quality assurance project plan for Biota Dose Assessment (available at http://www.lanl.gov/environment/air/qa.shtml?2), and McNaughton 2005 describes in detail the application of these methods to specific locations at LANL.

We calculate the dose to selected plants and animals following the guidance of DOE Standard 1153-2002 (DOE 2002) and LANL (LANL 2004). Trees of the pine family (Pinaceae) are representative of terrestrial plants because they are radiosensitive (UNSCEAR 1996) and because their deep roots might tap into buried contamination (Foxx et al. 1984a, b; Tierney and Foxx 1987). Deer mice are representative of terrestrial animals because of their relatively small home range, which means the maximally exposed mouse might spend a large fraction of its time in the most contaminated location. These representative plants and animals are common and widespread within LANL and the surrounding area. Other plants and animals (including aquatic plants and animals) may be collected and analyzed to estimate biota dose depending on availability and locations of interest.

b. Biota Dose Limits

The biota dose limits (DOE 2002) are applied to representative biota populations rather than to the MEIs because it is DOE's goal to protect populations, especially with respect to preventing the impairment of reproductive capability within the population.

The DOE dose limits to biota populations are

- Terrestrial animals: 0.1 rad/day (100 mrad/day)
- Terrestrial plants: 1 rad/day (1,000 mrad/day)
- Aquatic animals: 1 rad/day (1,000 mrad/day)

c. Methods

To ensure that the assessment is comprehensive, we began with a level 1 initial screening (DOE 2002) comparing the maximum radionuclide concentrations in soil, sediment, and surface water with the DOE Biota Concentration Guides (BCGs). The DOE Standard (DOE 2002) states, "An important point is that exceeding the BCGs should not force a mandatory decision regarding remediation of the evaluation area, but rather is an indication that further investigation is likely necessary." If the BCGs are exceeded, a level 2 site-specific assessment (DOE 2002) is conducted that uses average concentrations and incorporates site-specific bioaccumulation factors. Following the guidance of the DOE Standard (DOE 2002), we did not include external-radiation dose from experimental facilities such as the DARHT facility and LANSCE.

2. Biota Dose Results

As reported in Chapters 5 through 8, we collected water, soil, sediment, vegetation, bees, and small mammals in 2009 from several locations. All radionuclide concentrations in vegetation sampled were far below the plant 0.1 rad/day biota dose screening level (10% of the 1 rad/day dose limit), and all radionuclide concentrations in terrestrial animals sampled were far below the terrestrial animal 0.01 rad/day biota dose screening level (10% of the 0.1 rad/day dose limit). As previously mentioned in the soil pathway section of this chapter (see Section B.2.b.iv.), certain perimeter and on-site sample locations had soil radionuclide concentrations above background. However, none of these concentrations exceeded the limiting terrestrial animal BCG screening levels.

As reported in Chapter 6, there were several locations where surface water concentrations were above the BCG screening levels. Twenty percent of surface water samples collected from the Pajarito Plateau in 2009 contained radium at concentrations that were above the DOE BCG for aquatic systems. Radium is a naturally occurring radionuclide and was found in all major watersheds and from releases upstream of LANL. The concentrations that exceed

the BCG are for storm water containing sediment and not from aquatic habitats, so we used the maximum concentrations detected for this location in terrestrial biota dose assessments. The worst-case dose rates were 6×10^{-4} rad/day for terrestrial animals and 5×10^{-6} rad/day for plants and thus are less than the terrestrial biota dose limits.

D. NONRADIOLOGICAL RISK ASSESSMENT

1. Overview

Dose to members of the public and the environment from LANL radiological hazards is well understood and extensively documented. We place equal emphasis on the risk to members of the public and the environment from non-radiological hazards present at LANL, such as heavy metals and organic compounds.

This section assesses the potential human health risk from non-radiological materials released from LANL either during 2009 or during the previous 65 years of operations at LANL. The Clean Air Act regulates non-radiological air pollutants, as discussed in Chapter 2, Section 6. The applicable standards for other media are summarized in Table 5-1, Table 6-1, Table 8-1, and Appendix A. Air emissions data are reported in Chapter 2, ambient air data are reported in Chapter 4, and the data for other environmental media are reported in Chapters 5 through 8. The resulting potential public health risks are summarized below.

2. Results

a. General Considerations

Off-site concentrations of non-radiological contaminants in air, water, soil, and food described elsewhere in this report are well below the applicable standards or risk-based concentrations (EPA 2007, NMED 2006). The results from LANL monitoring and their potential human health impacts are summarized below.

i. Air (Inhalation Pathway)

Assessments of ambient air quality of non-radiological constituents, as reported in Chapter 4 Section D, indicate that LANL operations are not adversely impacting public health. The assessment of the ambient air impacts of high explosives testing, reported in Chapter 4, Section D.4, indicates no adverse impacts to the public. The beryllium concentrations reported in Chapter 4, Section D.5 are less than 1% of the NESHAP recommended concentration of 10 ng/m^3, and the PM-10 and PM-2.5 concentrations are lower than EPA limits (Chapter 4, Section D.3).

ii. Groundwater (Ingestion)

Groundwater results are reported in Chapter 5. The only Laboratory impact on a potential drinking water supply is at well Otowi-1 in Pueblo Canyon. For 2009, groundwater samples from this well had perchlorate concentrations ranging from 1.3 to 2.3 µg/L and were consistent with the 2008 concentrations. However, Los Alamos County does not use this well for its drinking water supply, and these values are below the EPA interim health advisory of 15 µg/L for drinking water. These perchlorate levels, therefore, do not present a potential risk to human health.

Basalt Spring, on Pueblo de San Ildefonso land in lower Los Alamos Canyon, had nitrate results in 2009 ranging from 2.8 mg/L to 4.7 mg/L, slightly lower than 2008 results which approached the NMED groundwater standard of 10 mg/L. The elevated level of nitrate in the spring water is most likely due to past and present releases of treated effluent from the Los Alamos County sanitary treatment plant. This spring is not a recognized drinking water source and because of minimal water ingestion expected from this source, i.e., less than 730 liters per year, and levels of nitrate around one-half of the standard, no deleterious health effects would be expected from these levels. Pine Rock Spring, also on Pueblo de San Ildefonso land, also had nitrate concentrations just above the NMED standard at 10 mg/L in 2008 and was near the NMED standard at 8.2 mg/L in 2009. Again, these levels should not present a deleterious health effect.

LANL has detected hexavalent chromium in the Mortandad Canyon regional aquifer monitoring well samples at levels above the New Mexico groundwater standard and at about 40% of the standard (50 µg/L of any dissolved form of chromium) in a Sandia Canyon regional aquifer monitoring well. However, hexavalent chromium has not been detected in Los Alamos County and Santa Fe Buckman drinking water supply wells above natural levels, so there is no health risk from ingestion of water from the drinking water supply wells.

iii. Surface Water and Sediment

The concentrations of chemicals in surface water and sediment are reported in Chapter 6. No potentially hazardous chemicals of LANL origin were detected off-site. We conclude there is no current hazard to the public from surface water and sediment exposure due to LANL past and present environmental releases.

Polychlorinated biphenyls (PCBs) are present in the on-site surface water and sediment. However, there are no aquatic organisms within the LANL boundaries that are part of a food ingestion pathway to humans. Measurements of PCBs in sediment using the Aroclor method indicated that none of the results were greater than recreational or residential screening levels.

PCBs are carried in sediment by storm water runoff to the Rio Grande. In 2009, sediment samples from the Rio Grande and the Abiquiu and Cochiti Reservoirs were analyzed for PCBs using the Aroclor method. Results from upstream and downstream sampling locations show that sources for PCBs are primarily from non-LANL sources, and the PCB congener homolog data generally supports this conclusion. Looking at these data together, we conclude that there is no measurable contribution of PCBs from LANL to the Rio Grande and, therefore, no detrimental health impact to humans from PCBs of LANL origin.

iv. Soil

Soil concentrations are reported in Chapter 7. The concentrations are far below their soil screening levels and, therefore, do not pose a potential human health risk.

v. Foodstuffs (Ingestion)

The concentrations of non-radioactive materials in foodstuffs are reported in Chapter 8. Of particular interest are PCB levels in bottom-feeding and predator fish caught in the Rio Grande. Crayfish sampled upriver and downriver of LANL contained low levels of PCBs in concentrations significantly below consumption limits for fish with no significant differences between the upstream and downstream values (Chapter 8, Table S8-3A). Concentrations of target analyte list elements (TALs) in downstream crayfish were higher than upstream crayfish for several TALs (aluminum, barium, beryllium, chromium, magnesium, vanadium, and arsenic), but the edible portions of the crayfish are expected to have low concentrations and negligible contribution to human risk (Chapter 8, Section A.3.d.).

Concentrations of TALs and PCBs in road-killed deer from Pajarito Plateau were measured for the first time and are documented for discussion and future use (Chapter 8, Table S8-5, and Table S8-6). Concentrations of PCBs in the muscle and bone appear to be low though there is no literature data to compare against. Human risk from TALs and PCBs in deer is considered negligible.

vi. Biota Samplings

TALs concentrations were measured in several important indicator species to assess potential impacts of particular LANL operations. Specifically, deer mice, several species of birds, and honey bees were sampled near the DARHT facility (Chapter 8, Section B.4.b.). Results show that the concentrations of TALs were below the RSRL for most elements. Barium concentrations in field mice were higher than the RSRLs, and birds contained concentrations of barium, antimony, and silver greater than the RSRLs, though intake of these elements likely occurred during migration given the low soil concentrations in the area. Concentrations of barium and copper in bees were higher than the background statistical reference level (similar to RSRL), but the concentrations agree with past results. While there are no ecological screening levels for concentrations of TALs in field mice and birds, the concentrations of these elements in the soil near DARHT are below the ecological screening levels.

Additionally, overstory vegetation was sampled for TALs (Table S8-8). All regional TAL concentrations were less than the RSRLs. Perimeter concentrations of TALs were mostly below the RSRLs except for lead at the Sportsman Club in Rendija Canyon (likely due to the public shooting range which is not on or near Laboratory land) and for mercury, which was found in several sites. The concentrations of the mercury were below health standards for consumption.

vii. Potential Future Risks

The possibility of hexavalent chromium and perchlorate from LANL sources entering the drinking-water supply in the future is being evaluated. Our goal is to assess both present and future risk. Models to calculate future risks are being developed.

3. Conclusion

The environmental data collected in 2009 show that there is no potential public health risk from non-radiological materials released from LANL.

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4. Air Surveillance

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A. AMBIENT AIR SAMPLING

1. Introduction

The radiological air sampling network, AIRNET, measures environmental levels of airborne radionuclides, such as plutonium, americium, uranium, tritium, and some activation products. Most regional airborne radioactivity is from fallout (from past nuclear weapons tests worldwide), natural radioactive constituents in particulate matter, terrestrial radon and its decay products, and cosmic radiation products. Table 4-1 summarizes regional levels of airborne radioactivity for the past five years.

Table 4-1
Average Background Concentrations of Radioactivity in the Regional[a] Atmosphere

			Annual Averages[c]				
Analyte	Units	EPA Concentration Limit[b]	2005	2006	2007	2008	2009
Alpha	fCi/m^3	No limit	0.9	1.0	1.0	0.9	1.0
Beta	fCi/m^3	No limit	16	17	19	17	19
Tritium[d]	pCi/m^3	1,500	0.1	-0.2	0.2	0.8	0.2
Am-241	aCi/m^3	1,900	0.1	0.2	-0.1	-0.3	-0.6
Pu-238	aCi/m^3	2,100	0.1	-0.3	-0.3	0.1	0.4
Pu-239	aCi/m^3	2,000	0.0	0.1	0.6	-0.1	1.0
U-234	aCi/m^3	7,700	12	17	15	18	17
U-235	aCi/m^3	7,100	1.2	0.8	0.8	1.3	0.7
U-238	aCi/m^3	8,300	13	16	15	17	16

[a] Regional air sampling stations operated by LANL (locations can vary by year).
[b] Each EPA Concentration Limit is from 10 CFR 40 and corresponds to 10 mrem/year.
[c] Alpha and beta values are gross air concentrations. All others are net air concentrations.
[d] Tritium values have been corrected for the tritium lost to bound water in the silica gel.

Particulate matter in the atmosphere is primarily caused by aerosolized soil. Windy, dry days increase soil entrainment; precipitation washes particulate matter out of the air. Meteorological conditions cause large daily and seasonal fluctuations in airborne radioactivity concentrations.

LANL staff compare ambient air concentrations and resulting off-site dose equivalents to the US Environmental Protection Agency (EPA) (EPA 1989) 10-mrem annual dose equivalent concentration limit, and on-site to those for a 100 mrem dose.

2. Air Monitoring Network

During 2009, LANL operated about 60 environmental air stations 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, waste site (Technical Area [TA] –54), decontamination and decommissioning (D&D) at Material Disposal Area B (MDA-B), or other on-site locations.

3. Sampling Procedures, Data Management, and Quality Assurance

The AIRNET quality assurance project plan and implementing procedures provide details about sample collection, sample management, chemical analysis, and data management.

a. Sampling Procedures

A station collects a continuous two-week sample. Particulate matter is collected on 47-millimeter polypropylene filters at airflow rates of about 110 liters per minute. Cartridges containing about 135 grams of desiccant (silica gel) collect water vapor samples with an air flow rate of 0.2 liters per minute. The silica gel is dried in an oven to remove most residual water before use. After use in the field, the silica gel is removed from the cartridge and shipped to the analytical laboratory where the moisture is distilled and then analyzed for tritium.

b. Data Management

In the field, personnel record the sampling data on a palm-held microcomputer, including timer readings, volumetric flow rates at the beginning and end of the sampling period, and comments pertaining to these data. These data are later transferred to a database.

c. Analytical Chemistry

A commercial laboratory analyzes each filter for gross alpha and gross beta activities. These filters are also grouped by region into 'clumps' of four to nine filters and screened for gamma-emitting radionuclides. A quarterly composite for each station is made up of half-filters from six or seven sampling periods. Analysts at the laboratory dissolve these composites, separate them chemically, and analyze them for isotopes of americium, plutonium, and uranium using alpha spectroscopy. The analytical laboratory uses liquid scintillation spectrometry to analyze the distillate from the gel for tritium. All analytical procedures satisfy Title 40 Code of Federal Regulations (CFR) Part 61, Appendix B. The AIRNET quality assurance project plan specifies the target minimum detectable activities for all samples.

d. Laboratory Quality Control Samples

The sampling team and the analytical laboratory maintain a program of blank, spike, duplicate, and replicate analyses. This program provides information on the quality of the data received from the analytical laboratory. These data are reviewed to ensure they meet all quality assurance requirements.

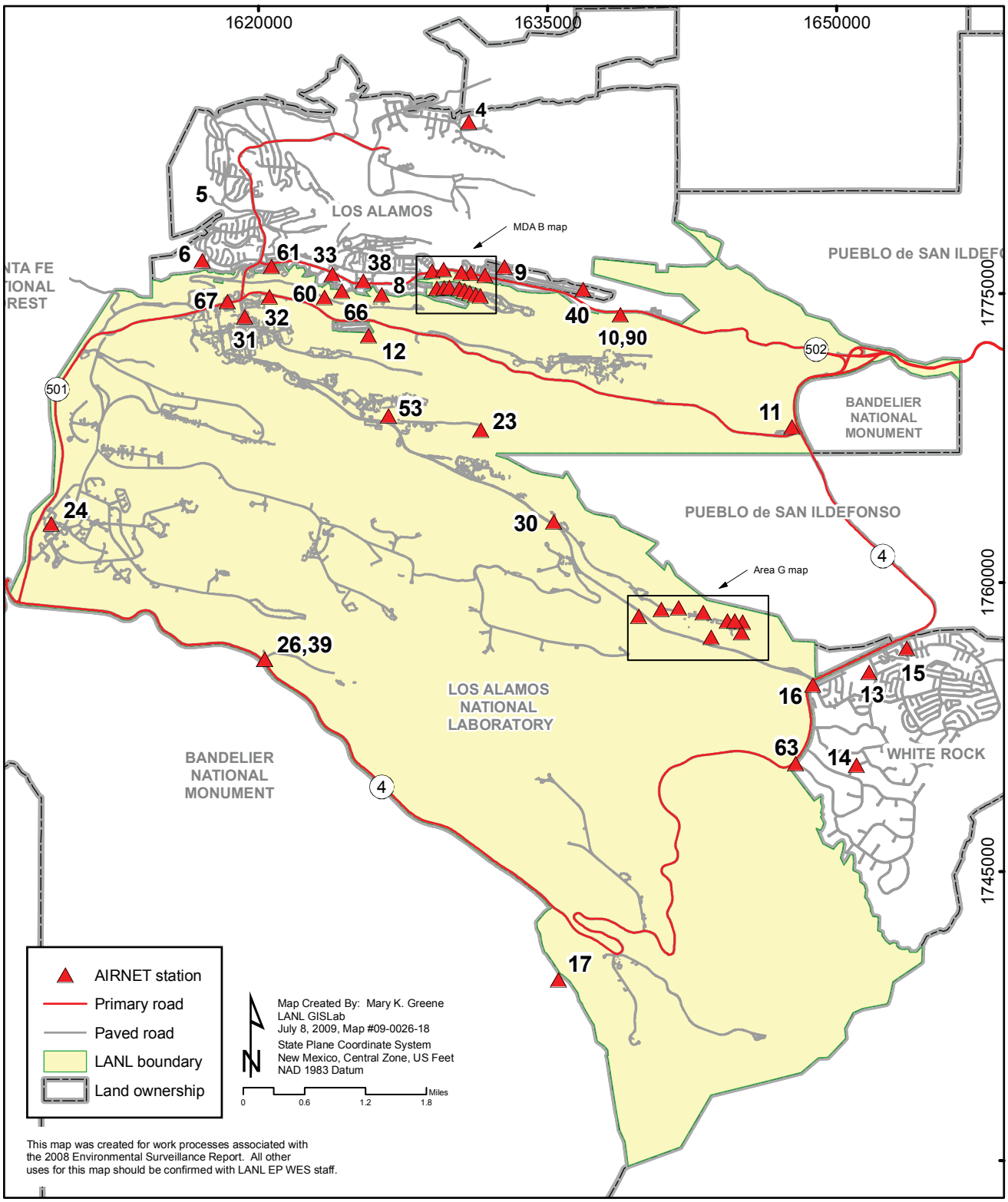

Figure 4-1. AIRNET locations at and near Los Alamos National Laboratory.

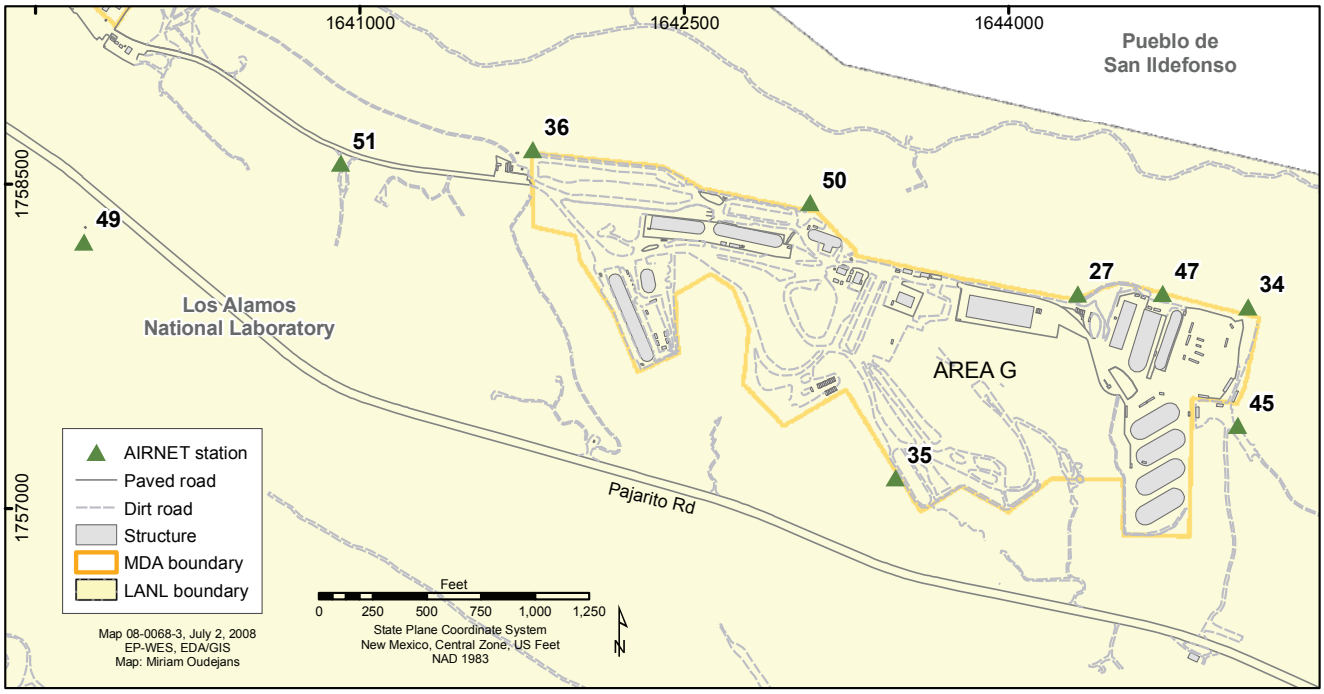

Figure 4-2. AIRNET station locations at Area G, TA-54, Los Alamos National Laboratory.

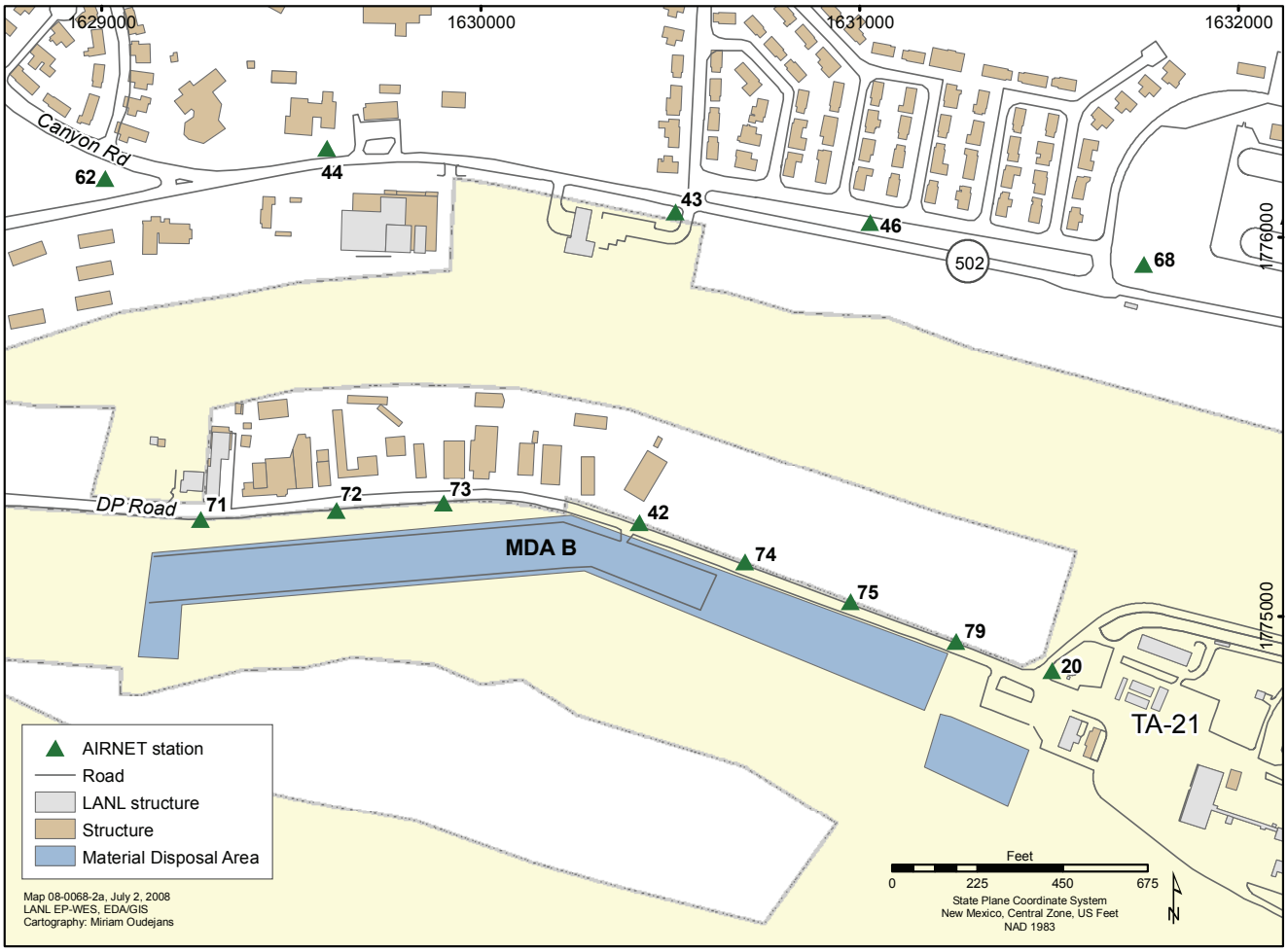

Figure 4-3. AIRNET station locations near TA-21, MDA B.

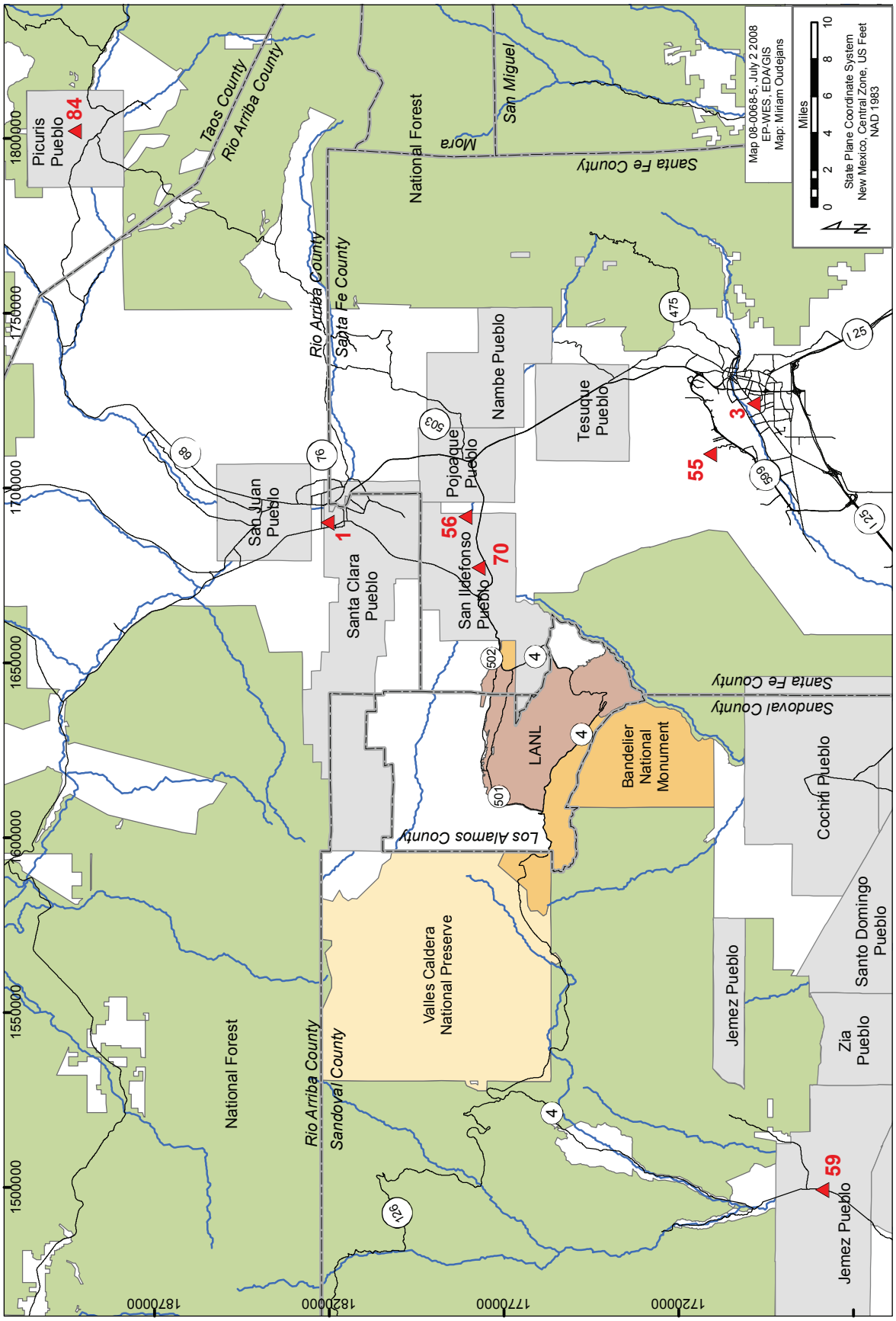

Figure 4-4. Regional and Pueblo AIRNET locations.

4. Ambient Air Concentrations

a. Explanation of Reported Concentrations

Tables 4-2 through 4-10 summarize the measured 2009 ambient air concentrations. The Supplemental data tables (on included compact disc) Tables S4-1 through S4-9 provide data from individual sites. AIRNET concentrations do not have any background subtraction, but do include blank corrections for radioactivity in the filter material, acids used to dissolve the filter, and tracers added to determine recovery efficiencies. The net uncertainties include the variation added by correcting for the blank measurements.

Uncertainties for all data in this ambient air sampling section represent a 95% confidence (2s) interval. Since confidence intervals are calculated with data from multiple sites and throughout the year, they include not only random measurements and analytical errors but also seasonal and spatial variations. The 95% confidence intervals are overestimated for the average concentrations and probably represent confidence intervals near 99%. Negative values are included in averages as their omission would bias averages upward.

Concentrations greater than their 3s uncertainties are used to identify samples of interest or detected concentrations. A control limit of 3s is widely used for statistical quality control charts (Duncan 1986, Gilbert 1987) since the rate of false positives or detections is 5% at 2s but only 0.3% at 3s.

Table 4-2
Airborne Long-Lived Gross Alpha Concentrations for 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval* (fCi/m³)		Maximum Station Concentration (fCi/m³)	
					Biweekly	Annual
Regional	104	100%	1.0	±0.1	2.3	1.1
Pueblo	71	100%	1.0	±0.2	3.5	1.1
Perimeter	769	100%	0.9	±0.03	2.8	1.1
Waste Site	208	99.5%	0.8	±0.06	2.2	0.9
Onsite	130	100%	0.7	±0.06	1.8	0.8
D and D	208	99.0%	0.8	±0.06	1.6	0.9

*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 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval* (fCi/m³)		Maximum Station Concentration (fCi/m³)	
					Biweekly	Annual
Regional	104	100%	19	±2	34	20
Pueblo	71	100%	18	±3	65	22
Perimeter	769	100%	18	±0.5	61	23
Waste Site	208	100%	17	±1	35	18
Onsite	130	100%	17	±1	33	17
D and D	208	100%	17	±1	29	18

*Confidence intervals are calculated using all calculated sample concentrations from every site within the group.

b. Investigation of Elevated Air Concentrations.

We have established two action levels to determine the potential impact of an unplanned release. The "investigation" action level is triggered when an air concentration exceeds a five-year average plus 3s at that location. "Alert" action levels are higher concentrations that are based on allowable EPA and DOE annual doses and require a more thorough and immediate follow-up.

When a measured air concentration exceeds an action level, we verify that the calculations were done correctly and that the sampled air concentrations are representative. If so, we work with operations personnel to assess potential sources and implement possible mitigation plans.

In 2009, no measurements of plutonium, americium, and uranium exceeded alert action levels. Tritium alert levels were not exceeded off-site, but elevated tritium levels were observed at Area G. Approximately 57 measurements were above the investigation levels but none exceeded 1% of the EPA dose limits.

c. Gross Alpha and Gross Beta Radioactivity

We use gross alpha and gross beta analyses for rapid evaluation of general radiological air quality, potential trends, and detection of sampling problems. Elevated gross results may cause additional investigative analyses.

The National Council on Radiation Protection and Measurements (NCRP) estimated the national average concentration of long-lived gross alpha activity in air to be 2 femtocuries per cubic meter (aCi/m^3). Polonium-210 and other naturally occurring radionuclides are the primary sources of alpha activity (NCRP 1975, NCRP 1987). The national average for long-lived gross beta activity in air is 20 aCi/m^3. Lead-210 and bismuth-210, decay products of radon, and other naturally occurring radionuclides are the primary sources of beta activity.

In 2009, we analyzed about 1,500 air samples for gross alpha and gross beta activity. The annual average for alpha at all stations (Table 4-2) is about half of the national average. At least two factors contribute: (1) the use of actual sampled air volumes instead of volumes at standard temperature and pressure and (2) the burial of alpha emitters in the filter that are missed by front-face counting. Gross alpha and beta activity depends on atmospheric pressure, atmospheric mixing, temperature, and soil moisture.

Table 4-3 shows gross beta concentrations at and around LANL. The variability is similar to that in the gross alpha concentrations. The annual average is slightly below the national average. Our gross beta measurements include little to no lead-210 due to its low-energy beta emission. We calculate the gross beta concentrations using actual sampled air volumes.

Figures 4-5 and 4-6 show the variability of gross alpha and gross beta activities. Geographical variability is usually much less than temporal variability and is often larger in winter than summer. In winter radon may be trapped below an inversion layer, resulting in higher count rates.

d. Tritium

Tritium is present in the environment primarily as the result of past nuclear weapons tests and natural production by cosmogenic processes (Eisenbud and Gesell 1997). We measure tritiated water (HTO) because the dose impact is about 25,000 times higher than from gaseous HT or T2 (ICRP 1978). We used water-vapor concentrations in the air and tritium concentrations in the water vapor to calculate ambient levels of tritium, including corrections for blanks, bound water in the silica gel, and isotopic distillation effects.

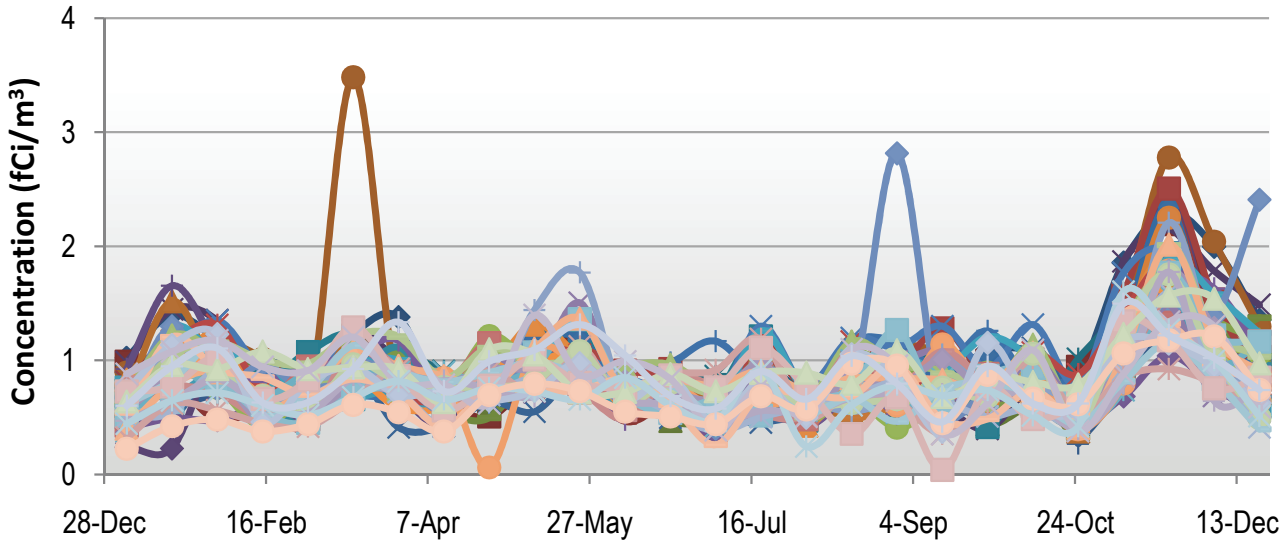

Figure 4-5. Gross alpha measurements for all sampling sites by date collected in 2009.

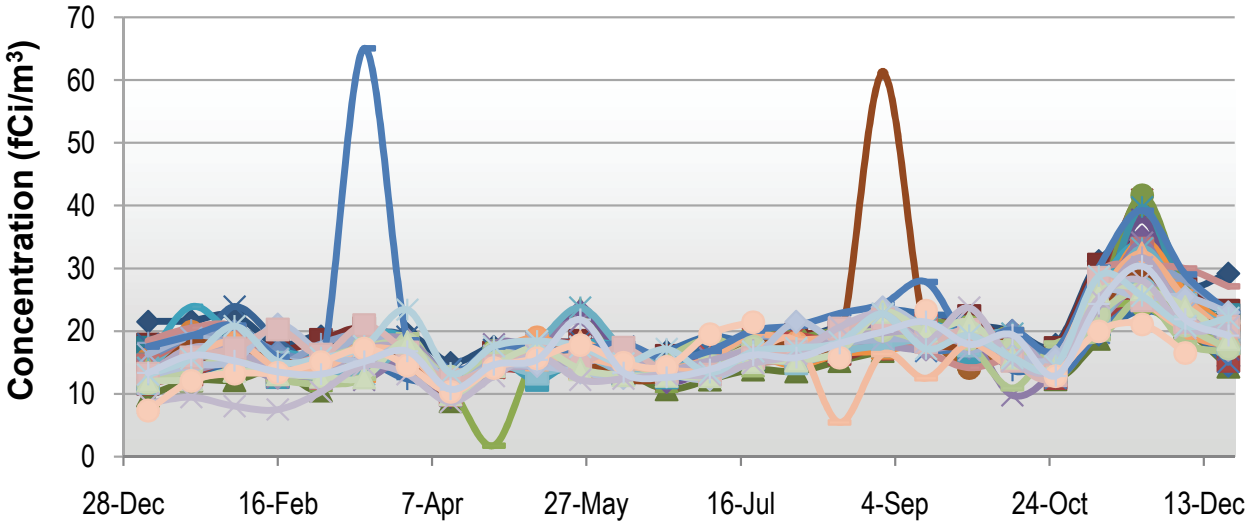

Figure 4-6. Gross beta measurements for all sampling sites by date collected in 2009.

During 2009, all annual mean concentrations were well below EPA and DOE guidelines (Table 4-4). The highest off-site annual tritium concentration is equivalent to about 0.25% of the EPA public dose limit. We measured elevated tritium concentrations at a number of on-site stations, with the highest annual mean concentration near a known source at TA-54 but at less than 3% of the on-site worker exposure limit.

Tritium concentrations reflect current operations and show no distinctive trends (Figure 4-7). In 2006, tritiated waste at Area G raised the annual average. This waste was moved to tritium shafts at Area G and levels decreased.

Table 4-4
Airborne Tritium as Tritiated Water Concentrations for 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval[a] (pCi/m³)		Maximum Station Concentration (pCi/m³)	
					Biweekly	Annual
Regional[b]	104	1%	0.2	±0.3	6	0.5
Pueblo[b]	72	1%	0.3	±0.6	7	0.3
Perimeter[b]	761	6%	0.6	±0.2	8	4
Waste Site[c]	205	78%	60	±53	2,200	430
On-Site[c]	130	16%	4	±3	67	17
D&D[b]	207	4%	0.7	±0.3	6	2

[a] Confidence intervals are calculated using all calculated sample concentrations from every site within the group.
[b] EPA 40, CFR Part 61, Appendix E, concentration limit is 1,500 pCi/m³.
[c] Ten times public limit in b.

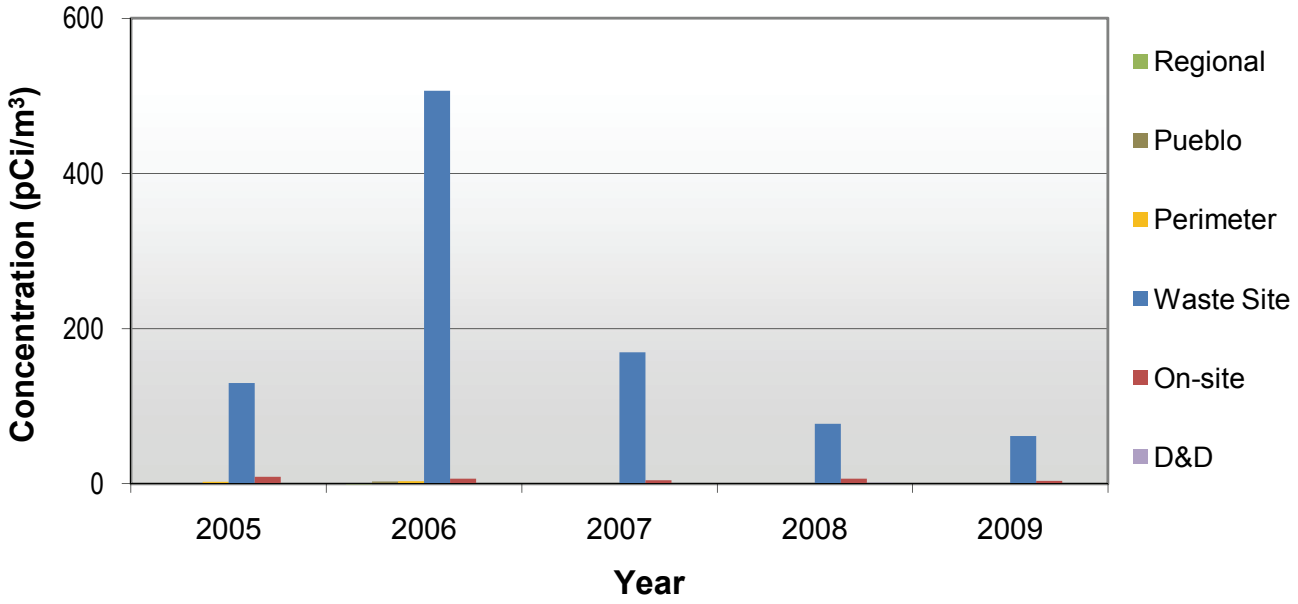

Figure 4-7. Annual average concentrations of tritium by group.

e. 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. Measurable sources in air are usually plutonium research activities, nuclear weapons production and testing, the nuclear fuel cycle, and other related activities. With few exceptions, fallout from atmospheric testing of nuclear weapons is the primary source of plutonium in ambient air.

Table 4-5 summarizes the plutonium-238 data for 2009. The highest annual average concentration was recorded off-site but was only 2.9 ± 7aCi/m³, about 0.15% of the EPA public limit and consistent with zero. Four quarterly concentrations above 3s were measured near MDA-B, and two others elsewhere off-site.

Table 4-6 summarizes the plutonium-239/240 data. All quarterly concentrations at Station 66 (on the canyon edge south of Ashley Pond) were above their 3s uncertainties. The annual mean concentration here was the highest at 26 ± 9 aCi/m³, about 1.3% of the EPA public dose limit. These higher ambient concentrations are from legacy deposits on the hillside to the south. Eleven quarterly concentrations above 3s were measured near the MDA-B clean-up site, and seven others elsewhere off-site. Twelve on-site quarterly concentrations exceeded 3s, all but one being at or near Area G.

Table 4-5
Airborne Plutonium-238 Concentrations for 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval[a] (aCi/m³)		Maximum Station Concentration (aCi/m³)	
					Biweekly	Annual
Regional[b]	16	0%	0.4	±0.7	2	1
Pueblo[b]	11	0%	0.5	±0.8	2	1
Perimeter[b]	120	5%	0.6	±0.3	8	3
Waste Site[c]	32	3%	0.7	±0.4	2	1
On-Site[c]	20	0%	0.6	±0.7	3	2
D&D[b]	32	0%	0.9	±0.4	2	1

[a] Confidence intervals are calculated using all calculated sample concentrations from every site within the group.
[b] EPA 40, CFR Part 61, Appendix E, concentration limit is 2,100 aCi/m³.
[c] Ten times public limit in b.

Table 4-6
Airborne Plutonium-239/240 Concentrations for 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval[a] (aCi/m³)		Maximum Station Concentration (aCi/m³)	
					Biweekly	Annual
Regional[b]	16	13%	1.0	±0.9	3	1
Pueblo[b]	11	0%	1.1	±1.4	4	2
Perimeter[b]	120	8%	1.4	±1.3	32	26
Waste Site[c]	32	31%	3.4	±2.9	26	14
On-Site[c]	20	10%	1.1	±1.5	9	3
D&D[b]	32	34%	2.7	±1.3	10	5

[a] Confidence intervals are calculated using all calculated sample concentrations from every site within the group.
[b] EPA 40, CFR Part 61, Appendix E, concentration limit is 2,000 aCi/m³.
[c] Ten times public limit in b.

Concentrations of plutonium show no distinctive trends over the past five years. In 2007 and 2008, remediation activities at TA-21 increased plutonium averages near that location. Figures 4-8 and 4-9 show the annual grouping average concentrations, except Area G which is shown separately in Figure 4-10. The increased concentration of plutonium-239 in 2006 was due to operations involving cleanup of waste.

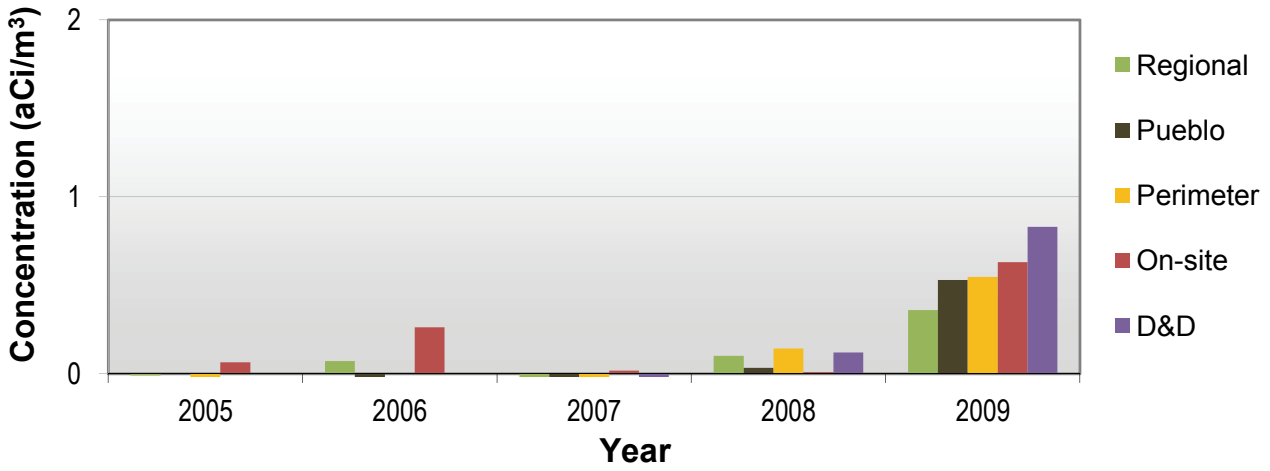

Figure 4-8. Annual average concentrations of plutonium-238 by group.

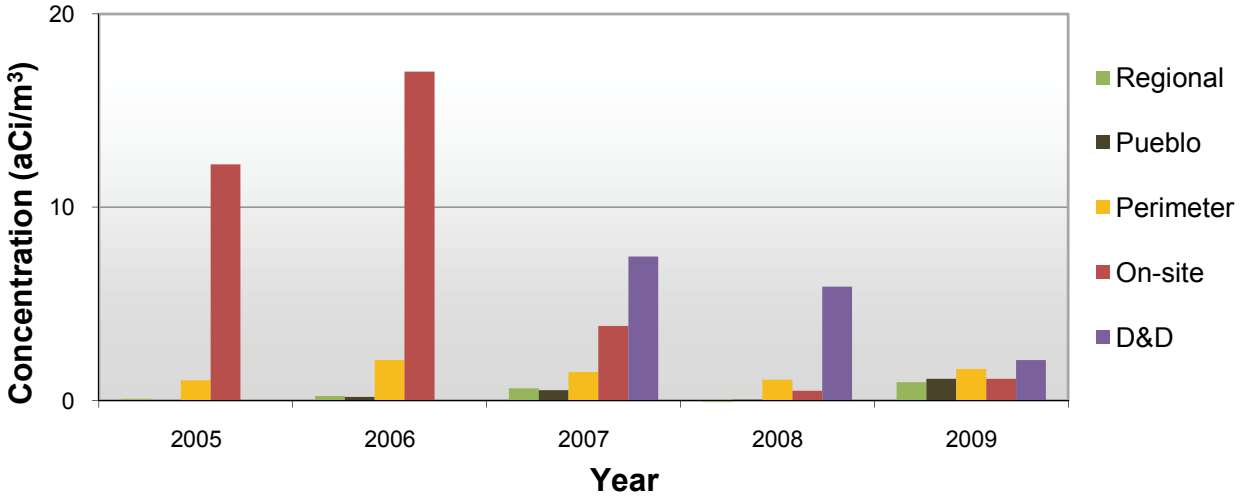

Figure 4-9. Annual average concentrations of plutonium-239/240 by group.

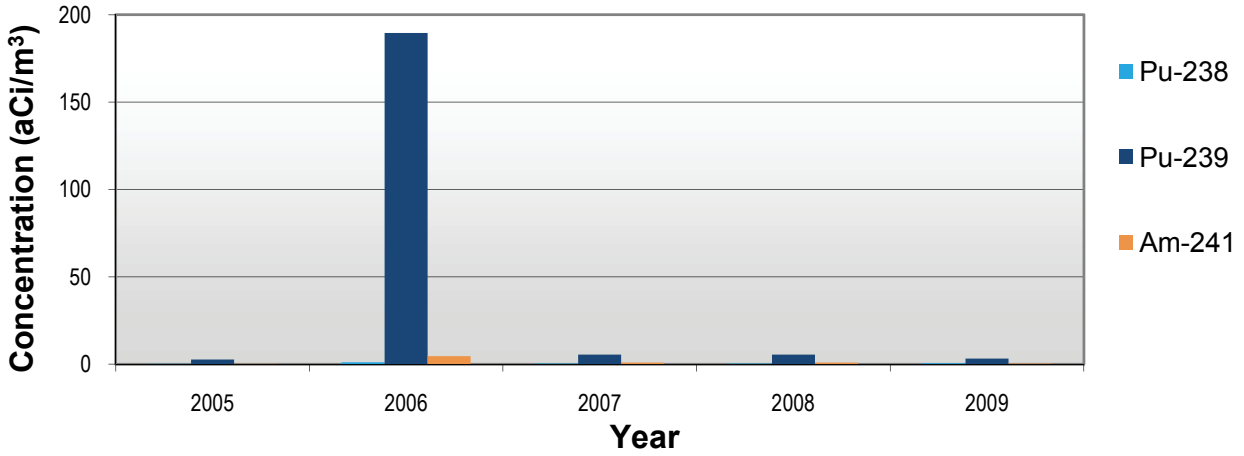

Figure 4-10. Americium and plutonium concentrations at TA-54, Area G.

f. Americium-241

Americium is present in very low concentrations in the environment. Table 4-7 summarizes the americium-241 data. Seven off-site quarterly samples with a concentration greater than 3s were measured. Six on-site quarterly samples (five at Area G) were measured with concentrations greater than 3s. The highest quarterly off-site and on-site concentrations were 0.1% and 0.01% of the public and worker limits, respectively.

Table 4-7
Airborne Americium-241 Concentrations for 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval[a] (aCi/m³)		Maximum Station Concentration (aCi/m³) Biweekly	Maximum Station Concentration (aCi/m³) Annual
Regional[b]	16	0%	-0.6	±0.8	1	0
Pueblo[b]	11	0%	-0.2	±0.9	1	0
Perimeter[b]	120	3%	-0.1	±0.4	9	2
Waste Site[c]	32	16%	0.4	±0.8	4	2
On-Site[c]	20	5%	0.0	±1.2	5	2
D&D[b]	32	9%	0.0	±0.7	5	2

[a] Confidence intervals are calculated using all calculated sample concentrations from every site within the group.
[b] EPA 40, CFR Part 61, Appendix E, concentration limit is 1,900 aCi/m³.
[c] Ten times public limit in b.

Americium concentrations show no distinctive trends over the past five years. In 2007 and 2008, remediation activities at TA-21 raised americium averages in that area. Figure 4-11 shows the annual group average concentrations, except Area G which is shown separately in Figure 4-10.

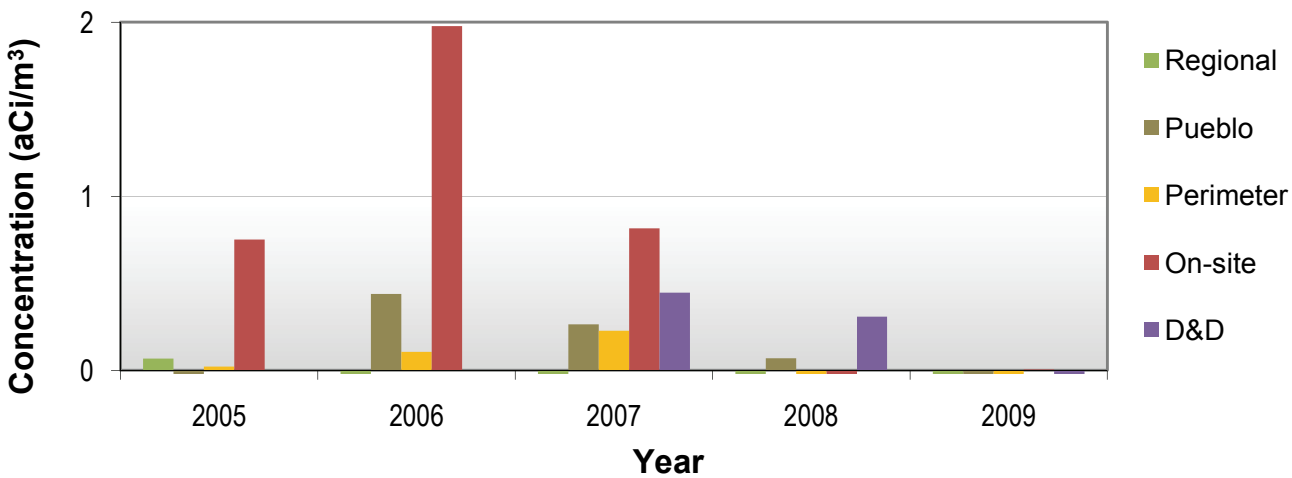

Figure 4-11. Annual average concentrations of Americium-241 by group.

g. Uranium

Three isotopes of uranium are normally found in nature: uranium-234, -235, and -238. In natural uranium, relative isotopic abundances are constant and known; the ratio of the activity of uranium-238 to that of uranium-234 is approximately 1 (Walker et al., 1989). LANL uses comparisons of isotopic concentrations to estimate its contributions because known Laboratory emissions in the past 50 years were not of natural uranium, but either enriched uranium (EU) (enriched in uranium-234 and -235) or depleted uranium (DU). EU and DU were identified by comparing uranium-234 and -238 concentrations. If they differed by more than 3s the sample was considered to have significant concentrations of EU or DU.

All annual mean concentrations of uranium isotopes (Tables 4-8 to 4-10) were below 0.5% of the EPA guidelines. The highest annual uranium concentrations are typically at dusty locations.

Table 4-8
Airborne Uranium-234 Concentrations for 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval[a] (aCi/m³)		Maximum Station Concentration (aCi/m³)	
					Biweekly	Annual
Regional[b]	16	94%	17	±5	38	4
Pueblo[b]	11	100%	20	±6	34	9
Perimeter[b]	120	97%	10	±1	50	0.3
Waste Site[c]	32	100%	17	±5	66	3
On-Site[c]	20	100%	9	±2	20	3
D&D[b]	32	94%	13	±4	71	4

[a] Confidence intervals are calculated using all calculated sample concentrations from every site within the group.
[b] EPA 40, CFR Part 61, Appendix E, concentration limit is 7,700 aCi/m³.
[c] Ten times public limit in b.

Table 4-9
Airborne Uranium-235 Concentrations for 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval[a] (aCi/m³)		Maximum Station Concentration (aCi/m³)	
					Biweekly	Annual
Regional[b]	16	6%	0.7	±1.2	4	2
Pueblo[b]	11	0%	0.9	±0.9	3	1
Perimeter[b]	120	3%	0.5	±0.3	3	3
Waste Site[c]	32	9%	1.1	±0.9	6	3
On-Site[c]	20	5%	0.9	±0.7	3	1
D&D[b]	32	9%	1.4	±1.0	9	3

[a] Confidence intervals are calculated using all calculated sample concentrations from every site within the group.
[b] EPA 40, CFR Part 61, Appendix E, concentration limit is 7,100 aCi/m³.
[c] Ten times public limit in b.

Table 4-10
Airborne Uranium-238 Concentrations for 2009 — Group Summaries

Station Grouping	Number of Biweekly Samples	Fraction of Samples > 3s Uncertainty	Mean ± 99.7% Confidence Interval[a] (aCi/m³)		Maximum Station Concentration (aCi/m³)	
					Biweekly	Annual
Regional[b]	16	100%	16	±4	32	23
Pueblo[b]	11	100%	18	±7	39	28
Perimeter[b]	120	98%	12	±2	51	37
Waste Site[c]	32	100%	16	±5	66	36
On-Site[c]	20	95%	12	±5	47	17
D&D[b]	32	100%	15	±3	42	18

[a] Confidence intervals are calculated using all calculated sample concentrations from every site within the group.
[b] EPA 40, CFR Part 61, Appendix E, concentration limit is 8,300 aCi/m³.
[c] Ten times public limit in b.

EU was detected once (near the eastern end of DP Road) and DU 15 times during 2009 (Figure 4-12). All the DU detections occurred in the same quarter and appear to be from the same event. The source of this DU was probably legacy waste on LANL property lofted by strong winds.

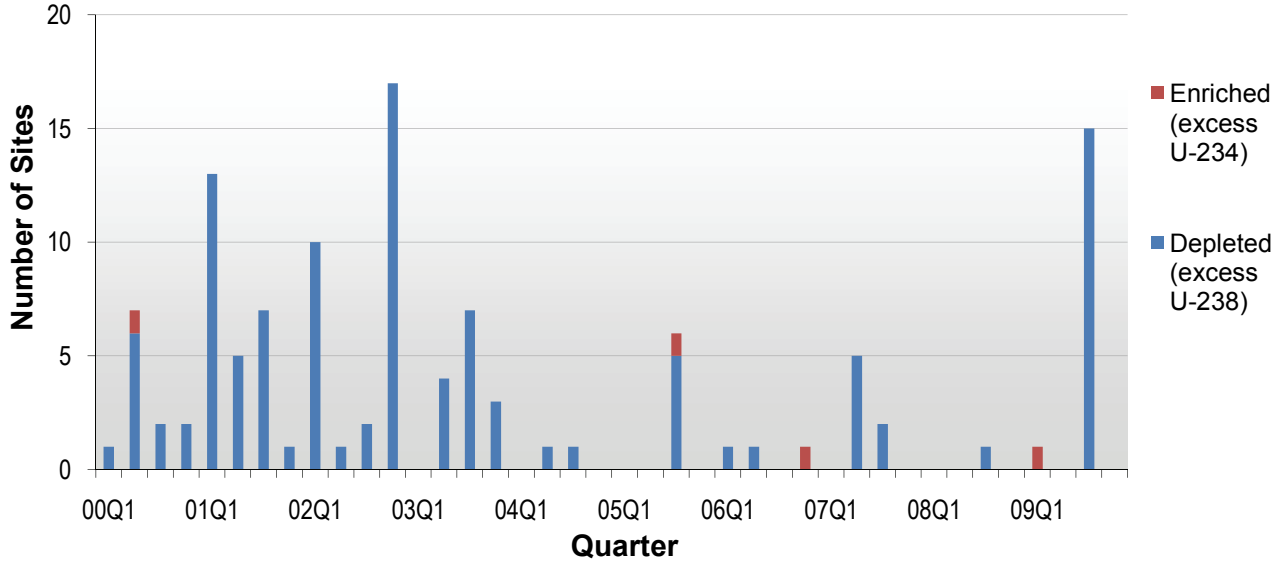

Figure 4-12. Number of sites where enriched or depleted uranium has been detected since 2000.

Concentrations for uranium isotopes typically peak during windier quarters (Figure 4-13). Over the last five years the trends are flat.

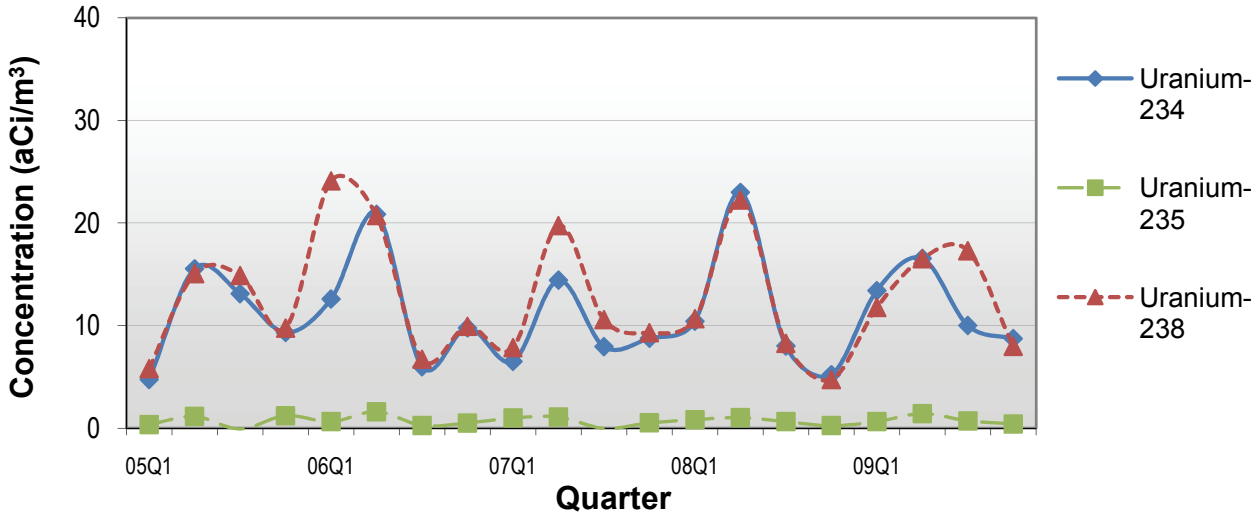

Figure 4-13. Quarterly all-station average concentrations of uranium isotopes.

h. Gamma Spectroscopy Measurements

For gamma screening, we group filters across sites in "clumps" for each sampling period. The clumps were analyzed for the following analytes: arsenic-73, arsenic-74, cadmium-109, cobalt-57, cobalt-60, cesium-134, cesium-137, manganese-54, sodium-22, rubidium-83, rubidium-103, selenium-75, and zinc-65. None have been detected in the last five years. We investigate the measurement of any of these analytes above its minimum detectable activity.

We also analyze the natural radionuclides beryllium-7, potassium-40, and lead-210. However, we only initiate investigations when elevated levels are found. No elevated levels of these were found during 2009.

5. Special Monitoring

In July we monitored a controlled burn in Bandelier National Monument. Eight high-volume samplers ran for a few days. No elevated levels were detected for any of the most likely elements or isotopes expected.

B. STACK SAMPLING FOR RADIONUCLIDES

1. Introduction

Radioactive materials are an integral part of many activities at LANL. Some operations involving these materials may be vented to the environment through a stack or other forced air release point. Members of the stack monitoring team at LANL evaluate these operations to determine potential impacts to the public and the environment. Emissions are estimated using engineering calculations and radionuclide materials usage information with the assumption there are no emission controls in place, such as the high-efficiency particulate air filters which are present on all stacks. If this evaluation shows that emissions from a stack may potentially result in a member of the public receiving as much as 0.1 mrem in a year, LANL must sample the stack in accordance with 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" (Rad-NESHAP) (EPA 1989). During 2009, we identified 26 stacks meeting this criterion.

2. Sampling Methodology

In 2009, we continuously sampled 26 stacks for the emission of radioactive material to the ambient air. LANL categorizes its radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous activation products, (3) tritium, and (4) gaseous mixed activation products (GMAP). For each of these emission types, LANL employs an appropriate sampling method, as described below.

We sample emissions of radioactive particulate matter generated by operations at facilities, such as the Chemistry and Metallurgy Research Building and the TA-55 Plutonium Facility, using a glass-fiber filter. A continuous sample of stack air is pulled through a filter that captures small particles of radioactive material. We collect these samples weekly and ship them to an off-site analytical laboratory. The analytical laboratory uses gross alpha/beta counting and gamma spectroscopy to identify any increase in emissions and to identify short-lived radioactive materials. Every six months, the analytical laboratory composites these samples and analyzes them to determine the cumulative activity on all the filters of radionuclides such as uranium-234, -235, and-238, plutonium-238 and -239/240, and americium-241. We use the isotopic data to calculate emissions from the stack for the six-month period.

A charcoal cartridge samples emissions of vapors, such as bromine-82, and highly volatile compounds, such as selenium-75, generated by operations at the Los Alamos Neutron Science Center (LANSCE) and hot cell activities at the Chemistry and Metallurgy Research Building and TA-48. A continuous sample of stack air is pulled through a charcoal filter that adsorbs vaporous emissions of radionuclides. This charcoal filter is mounted downstream of a glass-fiber filter (discussed above) that removes any particulates from this sample media prior to the vapor sampling. Gamma spectroscopy determines the amount and identity of the radionuclide(s) present on the charcoal filter, which is collected weekly at the same time as the filter.

We measure tritium emissions from LANL's tritium facilities with a collection device known as a bubbler. This device enables us 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 is then "bubbled" through three sequential vials containing ethylene glycol. The ethylene glycol collects the water vapor from the sample of air, including any tritium that may be part of a water molecule (HTO). "Bubbling" through these three vials removes essentially all HTO from the air, leaving only HT. The air is then passed through a palladium catalyst that converts the HT to HTO. The sample is pulled through three additional vials containing ethylene glycol, which collect the newly formed HTO. We collected the vials of ethylene glycol weekly and sent them to an analytical laboratory for liquid scintillation counting to determine the amount of HTO and HT.

In previous years, we monitored stacks at LANSCE for tritium. After an historical evaluation of HTO emissions from LANSCE in 2001, we discontinued sampling tritium following the July 2001 report period based on the low historical emissions of HTO from TA-53 and the low relative contribution of tritium to the off-site dose from TA-53 emissions. Emissions of tritium reported in 2009 from LANSCE are based on 2001 tritium generation rates.

We measure GMAP emissions from LANSCE activities using real-time monitoring data. A sample of stack air is pulled through an ionization chamber that measures the total amount of radioactivity in the sample. Gamma spectroscopy and decay curves are used to continuously identify specific radioisotopes and the quantity of each. From these data, the total emissions of each radionuclide are calculated.

3. Sampling Procedures and Data Analysis

a. Sampling and Analysis

Analytical methods used comply with EPA requirements in 40 CFR 61, Appendix B, Method 114 (EPA 1989). Section F of this chapter presents the results of analytical quality assurance measurements. This section discusses the sampling and analysis methods for each type of LANL's emissions.

b. Particulate Matter Emissions

We remove and replace the glass-fiber filters that each week sample facilities with significant potential for radioactive particulate emissions, and we then ship them to an off-site analytical laboratory. Prior to shipping, we screen each sample filter with a hand-held instrument to determine if there are any unusually high levels of gross alpha or beta radioactivity. The laboratory performs analyses for the presence of alpha and beta radioactivity after the sample has been allowed to decay for approximately one week (to allow short-lived radon progeny to decay). In addition to alpha and beta analyses, the laboratory performs gamma spectroscopy analysis to identify specific isotopes in the sample. While alpha and beta counting are performed on individual glass-fiber filters, gamma spectroscopy is performed on "clumps" of filters, a group of seven or eight filters stacked together to allow quick analysis for gamma-emitting radionuclides. Subsequent analyses, if needed, are performed on individual filters.

The glass-fiber filters are composited every six months for radiochemical analysis because gross alpha/beta counting cannot identify specific radionuclides. We use the data from these composite analyses to quantify emissions of radionuclides, such as the isotopes of uranium and plutonium. The Rad-NESHAP team compares the results of the isotopic analysis with gross activity measurements to ensure that the requested analyses (e.g., uranium-234, -235, and -238; and plutonium-238 and -239/240, etc.) identify all significant activity in the composites.

For particulate filters from the LANSCE accelerator facility, the analytical laboratory only performs gamma spectroscopy analyses based on the anticipated suite of emissions from this facility. Again, we perform hand-screening of each filter prior to shipping them to the off-site analytical laboratory.

c. Vaporous Activation Products Emissions

We remove and replace the charcoal canisters weekly at facilities with the potential for significant vaporous activation products emissions and ship the samples to the off-site analytical laboratory where gamma spectroscopy identifies and quantifies the presence of vaporous radioactive isotopes. For charcoal filters, gamma spectroscopy analyses are performed on individual filters instead of clumped filters.

d. Tritium Emissions

Each week, we collected tritium bubbler samples, used to sample facilities with the potential for significant elemental and oxide tritium emissions, and transport them to LANL's Health Physics Analytical Laboratory. The Health Physics Analytical Laboratory adds an aliquot of each sample to a liquid scintillation cocktail and determines the amount of tritium in each vial by liquid scintillation counting.

e. Gaseous Mixed Activation Products (GMAP) Emissions.

To record and report GMAP emissions, we used continuous monitoring, rather than off-line analysis, 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 GMAP monitoring system includes a flow-through ionization chamber in series with a gamma spectroscopy system. Total GMAP emissions are measured with the ionization chamber. The real-time current this ionization chamber measures is recorded on a strip chart and the total amount of charge collected in the chamber over the entire beam operating cycle is integrated on a daily basis. The gamma spectroscopy system analyzes the composition of these GMAP emissions. Using decay curves and energy spectra to identify the various radionuclides, we determine the relative composition of the emissions. Decay curves are typically taken one to three times per week based on accelerator operational parameters. When major ventilation configuration changes are made at LANSCE, new decay curves and energy spectra are recorded.

4. Analytical Results

Measurements of LANL stack emissions during 2009 totaled approximately 796 Ci (compared to 1,600 Ci in 2008). Of this total, tritium emissions contributed approximately 80 Ci (compared to 780 Ci in 2008), and air activation products from LANSCE stacks contributed nearly 716 Ci (compared to nearly 815 Ci in 2008). Combined airborne emissions of materials such as plutonium, uranium, americium, and thorium were less than 0.000027 Ci. Emissions of particulate matter plus vaporous activation products (P/VAP) were about 0.141 Ci, which is consistent with recent years.

Table 4-11 provides detailed emissions data for LANL buildings with sampled stacks.

Table 4-11
Airborne Radioactive Emissions from LANL Buildings with Sampled Stacks in 2009 (Ci)

TA-Bldg	H-3[a]	Am-241	Pu[b]	U[c]	Th[d]	P/VAP[e]	GMAP[f]	Sr-90[g]
TA-03-029		2.48×10^{-6}	1.29×10^{-5}	1.06×10^{-5}	2.50×10^{-7}			2.34×10^{-8}
TA-03-102								
TA-16-205/450	4.76×10^{1}							
TA-48-001						7.69×10^{-3}		
TA-50-001								1.15×10^{-7}
TA-50-037					2.88×10^{-9}			
TA-50-069			2.23×10^{-10}					
TA-53-003	1.64×10^{1}					1.82×10^{-4}	4.79×10^{1}	
TA-53-007	5.25					5.84×10^{-3}	6.68×10^{2}	
TA-55-004	7.45	5.10×10^{-10}	8.59×10^{-10}					
Total[h]	7.67×10^{1}	2.48×10^{-6}	1.29×10^{-5}	1.06×10^{-5}	2.53×10^{-7}	1.37×10^{-2}	7.75×10^{2} [i]	1.62×10^{-7}

Note: Some buildings have more than one sampled stack.

[a] Includes both gaseous and oxide forms of tritium.

[b] Includes Pu-238, Pu-239, and Pu-240.

[c] Includes U-234, U-235, and U-238. Does not include radioactive progeny of U-238.

[d] Includes Th-228, Th-230, and Th-232.

[e] P/VAP–Particulate/vapor activation products (with measured radionuclides and short-lived radioactive progeny).

[f] GMAP–Gaseous mixed activation products.

[g] Strontium-90 values include short-lived radioactive progeny of yttrium-90.

[h] Some differences may occur because of rounding.

[i] Total for GMAP includes 59.6 curies released from diffuse sources at TA-53.

Table 4-12 provides a detailed listing of the constituent radionuclides in the groupings of GMAP and P/VAP.

Table 4-13 presents the half-lives of the radionuclides typically emitted by LANL. During 2009, the LANSCE facility non-point source emissions of activated air comprised approximately 57 Ci of carbon-11 and 2 Ci of argon-41.

5. Long-Term Trends

Figures 4-14 to 4-17 present radioactive emissions from sampled LANL stacks and illustrate trends in measured emissions for plutonium, uranium, tritium, and GMAP emissions, respectively. As the figures demonstrate, emissions from plutonium and uranium isotopes stayed relatively steady over recent years, varying slightly each year but staying in the low-microcurie range. Tritium emissions showed a decrease in emissions relative to recent years, reflecting minimal operations taking place at the main tritium facility during the year. In 2009, emissions of GMAP decreased slightly from 2008 levels and are still very low relative to the one-year elevation in 2005, as described below.

LANSCE operated in the same configuration as recent years, with continuous beam operations to the 1L Target and the Lujan Neutron Scattering Center, causing the majority of radioactive air emissions. Operations to the 1L Target took place from late spring of 2009 through the end of the calendar year.

The emissions control system at the LANSCE 1L Target is a "delay line," which retains the short-lived activation products for a short time before release out the stack. This time interval allows decay of the short-lived radionuclides to non-radioactive components. A cracked valve in the inlet of this delay system caused substantially elevated emissions in 2005, compared with previous years. Additional delay line sections were installed in May and November 2005 and the defective valve was fixed in late 2005. The additional delay line contributed to the relatively low emissions in 2006 through 2009. In all years, emissions were below all regulatory limits.

Figure 4-18 shows the individual contribution of each emission type to total LANL emissions. It clearly shows that GMAP emissions and tritium emissions make up the vast majority of radioactive stack emissions. This plot does not directly relate to off-site dose because some radionuclides have a higher dose impact per curie released than others. GMAP and tritium remain the highest contributors to the total curies released. These gas-phase nuclides are not easily removed from an exhaust stack air stream by standard control techniques, such as filtration. GMAP and tritium emissions continue to fluctuate as the major emissions type; tritium facility operations and LANSCE operations vary from year to year. GMAP emissions are normally the greatest source of off-site dose from the airborne pathway because of the close proximity of the LANSCE facility to the LANL boundary.

Table 4-12
Detailed Listing of Activation Products Released from Sampled LANL Stacks in 2009 (curies)

TA-Building	Nuclide	Emission (Ci)
TA-48-0001	As-74	0.00000104
TA-48-0001	Br-77	0.00000276
TA-48-0001	Ga-68	0.00362
TA-48-0001	Ge-68	0.00362
TA-48-0001	Hg-197	0.000149
TA-48-0001	Hg-197m	0.000149
TA-48-0001	Se-75	0.000108
TA-48-0001	As-73	0.000000168
TA-48-0001	Ga-68	0.0000106
TA-48-0001	Ge-68	0.0000106
TA-48-0001	Hg-197	0.0000105
TA-48-0001	Hg-197m	0.0000105
TA-48-0001	Se-75	0.0000000884
TA-53-0003	Ar-41	1.92
TA-53-0003	Be-7	0.0000640
TA-53-0003	Br-76	0.0000269
TA-53-0003	Br-77	0.0000211
TA-53-0003	Br-82	0.0000573
TA-53-0003	C-11	46.0
TA-53-0003	Mn-54	0.000000198
TA-53-0003	Na-22	0.000000118
TA-53-0003	Na-24	0.0000127
TA-53-0007	Ar-41	13.6
TA-53-0007	As-73	0.00000656
TA-53-0007	Be-7	0.000000523
TA-53-0007	Br-76	0.000488
TA-53-0007	Br-77	0.0000915
TA-53-0007	Br-82	0.00233
TA-53-0007	C-10	1.06
TA-53-0007	C-11	500.0
TA-53-0007	Hg-197	0.00117
TA-53-0007	Hg-197m	0.00117
TA-53-0007	I-126	0.000000706
TA-53-0007	N-13	30.5
TA-53-0007	N-16	0.946
TA-53-0007	Na-24	0.000548
TA-53-0007	O-14	2.02
TA-53-0007	O-15	120.0
TA-53-0007	Os-191	0.0000135
TA-53-0007	Se-75	0.0000162

Table 4-13
Radionuclide Half-Lives

Nuclide	Half-Life
H-3	12.3 yr
Be-7	53.4 d
C-10	19.3 s
C-11	20.5 min
N-13	10.0 min
N-16	7.13 s
O-14	70.6 s
O-15	122.2 s
Na-22	2.6 yr
Na-24	14.96 h
P-32	14.3 d
K-40	1,277,000,000 yr
Ar-41	1.83 h
Mn-54	312.7 d
Co-56	78.8 d
Co-57	270.9 d
Co-58	70.8 d
Co-60	5.3 yr
As-72	26 h
As-73	80.3 d
As-74	17.78 d
Br-76	16 h
Br-77	2.4 d
Br-82	1.47 d
Se-75	119.8 d
Sr-85	64.8 d
Sr-89	50.6 d
Sr-90	28.6 yr
I-131	8 d
Cs-134	2.06 yr
Cs-137	30.2 yr
Os-183	13 h
Os-185	93.6 d
Os-191	15.4 d
Hg-193	3.8 h
Hg-195	9.5 h
Hg-195m	1.67 d
Hg-197	2.67 d
Hg-197m	23.8 h
U-234	244,500 yr
U-235	703,800,000 yr
U-238	4,468,000,000 yr
Pu-238	87.7 yr
Pu-239	24,131 yr
Pu-240	6,569 yr
Pu-241	14.4 yr
Am-241	432 yr

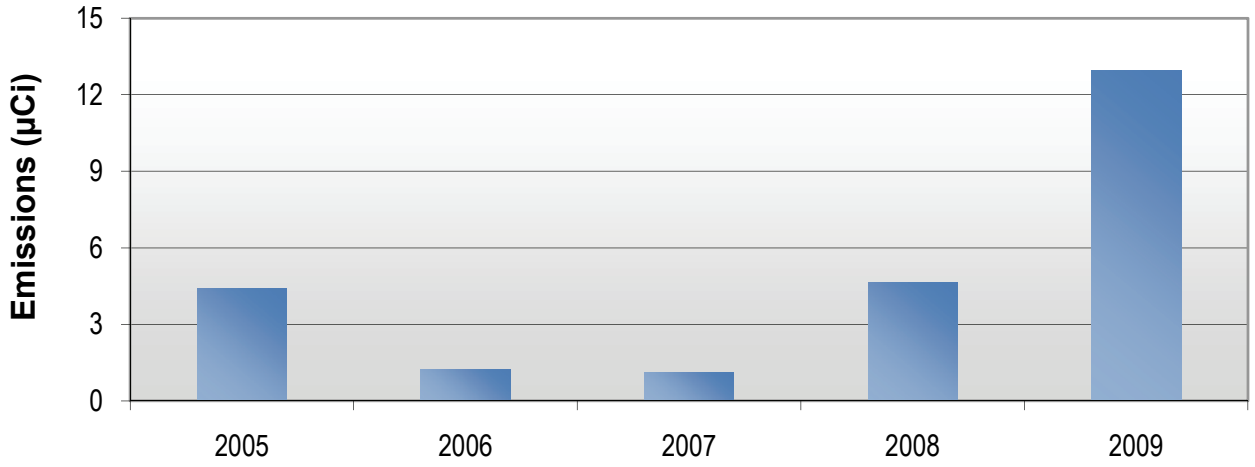

Figure 4-14. Plutonium emissions from sampled LANL stacks.

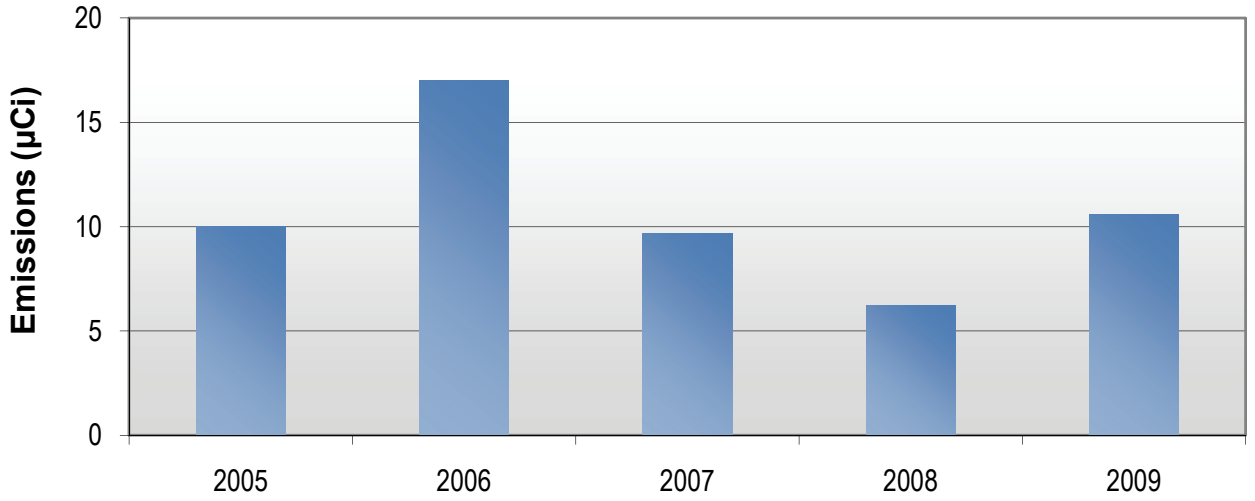

Figure 4-15. Uranium emissions from sampled LANL stacks.

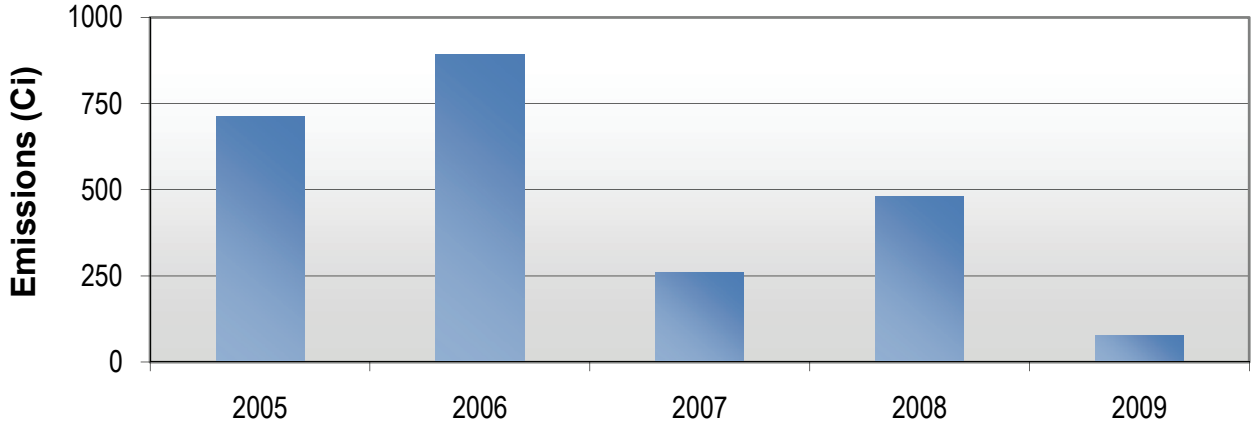

Figure 4-16. Tritium emissions from sampled LANL stacks.

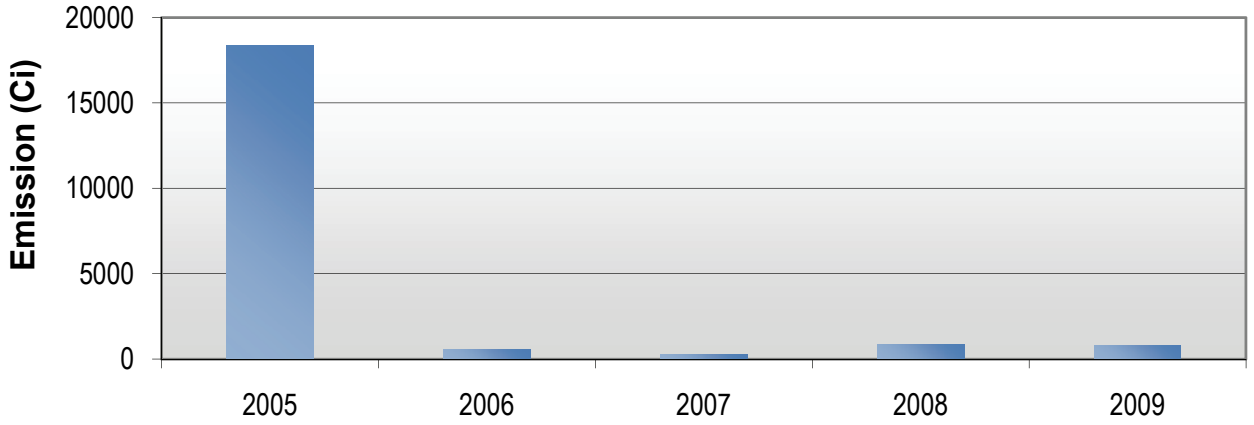

Figure 4-17. GMAP emissions from sampled LANL stacks.

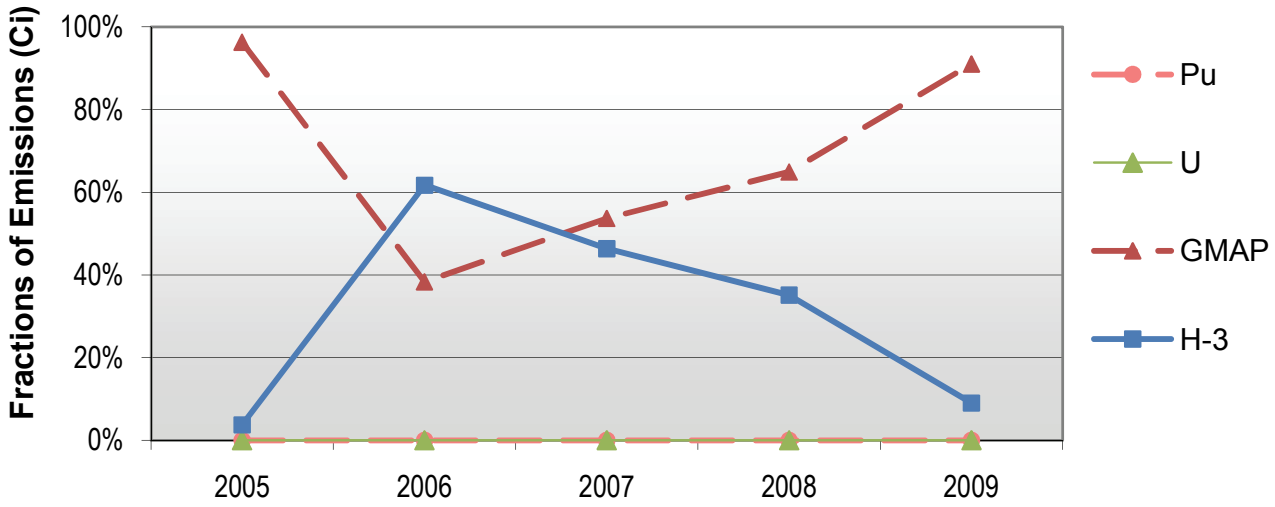

Figure 4-18. Fraction of total annual stack emissions resulting from plutonium, uranium, tritium, and GMAP.

C. GAMMA AND NEUTRON RADIATION MONITORING PROGRAM

1. Introduction

We monitor gamma and neutron radiation in the environment—that is, outside of the workplace—according to the criteria specified in McNaughton et al. (2000) as part of a network of radiation detectors known as the Direct Penetrating Radiation Monitoring Network (DPRNET). Naturally occurring radiation originates from terrestrial and cosmic sources. It is extremely difficult to distinguish man-made sources from the natural background because the natural radiation doses are generally much larger than those from man-made sources. The external dose rate from natural terrestrial and cosmic sources measured by the dosimeters varies from approximately 100 to 200 mrem/yr.

2. Monitoring Network

a. Dosimeter Locations

In an attempt to distinguish any impact from LANL operations on the public, we located 93 thermoluminescent dosimeter (TLD) stations around LANL and in the surrounding communities. There is a TLD at every AIRNET station (shown in Figures 4-1 and 4-3). The corresponding TLD station numbers are listed in Supplementary Data Table S4-10. Additional stations are around TA-54, Area G (shown in Figure 4-19); at TA-53, LANSCE (eight stations); at Santa Clara Pueblo (five stations); and inside the Pueblo de San Ildefonso sacred area (two stations).

b. Neutron Dosimeters

We monitor potential neutron doses with 47 albedo TLD stations near known or suspected sources of neutrons: TA-53 (LANSCE) and TA-54 (Area G). Albedo dosimeters are sensitive to neutrons and use a hydrogenous material that causes neutron backscatter to simulate the human body.

c. Neutron Background

We measure the neutron background at station #25, near Bandelier National Monument, and #101 in Santa Fe. During 2009, the average neutron background at these two stations was 1.7 mrem. To be consistent with previous estimates, we use 2 mrem/yr as our estimated neutron background.

3. Quality Assurance

The calibration laboratory at LANL's Health Physics Measurements Group (RP-2) calibrates the dosimeters every quarter of the calendar year. The DOE Laboratory Accreditation Program has accredited the dosimeters that RP-2 provides, and RP-2 provides quality assurance (QA) for the dosimeters. The uncertainty in the TLD data is estimated from the standard deviation of data from dosimeters exposed to the same dose. The overall uncertainty (one standard deviation) is similar to previous data and is 8%.

4. Results

The annual dose equivalents at all stations except those within TA-53 or near Area G are consistent with natural background radiation and with previous measurements. Detailed results are listed in the Supplemental Data Table S4-10. The only locations with a measurable contribution from LANL operations are within the boundaries of TA-53 (LANSCE) and near TA-54 (Area G). Figure 4-19 shows the locations of the stations at TA-54, Area G.

South of the line of TLDs from #601 to #608, Area G is a controlled-access area, so these data are not representative of a potential public dose. However, TLDs #642 and #643 are close to the boundary of the Pueblo de San Ildefonso sacred area, which is accessible to members of the Pueblo. Furthermore, TLDs #133 and #134 are deployed by Pueblo staff within the boundaries of the sacred area.

After subtracting background, the annual doses measured by TLDs #134, #642, and #643 were 15 mrem, 10 mrem, and 7 mrem, respectively. The dose measured by TLD #134 is higher than the others because TLDs #642 and #643 are in Cañada del Buey and are partially shielded by the rim of the canyon. These are the doses that would be received by a person who is at the location of the TLDs 24 hours per day, 365 days per year. As discussed in Chapter 3, we apply an occupancy factor of 1/16 (NCRP 1976) so the public dose near TLD #134 is calculated to be 0.9 mrem/yr, which is similar to previous years.

TLD #133 is located several hundred meters farther from Area G and measures nothing above the terrestrial and cosmic-ray natural background. This is expected because of the distance and the shielding provided by the air. Annual doses of 12 mrem were measured by TLDs #651 and #652, which are located along Pajarito Road, south of Area G. This section of Pajarito Road has limited public access.

D. NONRADIOLOGICAL AMBIENT AIR MONITORING

1. Introduction

The non-radioactive ambient air monitoring network measures concentrations of total suspended particulates and some selected non-radiological species in communities near LANL. The program consists of four ambient particulate matter monitoring units at two locations plus selected AIRNET samples, which are analyzed for the non-radiological constituents aluminum, calcium, and beryllium.

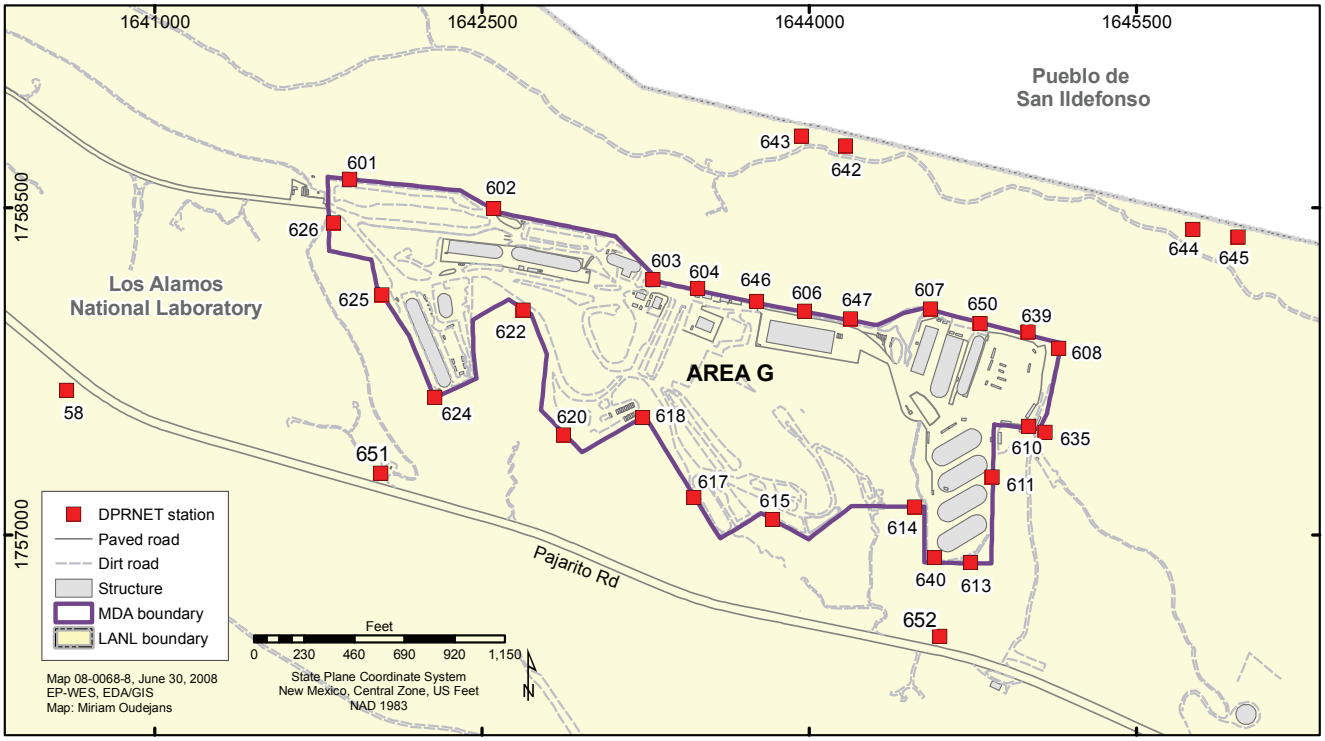

Figure 4-19. Thermoluminescent dosimeter locations at TA-54, Area G, as part of the Direct Penetrating Radiation Monitoring Network (DPRNET).

2. Air Monitoring Network and Equipment

Ambient particulate matter monitoring continued at the old White Rock Fire Station on Rover Boulevard and at the Los Alamos Medical Center. Two monitors run at each location: one for particles smaller than 10 micrometers (PM-10) and another for those smaller than 2.5 micrometers (PM-2.5). A tapered-element oscillating microbalance ambient particulate monitor is fitted with an appropriate sample inlet. The microbalance has an oscillating ceramic "finger" with a filter that collects particles. The mass of accumulated particulate matter is derived and saved for later download. These data measure the dust and pollutant loadings in the atmosphere.

3. Ambient Air Concentrations

In 2009, the particulate matter data collection efficiency was about 93%. Annual averages and 24-hour maxima are shown in Table 4-14. The annual averages and the 24-hour maxima for both PM-2.5 and PM-10 are well below EPA standards.

Table 4-14
PM-2.5 and PM-10 Concentration Data Summary for 2009 (µg/m³)

Station Location	Constituent	Maximum 24-Hour (µg/m³)	Annual Average (µg/m³)
Los Alamos Medical Center	PM-10	38	14
	PM-2.5	20	7
White Rock Fire Station	PM-10	35	14
	PM-2.5	13	7
EPA Standard[a]	PM-10	150	n/a[b]
	PM-2.5	35	15

[a] EPA 40 CFR Part 50 and www.epa.gov/air/criteria.html.
[b] None applicable.

4. Detonation and Burning of Explosives

LANL uses explosives at firing sites and maintains records that include the type of explosives used and other materials expended. Supplemental Table S4-10 summarizes the amounts of expended materials for the last three years. LANL also burns scrap and waste explosives because of treatment requirements and safety concerns. In 2009, LANL burned roughly 3,600 kilograms of high explosives. An assessment of the ambient impacts of high-explosives testing (DOE 1999) indicated no adverse air-quality impacts.

5. Beryllium Sampling

We analyzed quarterly composite samples from 38 sites for beryllium, aluminum, and calcium (Supplemental Data Table S4-11). These sites are located near potential beryllium sources at LANL or in nearby communities. New Mexico has no ambient air quality standard for beryllium. All concentrations measured this year were below 1% of the NESHAP standard of 10 ng/m^3 from 40 CFR Part 61 Subpart C (EPA 1989) and were similar to those of recent years. Aluminum and calcium are used to evaluate elevated uranium measurements. No unusual concentrations were measured.

E. METEOROLOGICAL MONITORING

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, the meteorology team measures a wide variety of meteorological variables across the network, including wind, temperature, pressure, relative humidity and dew point, precipitation, and solar and terrestrial radiation. The Meteorological Monitoring Plan (Johnson and Young 2008) provides details of the meteorological monitoring program. An electronic copy of the "Meteorological Monitoring Plan" is available online at http://www.weather.lanl.gov/.

2. Monitoring Network

A network of seven stations gathers meteorological data at the Laboratory (Figure 4-20). Four of the stations are located on mesa tops (TA-6, TA-49, TA-53, and TA-54), two are in canyons (TA-41 in Los Alamos Canyon and MDCN in Mortandad Canyon), and one is on top of Pajarito Mountain (PJMT). A precipitation gauge is also located in North Community (NCOM) of the Los Alamos town site. The TA-6 station is the official meteorological measurement site for the Laboratory. A sonic detection and ranging (SODAR) instrument is part of the TA-6 meteorological station and measures wind speed and direction to an elevation of approximately 2000 meters above ground level.

3. Sampling Procedures, Data Management, and Quality Assurance

We place instruments in the meteorological network in areas with good exposure to the elements being measured, usually in open fields, to avoid wake effects on wind and precipitation measurements. Temperature and wind are measured at multiple levels on open lattice towers at TA-6, TA-41, TA-49, TA-53, and TA-54. 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 that support data quality checks. The boom-mounted temperature sensors are shielded and aspirated to minimize solar-heating effects. The Mortandad Canyon (MDCN) station includes a 10-m tripod tower which measures wind at a single level (tower top). In addition, temperature and humidity are measured at ground level at all stations except North Community (NCOM) which only measures precipitation.

Data loggers at the station sites sample most of the meteorological variables at 0.33 Hz, store the data, average the samples over a 15-min period, and transmit the data to a Hewlett-Packard workstation located at the Meteorology Laboratory (TA-59) by telephone or cell phone. The workstation automatically edits measurements that fall outside of realistic ranges. Time-series plots of the data are also generated for a meteorologist's data-quality review. Daily statistics of certain meteorological variables (e.g., daily minimum and maximum temperatures, daily total precipitation, maximum wind gust, etc.) are also generated and checked for quality. For over 50 years, we have provided these daily weather statistics to the National Weather Service. In addition, cloud type and percentage cloud cover are logged three times daily.

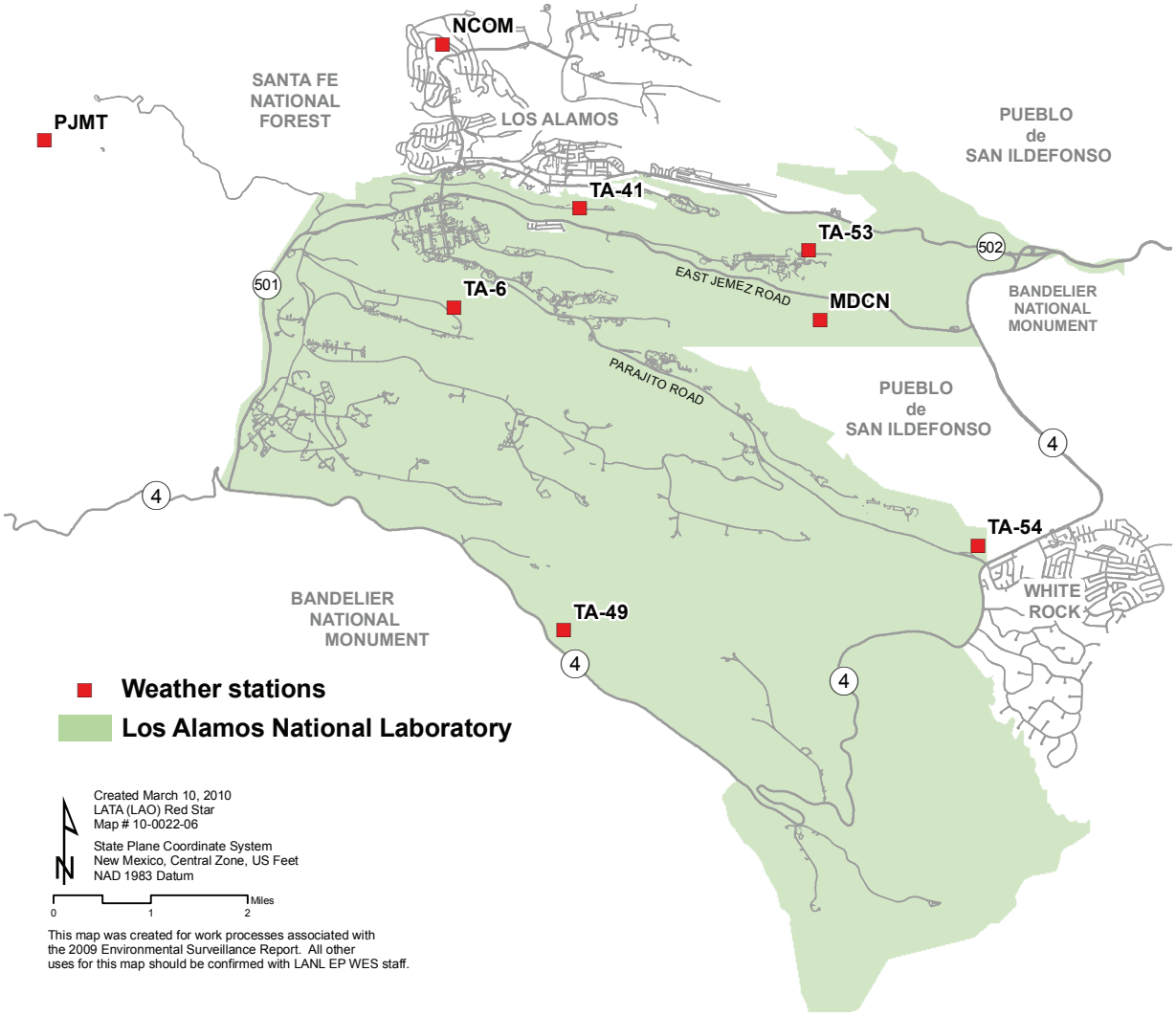

Figure 4-20. Location of meteorological monitoring towers and rain gauges.

We calibrate all meteorological instruments through the LANL Standards and Calibration Laboratory on an annual basis. An external audit of the instrumentation and methods is typically performed once every three to five years. The most recent audit was an "assist visit" by the DOE Meteorological Coordinating Council (DMCC) in August 2006. The DMCC report can be requested at http://www.weather.lanl.gov/. An external subcontractor inspects and performs maintenance on the station network structures and hoists on an annual basis.

4. Climatology

Los Alamos has a temperate, semiarid mountain climate. Atmospheric moisture levels are low, and clear skies are present about 75% of the time. These conditions lead to high solar heating during the day and strong long-wave radiative cooling at night. Winters are generally mild, with occasional winter storms. Spring is the windiest season. Summer is the rainy season, with frequent afternoon thunderstorms. Fall is typically dry, cool, and calm. The climate statistics summarized here are from analyses of historical meteorological databases maintained by the meteorology team and following Bowen (1990 and 1992).

The years from 1971 to 2000 represents the time period over which the climatological standard normal is defined. According to the World Meteorological Organization, the standard should be 1961–1990 until 2021 when 1991–2020 will become the standard, and so on every 30 years (WMO 1984). In practice, however, normals are computed every decade, and so 1971–2000 is generally used. Our averages are calculated according to this widely followed practice.

December and January are the coldest months. The majority (90%) of minimum temperatures during December and January range from 4°F to 31°F. Minimum temperatures are usually reached shortly before sunrise. Ninety percent of maximum temperatures, which are usually reached in mid-afternoon, range from 25°F to 55°F. The record low temperature of -18°F was recorded on January 13, 1963. Wintertime arctic air masses that descend into the central United States tend to have sufficient time to heat before they reach our southern latitude so the occurrence of local subzero temperatures is rare. Winds during the winter are relatively light, so extreme wind chills are uncommon.

Temperatures are highest from June through August. Ninety percent of minimum temperatures during these months range from 45°F to 61°F. Ninety percent of maximum temperatures range from 67°F to 89°F. The record high temperature of 95°F was recorded on June 29, 1998.

The average annual precipitation, which includes both rain and the water equivalent from frozen precipitation, is 18.95 in. The average annual snowfall is 58.7 in. The largest winter precipitation events in Los Alamos are caused by storms approaching from the west to southwest. Snowfall amounts are also occasionally enhanced as a result of orographic lifting of the storms by the high terrain. The record single-day snowfall is about 39 in., which occurred between 11 a.m. on January 15, 1987, and 11 a.m. the next day. The record single-season snowfall is 153 in. set in 1986–87.

Precipitation in July and August account for 36% of the annual precipitation and encompass the bulk of the rainy season, which typically begins in early July and ends in mid-September. Afternoon thunderstorms form as moist air from the Gulf of California and the Gulf of Mexico is convected and/or orographically lifted by the Jemez Mountains. The thunderstorms yield short, heavy downpours and an abundance of lightning.

The complex topography of Los Alamos influences local wind patterns. Often a distinct diurnal cycle of winds occurs. As air close to the ground is heated during the day, it tends to flow upslope along the ground. This is called anabatic flow. During the night, cool air that forms close to the ground tends to flow downslope and is known as katabatic flow. As the daytime anabatic breeze flows up the Rio Grande valley, it adds a southerly component to the prevailing westerlies of the Pajarito Plateau. Nighttime katabatic flow enhances the local westerly winds. Flow in the east-west-oriented canyons of the Pajarito Plateau is generally aligned with the canyons, so canyon winds are usually from the west at night as katabatic flow and from the east during the day.

5. 2009 in Perspective

Figure 4-21 presents a graphical summary of Los Alamos weather for 2009. The figure depicts the year's monthly average temperature ranges, monthly precipitation, and monthly snowfall totals compared to monthly normals (averages during the 1971–2000 time period). Table 4-15 presents a tabular perspective of Los Alamos weather during 2009.

The year 2009 was slightly warmer and drier than normal. The average annual temperature in 2009 of 48.7°F exceeded the normal annual average of 47.9°F by 0.8°F. The total precipitation of 18.6 in. was 98% of normal (18.95 in.). The first half of the year was generally warmer than normal and the second half was colder than normal, with the exception of November in particular. The year began with two very dry months but precipitation caught up during a very wet May through July. August and November were again very dry, and September, October, and December had roughly normal precipitation. Although precipitation amounts see-sawed during 2009, the total at year's end was close to normal. And despite over 14 inches of snow from December 6 to 7, the year ended with only 74% of the normal year's total snowfall, or 43.3 inches.

Temperature and precipitation data have been collected in the Los Alamos area since 1910. Figure 4-22 shows the historical record of temperatures in Los Alamos from 1925 through 2009. The annual average temperature is not the average temperature per se, but the mid-point between daily high and low temperatures, averaged over the year. One-year averages are shown in green in Figure 4-22. Every year since 1998 has been warmer than the 1971–2000 normal, which is just under 48°F. To aid in showing longer-term trends, the five-year running mean is also shown. With five-year averaging, for example, it appears that the warm spell during the past decade is not as extreme as the warm spell during the early-to-mid 1950s. On the other hand, the current warm trend is much longer-lived with twelve straight years of above average temperatures.

Table 4-15
Monthly and Annual Climatological Data for Los Alamos During 2009

Month	Temperatures[a] (°F)								Precipitation[a] (inches)				12-meter wind[b] (mph)				
	Averages				Extremes						Snowfall				Peak Gusts		
	Daily Maximum	Daily Minimum	Overall	Departure[c]	Highest	Date	Lowest	Date	Total	Departure[c]	Total	Departure[c]	Average Speed	Departure[d]	Speed	From	Date
January	41.6	21.9	31.7	3.1	50	19th	10	28th	0.26	-0.7	4.8	-9.0	5.2	-0.2	40.3	NW	27th
February	48.3	25.7	37.0	4.0	63	23rd	13	15th	0.02	-0.73	0.2	-8.8	7.3	1.0	42.8	WNW	17th
March	53.2	29.0	41.1	2.2	66	21st	14	27th	1.18	-0.1	8.7	-2.2	8.7	1.6	55.1	W	30th
April	58.5	33.9	46.2	0.3	74	30th	19	2nd	1.31	0.26	9.8	5.0	9.1	0.9	56.9	WSW	3rd
May	71.3	45.9	58.6	3.8	82	20th	32	3rd	2.14	0.71	0	-0.9	8.5	0.4	39.2	WNW	13th
June	73.6	50.7	62.1	-2.6	83	23rd	41	3rd	2.67	1.23	0	0	7.5	-0.5	44.3	N	3rd
July	81.4	56.0	68.7	1.1	88	13th	48	30th	4.01	1.04	0	0	7.6	0.7	50.4	NNE	21st
August	80.4	54.0	67.2	1.8	89	5th	46	26th	1.66	-1.67	0	0	7.7	1.2	50.4	SSW	12th
September	70.6	46.4	58.5	-0.9	81	2nd	32	22nd	1.95	-0.13	0	0.1	7.2	0.5	44.8	W	30th
October	57.6	35.5	46.6	-2.3	69	19th	16	29th	1.87	0.33	1.6	-1.3	7.3	0.9	49.5	NW	20th
November	53.3	30.1	41.7	4.7	67	6th	17	16th	0.26	-0.93	1.6	-3.7	6.0	0.3	33.1	WSW	13th
December	33.0	14.9	23.9	-5.9	48	1st	-2	4th	1.27	0.35	16.7	5.6	5.8	0.4	59.6	WNW	8th
Year	**60.3**	**37.1**	**48.7**	**0.8**	**89**	**Aug 5**	**-2**	**Dec 4**	**18.6**	**-0.35**	**43.4**	**-15.3**	**7.3**	**0.5**	**59.6**	**WNW**	**Dec 8**

[a] Data from Technical Area 6, the official Los Alamos weather station.

[b] Wind data from Technical Area 53. Technical Area 6 wind data were too incomplete in 2009 to extract monthly values.

[c] Departure columns indicate positive or negative departure from 1971-2000 (30-year) climatological norm.

[d] Departure column indicates positive or negative departure from 1992-2009 (18-year) climatological norm.

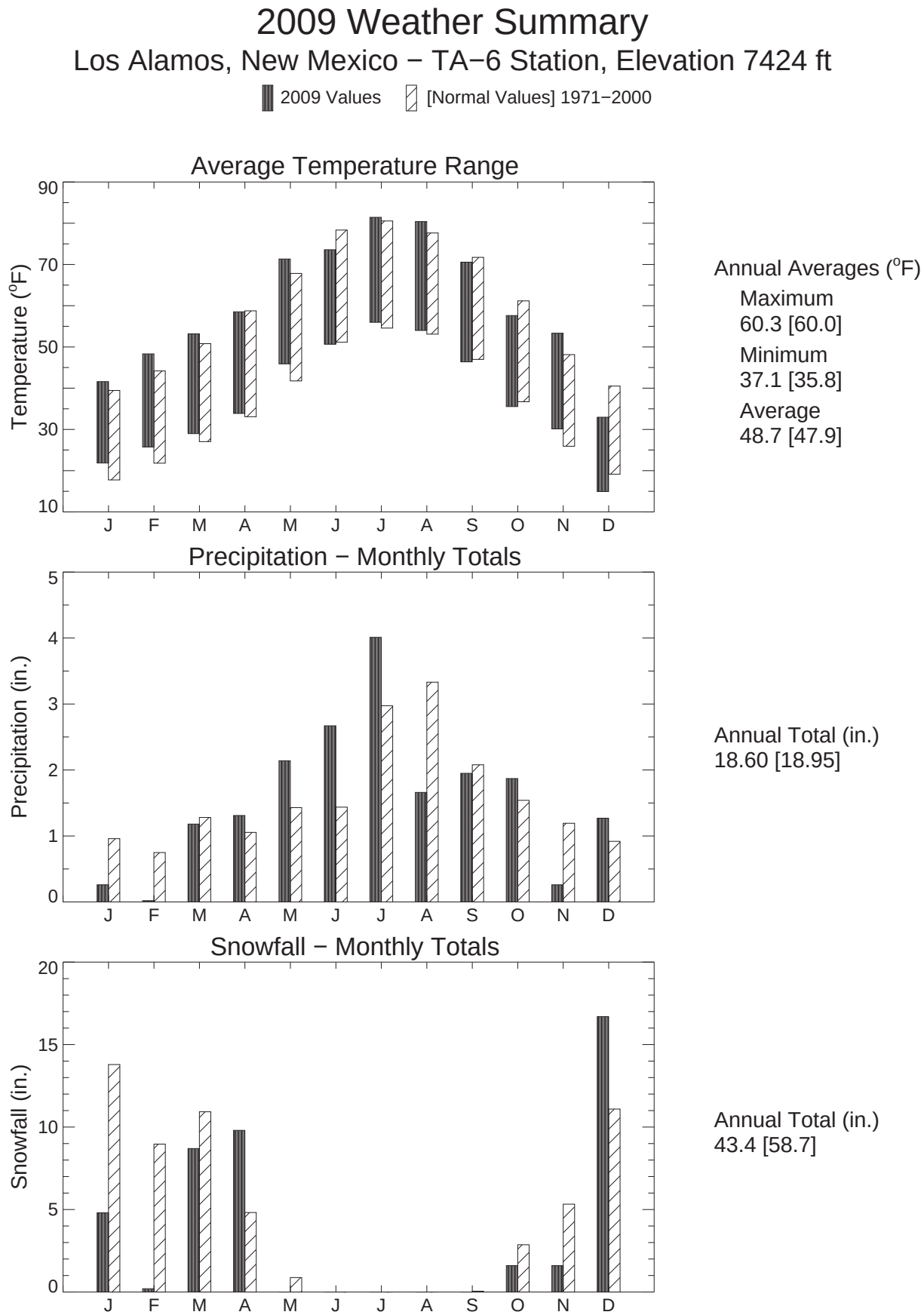

Figure 4-21. Weather summary for Los Alamos for 2009 at the TA-6 meteorology station.

Figure 4-23 shows the historical record of the annually summed total precipitation. The most recent drought spanned the years 1998 through 2003, and 2004 and 2005 brought surplus precipitation to help restore normal conditions. The 2009 total of 18.6 in. was slightly below normal. As with the historical temperature profile, the five-year running mean is also shown. The five-year average suggests not only that the recent drought is behind us, but that it was the most severe drought during the 80-year record. The 1998 to 2003 drought was longer lived than the 1950's drought, which still holds the record for the driest year in recorded history (1956).

Daytime winds (sunrise to sunset) and nighttime winds (sunset to sunrise) are shown in the form of wind roses in Figure 4-24. Wind roses depict the percentage of time that wind blows from each of 16 direction bins. For example, winds are directly from the south at TA-6 over 12% of the time during days in 2009. Winds are directly from the north about 3% of the time during the day. Wind roses also show the distribution of wind speed. About 6% of the time, for example, winds at TA-6 are from the south and range from 2.5 to 5 meters per second. Winds from the south at TA-6 exceed 7.5 meters per second only a fraction of 1% of the time, and winds are calm there 1.2% of the time.

The wind roses are based on 15-minute-averaged wind observations for 2009 at the four Pajarito Plateau stations. Although it is not shown here, wind roses from different years are almost identical, indicating that wind patterns are constant when averaged over a year.

Daytime winds measured by the four Pajarito Plateau stations are predominately from the south, consistent with the typical upslope flow of heated daytime air moving up the Rio Grande valley. Nighttime winds on the Pajarito Plateau are lighter and more variable than daytime winds and typically have a westerly component, resulting from a combination of prevailing westerly winds and downslope katabatic flow of cooled mountain air.

Winds on the Pajarito Plateau are faster during the day than at night. This is due to vertical mixing that is driven by sunshine. During the day, the mixing is strong and brings momentum down to the surface, resulting in faster surface winds. At night, there is little mixing so wind at the surface receives less boosting from aloft.

F. QUALITY ASSURANCE PROGRAM

1. Quality Assurance Program Development

During 2009, the air quality monitoring and compliance organizations implemented approximately 18 revised procedures and three QA project plans to reflect constant improvements. These plans and procedures describe or prescribe all planned and systematic activities needed to provide confidence that processes perform satisfactorily. Quality-related documents are available at www.lanl.gov/environment/air/qa.shtml.

2. Field Sampling Quality Assurance

a. Methods

Overall quality of this portion of the program is maintained through the rigorous use of documented procedures that govern all aspects of the sample collection program.

Particulate and water-vapor samples are (1) collected from commercially available media of known performance, (2) collected under common chain-of-custody procedures using field-portable electronic data systems to minimize the chances of data transcription errors, and (3) prepared in a secure and radiologically clean laboratory for shipment. We deliver the samples to all internal and external analytical laboratories under full chain-of-custody, including secure FedEx shipment, and track them at all stages of their collection and analysis through the AIRNET and RADAIR relational databases.

Field sampling completeness is assessed every time the analytical laboratory returns the AIRNET biweekly gross alpha/beta data. RADAIR field sampling completeness is evaluated each week upon receipt of the gross alpha/beta and tritium bubbler data. All these calculations are performed for each ambient air and stack sampling site and are included in the QA memo prepared by stack monitoring staff to evaluate every data group received from a supplier.

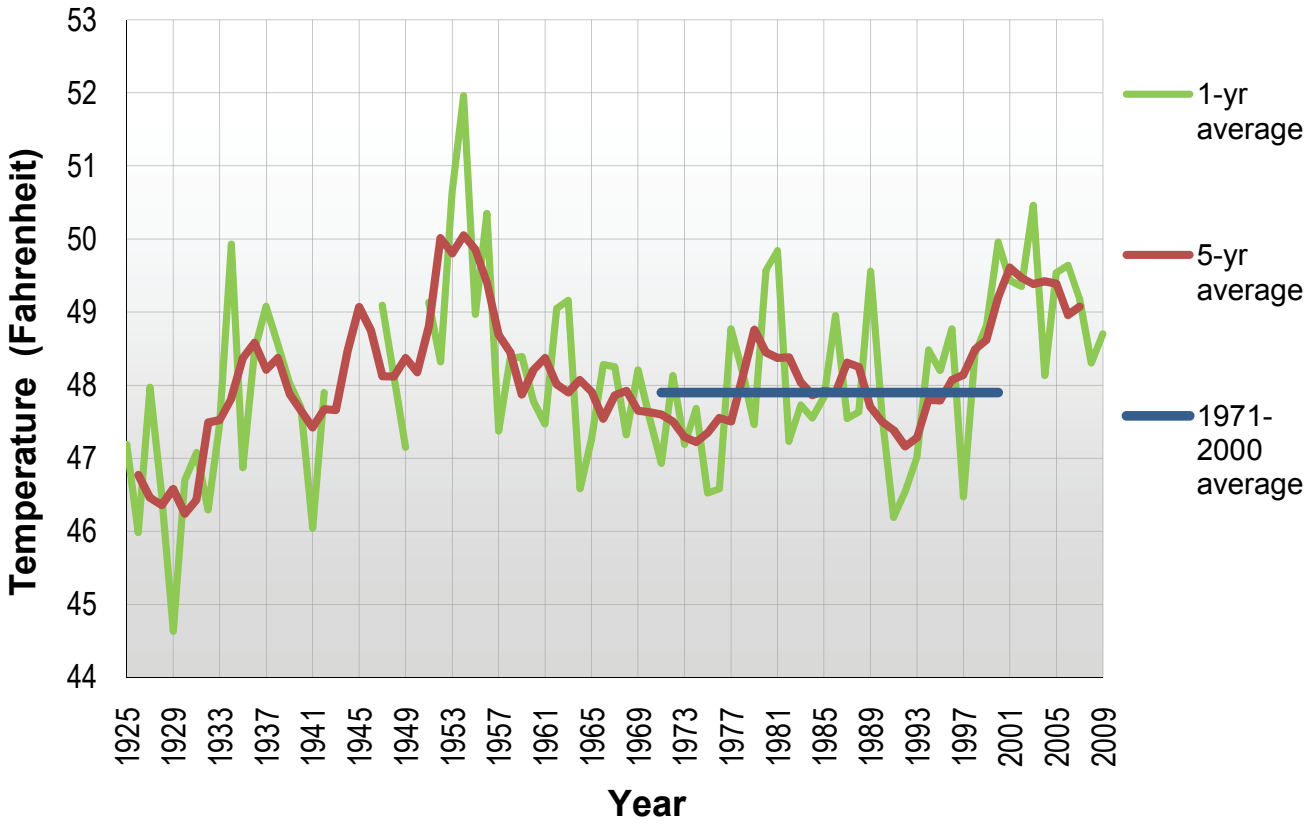

Figure 4-22. Temperature history for Los Alamos.

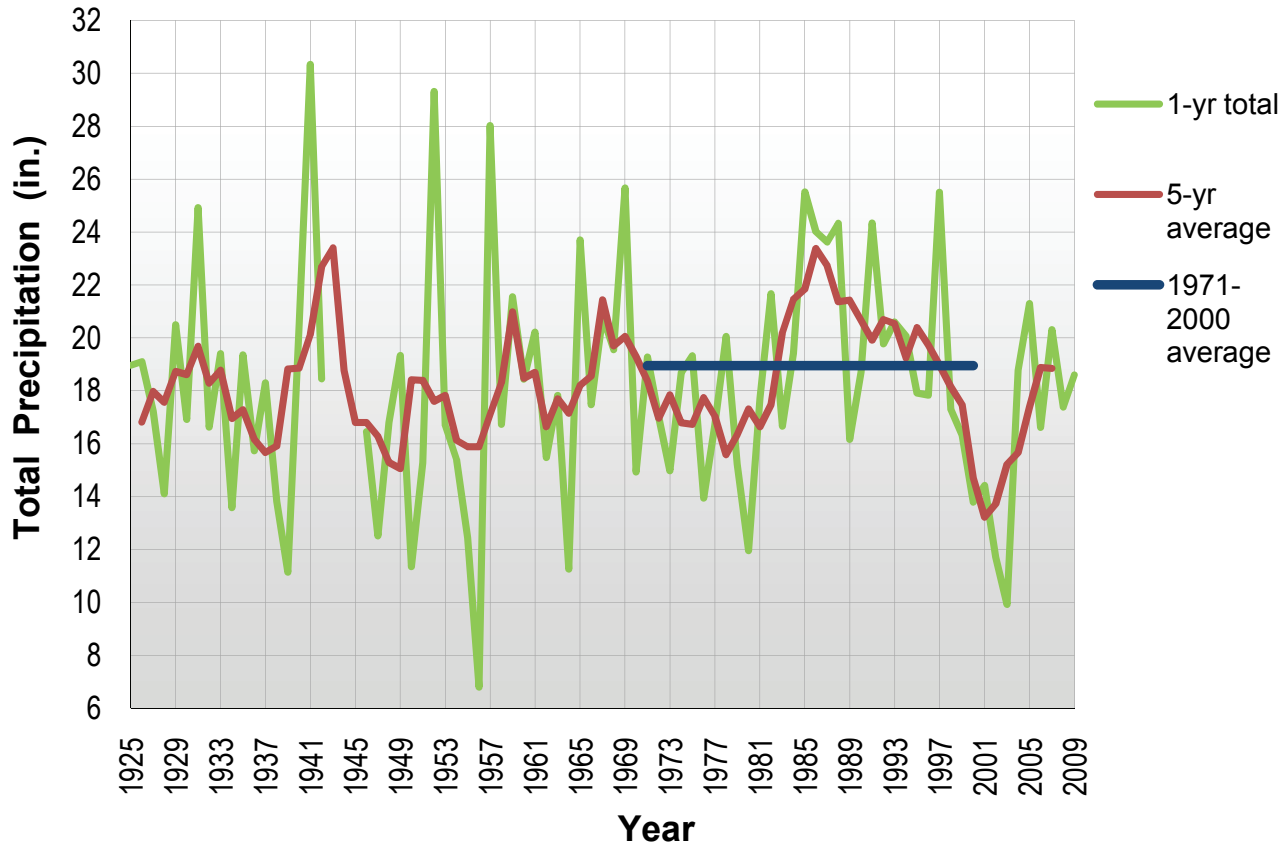

Figure 4-23. Total precipitation history for Los Alamos.

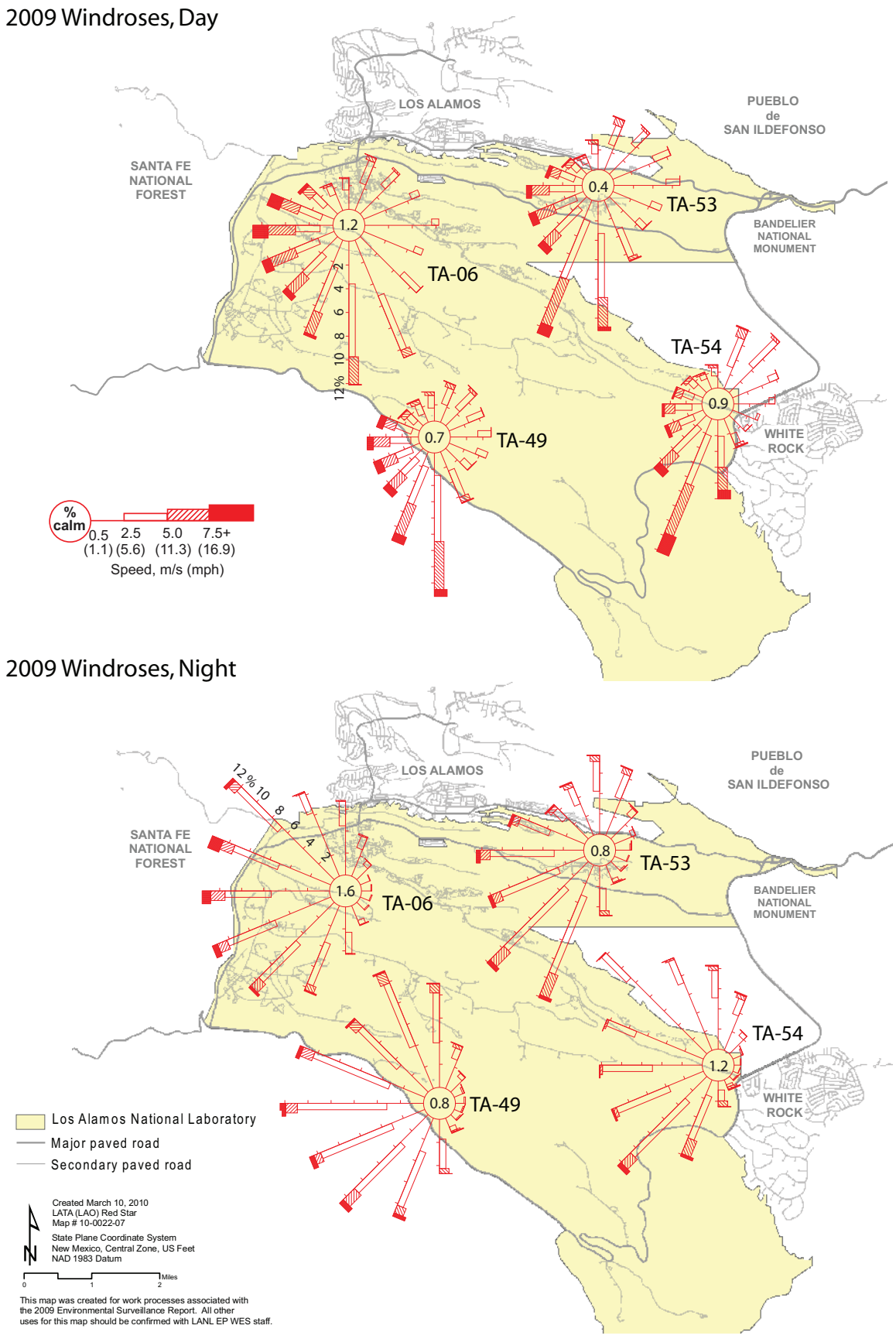

Figure 4-24. Daytime and nighttime wind roses for 2009.

b. Results

Field sample completeness for AIRNET was 100% for filters and 98.4% for silica gel (tritium samples). Field sample completeness for stack samples was 100%. In AIRNET the sample run time was 98.5% for filters and 98.2% for gels. The stack run time was 99.65%.

3. Analytical Laboratory Quality Assessment

a. Method

LANL writes specific statements of work to govern the acquisition and delivery of analytical-chemistry services after the Data Quality Objective process has identified and quantified our program objectives. We send these statements of work to potentially qualified suppliers who undergo a pre-award, on-site assessment by experienced and trained quality systems and chemistry-laboratory assessors. Statement of work specifications, professional judgment, and quality system performance at each laboratory, including recent past performance on nationally conducted performance evaluation programs, are primarily used to award contracts for specific types of radiochemical and inorganic chemical analyses.

Each analytical laboratory conducts its chain-of-custody and analytical processes under its own quality plans and analytical procedures. We submit independently prepared blind spiked samples with each sample set to be analyzed for tritium. Preliminary data are returned by email in an electronic data deliverable of specified format and content. The analytical laboratory also submits a full paper set of records that serves as the legally binding copy of the data. Each set of samples contains all the internal QA/quality control data the analytical laboratory generates during each phase of analysis, including laboratory control standards, process blanks, matrix spikes, duplicates, and replicates, when applicable. The electronic data are uploaded into either the AIRNET or RADAIR databases and immediately subjected to a variety of quality and consistency checks. Analytical completeness is calculated, tracking and trending of all blank and control-sample data is performed, and all tracking information documented in the quality assessment memo mentioned in the field sampling section. All parts of the data management process are tracked electronically in each database, and periodic reports to management are prepared.

b. Results

Analytical data completeness was 100% for AIRNET filters, 98.4% for AIRNET silica gel, and 97.866% for stacks. The overall results of the quality monitoring in 2009 indicate that all analytical laboratories maintained the same high level of control observed in the past several years.

4. Analytical Laboratory Assessments

During 2009, one internal and one external laboratory performed all analyses reported for AIRNET and stack samples. Paragon Analytics, Inc., Fort Collins, Colorado, provided the following analyses:

- Biweekly gross alpha, gross beta, and gamma analyses of filters for AIRNET.
- Biweekly analyses for tritium in AIRNET silica gel.
- Weekly gross alpha, gross beta, gamma, and stable beryllium analyses on stack samples.
- Quarterly analyses for alpha-emitting isotopes (americium, plutonium, and uranium) and stable beryllium, calcium, and aluminum on AIRNET quarterly composite samples.
- Semester analyses of composites of stack filters for gross alpha, gross beta, americium-241, gamma-emitting isotopes, lead-210, polonium-210, plutonium isotopes, strontium-90, thorium isotopes, and uranium isotopes.

The Laboratory's on-site Health Physics Analytical Laboratory (HSR-4) performed instrumental analyses of tritium in stack emissions.

LANL assessed Paragon Analytics during 2006, and we found that the laboratory provides very high quality work in compliance with all LANL requirements. This laboratory has consistently performed well. The laboratory annually participates in two national performance evaluation studies and the study sponsors have consistently judged the analytical laboratory to have acceptable performance for all analytes attempted in all air sample matrices.

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