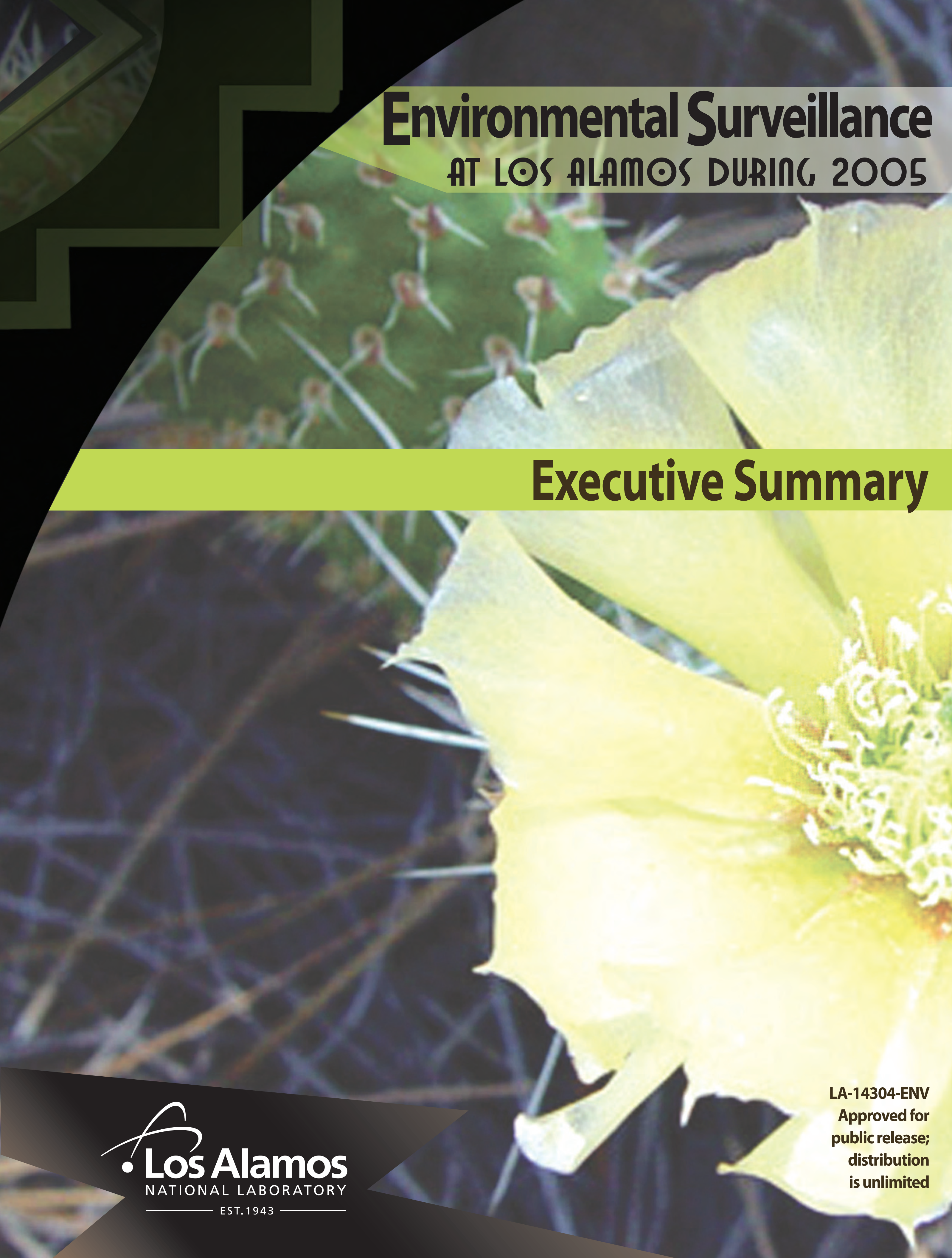


Environmental Surveillance at Los Alamos during 2005

Executive Summary

Los Alamos National Laboratory
EST. 1943

LA-14304-ENV

EXECUTIVE SUMMARY

The Los Alamos National Laboratory (LANL) is 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 ES-1). The 40-square-mile Laboratory is situated on the Pajarito Plateau, which consists of a series of 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 above the Rio Grande Canyon. Most Laboratory and 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; 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, the Bandelier National Monument, the US General Services Administration, and the County of Los Alamos. 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 the threat of weapons of mass destruction, proliferation, and terrorism, and (3) solve national problems in defense, energy, environment, and infrastructure. 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 the commitment to environmental stewardship and compliance. Part of LANL's commitment is to report on the environmental performance of the Laboratory. This report

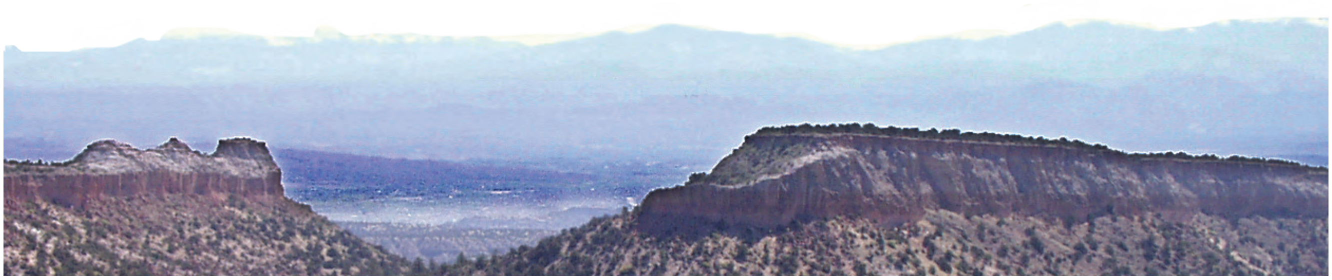
- Characterizes site environmental management,
- Describes compliance with environmental standards and requirements,
- Summarizes environmental occurrences and responses, and
- Highlights significant environmental programs and efforts.

▶ ***The Laboratory was certified as compliant with ISO 14001:2004 requirements for an Environmental Management System, the first DOE/NNSA Laboratory to achieve certification.***

ENVIRONMENTAL MANAGEMENT SYSTEM (see Chapter 1)

LANL has implemented an Environmental Management System (EMS) pursuant to Department of Energy (DOE) Order 450.1 and the international standard International Standards Organization (ISO) 14001:2004. In early 2006, LANL was certified by a third-party auditor as compliant with the ISO standard, the first national laboratory operated by the DOE's National Nuclear Security Administration (NNSA) to be certified. 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.

The Laboratory developed a site-wide approach and framework for the EMS. Each division implemented the system within its organization and ensures internal systems are appropriate and tailored to its specific functions. The EMS core team supported divisions by facilitating meetings, providing standard procedures, tools, environmental subject matter expertise, and training as needed. The divisions evaluated products, activities, and processes to determine if they have significant potential environmental impacts. This evaluation guided development of objectives, targets, action plans, and continuous improvement plans.



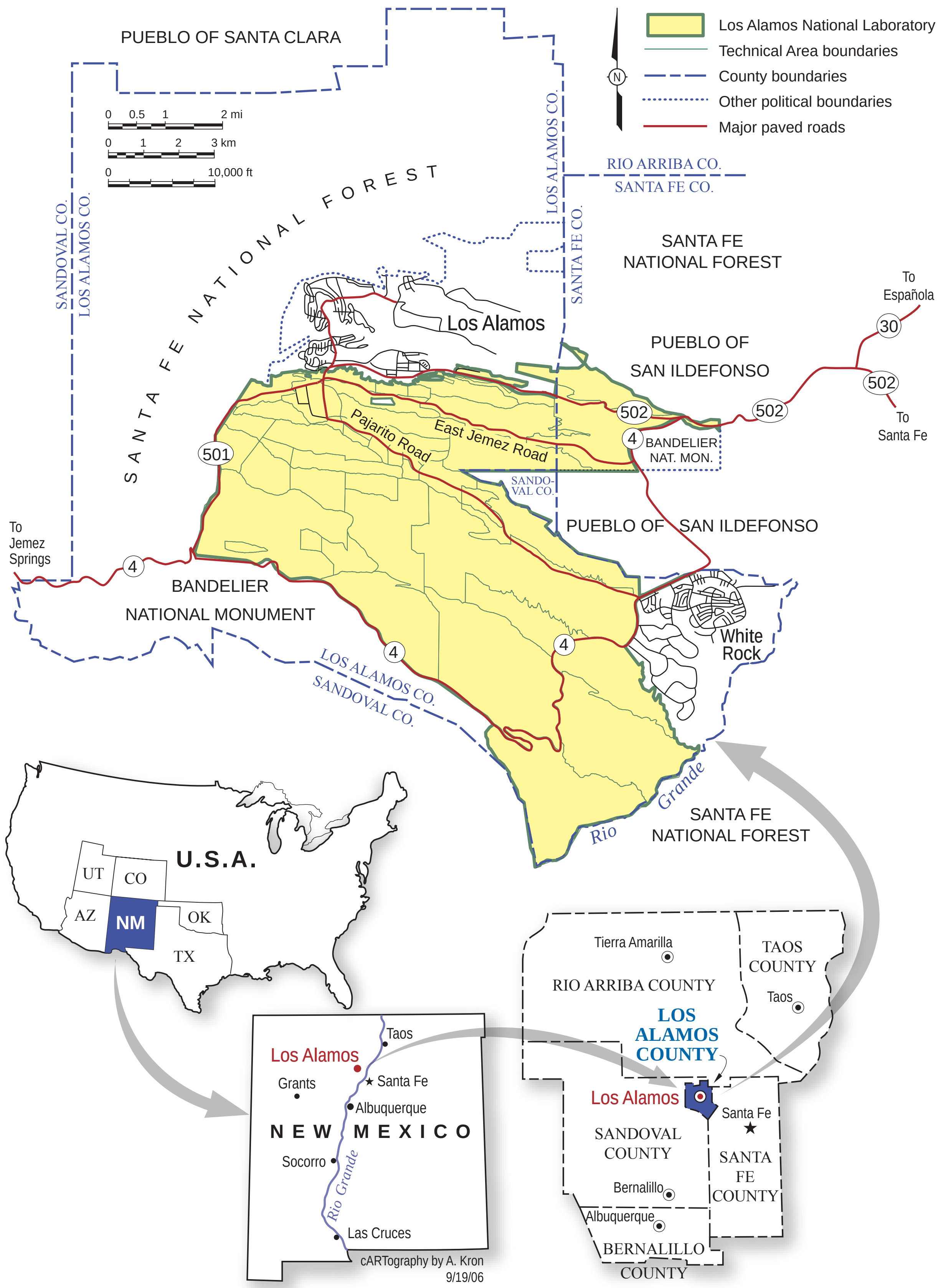


Figure ES-1. Regional location of Los Alamos National Laboratory.

ENVIRONMENTAL COMPLIANCE PROGRAMS (see Chapter 2)

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

Federal Facility Compliance Agreement

During 2005, the Laboratory continued to comply with the requirements of a Federal Facility Compliance Agreement (FFCA) between the Environmental Protection Agency (EPA) and the DOE. The agreement establishes a compliance plan for the regulation of storm water point source discharges from Solid Waste Management Units (SWMUs) and areas of concern (AOCs) at the Laboratory until such time as those sources are subject to an individual storm water permit issued by the EPA. In good faith, the Laboratory began implementing the intent of the FFCA in 2004 before the FFCA was finalized.

Compliance Order on Consent (Consent Order)

A Compliance Order on Consent (Consent Order) was signed by the NMED, DOE, and University of California (UC) in March 2005. The Consent Order is the principal regulatory document for the Laboratory's Environmental Remediation and Surveillance Program and replaces the corrective action requirements of the Hazardous and Solid Waste Amendments Module of the Laboratory's Hazardous Waste Facility Permit (Module VIII). The Consent Order contains requirements for investigation and cleanup of solid waste management units and areas of concern at the Laboratory. The major activities conducted by the Laboratory included investigations and cleanup actions. All of the Laboratory deliverables were submitted on time.

- ***The Consent Order with the NMED, signed in March 2005, replaces the corrective action requirements of the Laboratory's Hazardous Waste Facility Permit and regulates non-radioactive constituents at contaminated sites and in water at the Laboratory.***
- ***The Order specifies actions that the Laboratory must complete to characterize and remediate contaminated sites and monitor the movement of contaminants.***
- ***All required deliverables and remediations were submitted or completed on time.***

Unplanned Releases

There were no reportable unplanned airborne releases from LANL in 2005. There were no unplanned releases of radioactive liquids. There were 10 spills or releases of non-radioactive liquids which included potable water (100,000 gallons), raw sewage (750 gallons), treated wastewater (7,000 gallons), boiler condensate (36,000 gallons), storm water (18,000 gallons), vegetable oil (10 gallons), and diesel fuel from leaking vehicles (2 gallons). All liquid releases were reported to NMED and will be administratively closed upon final inspection.

ENVIRONMENTAL SURVEILLANCE PROGRAMS

LANL uses a variety of materials to accomplish mission activities. Some materials are relatively benign, while other materials are hazardous or radioactive. Experiments and mission activities result in the release of some excess materials in the forms of air emissions and water discharges. These releases have the potential to affect different receptors or components of the environment including people, air, water, plants, and animals by one or many pathways, such as breathing in contaminants or coming into close proximity or contact with hazardous materials.

Environmental monitoring (surveillance of) the complex activities and multiple receptors (people, air, water, plants, and animals) over a long time period requires a comprehensive monitoring plan and strategy. In addition, monitoring information has several uses, including serving as a basis for policy, identifying actions to protect or improve the environment, and calculating the doses received by the public (Chapter 3).

Table ES-1
Environmental Statutes under which LANL Operates and Compliance Status in 2005

Federal Statute	What it Covers	Status
Resource Conservation and Recovery Act (RCRA)	Generation and management of hazardous waste and cleanup of inactive, historical waste sites.	NMED conducted one RCRA hazardous waste compliance inspection in 2005 and identified 4 alleged violations. The Laboratory completed 1,888 self-assessments that resulted in a nonconformance finding rate of less than 2% (3.5% in 2004). The Laboratory, DOE, and NMED signed the Compliance Order on Consent (Consent Order) in March 2005, which replaces Module VIII of the Hazardous Waste Facility Permit.
Emergency Planning and Community Right-to-Know Act (EPCRA)	The public's right to know about chemicals released into the community.	Only lead and mercury were used above reportable quantities. The Laboratory reported releases, waste disposal, and waste transfers totaling 9,033 lb of lead and 222 lb of mercury. No leaks, spills, or releases exceeded reporting thresholds. No updates to Emergency Planning Notifications were necessary in 2005. Chemical Inventory Reports were updated to the Los Alamos County fire and police departments for 32 chemicals or explosives.
Clean Air Act (CAA)	Air quality and emissions into the air from facility operations	The Laboratory met all permit limits for emissions to the air. Non-radiological air emissions continued to be reduced in comparison to previous years. LANL is ahead of schedule in implementing requirements designed to eliminate the use of refrigerants. The radiation dose to the maximum exposed individual (MEI) from LANL air emissions increased to 6.46 mrem during 2005, but was less than the EPA annual limit of 10 mrem. The Los Alamos Neutron Science Center (LANSCE) was the principal contributor to the dose.
Clean Water Act (CWA)	Water quality and effluent stormwater discharges from facility operations	Only one sample (a residual chlorine level) of 949 samples collected from industrial outfalls, and none of the 126 samples collected from the Sanitary Wastewater Systems Plant's outfall, exceeded effluent limits. About 93% of the Laboratory's permitted construction sites were compliant with National Pollutant Discharge Elimination System (NPDES) stormwater requirements.
Toxic Substances Control Act (TSCA)	Chemicals such as PCBs	The Laboratory shipped 88 containers 37 kg of capacitors for disposal at an EPA-permitted treatment and disposal facility, and 1,893 kg of fluorescent light ballasts for recycling.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	Storage and use of pesticides	The Laboratory remained in compliance with regulatory requirements regarding use of pesticides and herbicides. Four internal inspections were conducted in 2005 and no violations were found.
Endangered Species Act (ESA) & Migratory Bird Treaty Act (MBTA)	Rare species of plants and animals	The Laboratory maintained compliance with the ESA and MBTA and they continued to monitor endangered species status.
National Historic Preservation Act (NHPA) and others	Cultural resources	The Laboratory maintained compliance with the NHPA. The Laboratory identified seven new archaeological sites and 19 historic buildings. Forty-one archaeological sites were determined eligible for the National Register of Historic Places, and 10 historic buildings were determined eligible.
National Environmental Policy Act (NEPA)	Projects evaluated for environmental impacts	The NEPA team completed two environmental evaluations. No non-compliances were reported.

The Laboratory employs a tiered approach to monitor the environment and identify impacts from LANL operations. First, the Laboratory monitors the general region to establish a baseline of environmental conditions not influenced by LANL operations. Regional monitoring also demonstrates if LANL operations are impacting areas beyond the Laboratory's boundaries. Examples of regional monitoring include the radiological air-sampling network (AIRNET) and foodstuff and biota sampling locations. The second level of environmental monitoring is at the Laboratory perimeter. This information helps determine if operations are impacting the general LANL property and neighboring property (e.g., pueblo and county lands). Perimeter monitoring also measures the highest potential impact to the public. The third level of monitoring is at specific project sites on LANL lands or property that are known or have the potential to result in emissions or discharges. Examples of locations with this type of monitoring include facility stacks for air emissions, the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, the Los Alamos Neutron Science Center (LANSCE), remediation sites where legacy waste is being managed, decontamination and decommissioning projects, Area G at TA-54 (where waste is being handled and stored), and water discharge locations (outfalls). This tiered approach provides the data used to demonstrate compliance with applicable environmental laws and regulations. During 2005, the Laboratory collected over 10,800 samples and requested over 601,000 analyses or measurements on these samples.

Radiation doses to the public were mostly from LANSCE and were up substantially from the previous year because of

- ***over twice the operational run time at LANSCE***
- ***a defective valve (now repaired) on the emissions control system that allowed radioactive gases to bypass the delay system.***
- ***All emissions are doses were below DOE and EPA regulatory limits.***

RADIOLOGICAL DOSE ASSESSMENT (see Chapter 3)

Humans, plants, and animals receive radiation doses from natural sources and 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) over the last 13 years at an off-site location (East Gate). We calculated potential radiological doses to members of the public that resulted from LANL emissions and discharges. During 2005, the population within 80 km of LANL (approximately 280,000 people) received a collective dose of about 2.46 rem (called a person-rem), which is an increase from the dose of 0.90 person-rem reported for 2004. The dose to the hypothetical maximally exposed individual was approximately 6.46 millirem (mrem), compared to 1.68 in 2004 (Figure ES-2). The dose received in 2005 from Laboratory operations by an average Los Alamos residence and an average White Rock residence totaled about 0.11 mrem and 0.06 mrem, respectively. The increase in these doses was almost all attributable to emissions from the LANSCE accelerator facility which releases very short-lived radioactive gases from a location relatively close to the LANL boundary. The increase in emissions occurred because LANSCE operational time was over twice the previous year's level and a defective valve allowed some of the gases to bypass the emission control system. All emissions and doses were below DOE and EPA regulatory limits for the public.

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

Source or pathway (and receptor)	Dose	Location	Trends
Natural and man-made background (humans)	~500 mrem/yr	All sites	Not applicable
Air (humans)	6.46 mrem/yr	East Gate	Substantial increase from previous year but remains below DOE and EPA regulatory limits
Direct irradiation from Area G (humans)	0.9 mrem/yr	San Ildefonso – offsite	None
Food (humans)	<0.1 mrem/yr	All sites	None
Drinking water (humans)	<0.1 mrem/yr	All sites	None
All (terrestrial animals)	<10 mrad/day	TA-15 EF site, TA-21 MDA B	None
All (aquatic animals)	<11 mrad/day	LA Canyon between DP and SR-4	None
All (terrestrial plants)	<100 mrad/day	TA-15, TA-54 MDA G	None

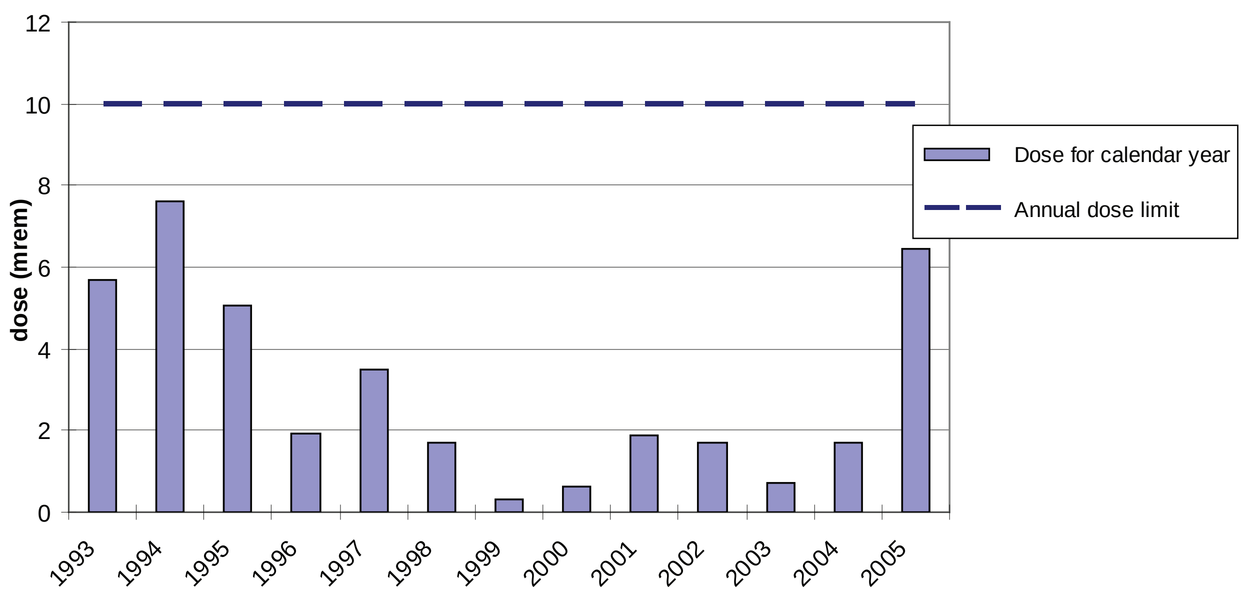


Figure ES-2. Annual dose (mrem) to the maximally exposed individual off-site over the past 13 years.

BIOTA DOSE (see Chapter 3)

The DOE biota dose limits are intended to protect populations, especially with respect to preventing the impairment of reproductive capability within the population, and are thus applied to biota populations rather than to individual plants and animals. Vegetation samples were collected from TA-54 Area G and DARHT, honey bees were collected in the area of DARHT, and surface waters were collected in specific canyons for purposes of comparing radionuclide concentrations with the DOE biota concentration guides (BCGs). Radionuclide concentrations in the vegetation and honey bee samples did not exceed 10 percent of the BCGs (and appropriate biota dose limits), which is the initial screening level. The time-weighted sum of ratios for estimated annual average surface water concentrations of radionuclides in the major canyons potentially affected by the Laboratory were well below the aquatic animal BCGs (less than 11 percent of the standard or 0.11 rad/day).

AIR EMISSIONS AND AIR QUALITY (see Chapter 4)

The Laboratory measures the emissions of radionuclides at the emission sources (building stacks) and categorizes its radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous activation products (radionuclides in gaseous state), (3) tritium, and (4) gaseous mixed activation products (air molecules made into radioactive isotopes by particle beam irradiation). Similarly, the Laboratory takes 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 plutonium, americium, uranium, and tritium.

> ▶ ***Stack emissions increased significantly in 2005 because of increased LANSCE operations and because of a malfunctioning valve in the LANSCE system.***
>
> ▶ ***About 98 percent of radioactive air emissions were from LANSCE operations.***
>
> ▶ ***The dose rate decreases very quickly with distance because of the very short half-lives of the radionuclides released by LANSCE.***

Gaseous activated air product emissions from the LANSCE stack were substantially increased from 2004 while emissions from all other stacks were comparable to previous years or slightly lower. Total stack emissions during 2005 increased to approximately 19,100 curies (Ci). Of this total, tritium emissions composed about 704 Ci (slightly less than in 2004), and short-lived air activation products from LANSCE stacks contributed nearly 18,400 Ci (a substantial increase from 2004 and 98 percent of total emissions). Combined airborne emissions of materials such as plutonium, uranium, americium, and thorium were about 0.00002 Ci and emissions of particulate/vapor activation products were less than 0.02 Ci (both about a fifth of 2004 emissions). Because of the close proximity of the LANSCE facility to the LANL site boundary, air activation emissions from LANSCE remain the greatest source of off-site dose from the airborne pathway, though this dose rate falls off very quickly with increasing distance.

> ▶ ***Measurable concentrations of radionuclides in ambient air were not detected at regional sampling locations nor at most perimeter locations.***
>
> ▶ ***The highest air concentrations at LANL and at perimeter locations were well below 1 percent of the applicable EPA and DOE dose guidelines.***

Radionuclide concentrations from ambient air samples in 2005 were generally comparable with concentrations in past years. Measurable concentrations of radionuclides were not detected at regional sampling locations nor at most perimeter locations. The highest annual mean radionuclide concentrations from air samples within LANL boundaries and at perimeter locations were well below one percent of the applicable EPA and DOE standards. Measurable amounts of tritium were reported at most on-site locations and at perimeter locations; the highest measurement was on-site at TA-16 near a known source and was less than 0.5 percent of the EPA public dose limit. We measured elevated tritium levels at a number of on-site stations, with the highest annual concentration, 950 picocuries per cubic meter (pCi/m^3) or about 0.005 percent of the DOE worker exposure limit, at TA-54, Area G, at a location near shafts containing tritium-contaminated waste. Plutonium was detected at two off-site stations: near Los Alamos Lodge at about 16 attocuries m^3 (aCi/m^3) or about 1 percent of the EPA public dose limit (from historical activities at LANL's old main technical area), and near the Los Alamos Airport (from remediation work at TA-21). On-site detections of plutonium occurred at TA-21 and at Area G and were substantially below 1 percent of the DOE limit for workplace exposure. Americium-241 was detected only at TA-21 and at TA-54 Area G at levels far less than 1 percent of public and worker exposure limits. The maximum annual uranium concentrations were from natural uranium at locations with high dust levels from local soil disturbances such as dirt roads at the Los Alamos County Landfill and LANL's TA-54, Area G. The regional and pueblo samples had higher average concentrations of uranium isotopes than the perimeter group at ratios that indicate natural sources.

> ▶ ***PM-10 and PM-2.5 particulate measurements in ambient air were well below EPA standards.***
>
> ▶ ***Beryllium air concentrations for 2005 were similar to past years and were equal to or less than 2 percent of the NESHAP standard; a natural origin is indicated by correlation with aluminum concentrations.***

Air monitoring continued at one White Rock and two Los Alamos locations 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). The annual average for PM-10 was about 13 micrograms/m^3 and about seven micrograms/m^3 for

PM-2.5 at all locations and was mostly caused by natural dust and wildfire smoke. These averages are well below the EPA standards. In addition, the 24 hour maxima for both PM-2.5 and PM 10 at all three locations were much less than the EPA standards.

The Laboratory analyzed filter samples from 23 sites for beryllium. These sites are located near potential beryllium sources at LANL or in nearby communities. Correlation with aluminum concentrations indicates that all measurements of beryllium are from naturally occurring beryllium in resuspended dust. Beryllium air concentrations for 2005 were similar to those measured in recent years. All values are equal to or less than 2 percent of the National Emission Standard for Hazardous Air Pollutants (NESHAP) standard.

GROUNDWATER MONITORING (see Chapter 5)

Groundwater at the Laboratory occurs as a regional aquifer 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.

In general, groundwater quality is improving as

- ***outfalls are eliminated,***
- ***quantity of discharges are reduced, and***
- ***water quality of the discharges improves.***

However, contamination may be discovered in additional locations as contaminants migrate over time.

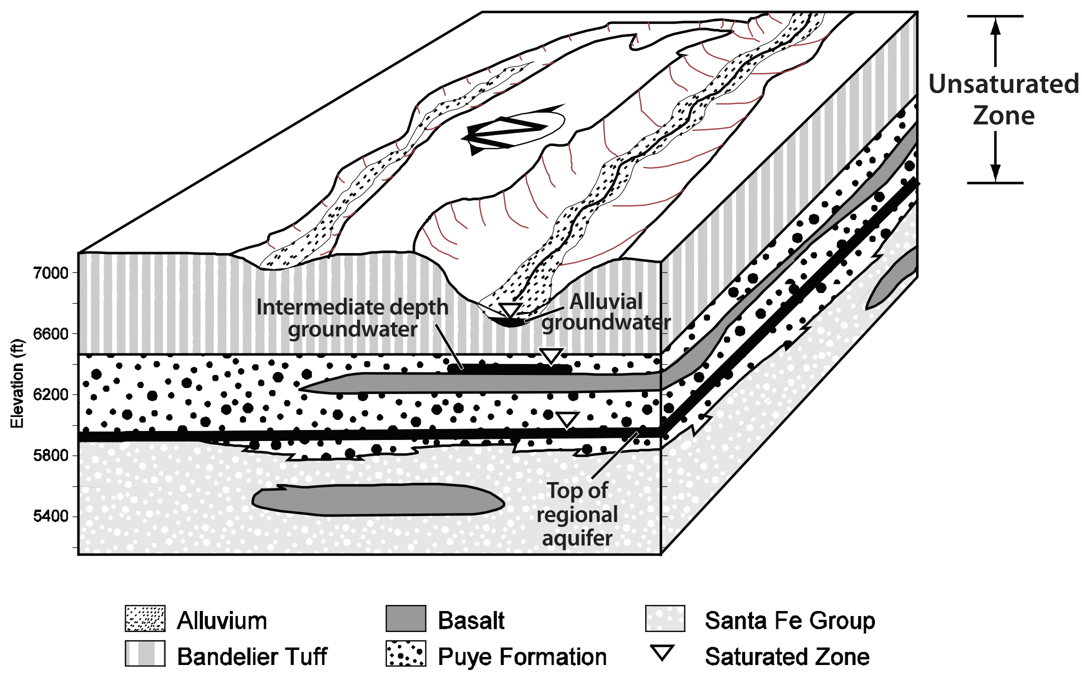


Figure ES-3. Illustration of geologic and hydrologic relationships in the Los Alamos area, showing the three modes of groundwater occurrence.

Monitoring of the groundwater increased substantially from previous years to work towards monitoring requirements specified in the Consent Order. Table ES-3 summarizes contaminants found in portions of the groundwater system.

Table ES-3
Where Can We See LANL Impacts on Groundwater That Result in Values Near or Above Regulatory Standards or Risk Levels?

Chemical	On-Site	Off-Site	Significance	Trends
Hexavalent chromium	Regional and intermediate groundwater in Mortandad Canyon, regional in Sandia Canyon	No	Exceeds NM groundwater standard by factor of 8 in regional aquifer beneath Mortandad Canyon; not seen above background in water supply wells	Insufficient data to evaluate trend, extent under investigation
Perchlorate	All groundwater zones in Mortandad Canyon, regional aquifer in Pueblo Canyon, alluvial groundwater in Cañon de Valle	Yes, in Pueblo Canyon	Values exceed EPA drinking water risk level in Mortandad Canyon alluvial and intermediate groundwater; supply well with values at 1/10th of risk level is permanently off line	Decreasing in Mortandad Canyon alluvial groundwater due to effluent quality improvement; insufficient data for other groundwater
Dioxane[1,4-]	Intermediate groundwater in Mortandad Canyon	No	Just below EPA drinking water risk level, not used as drinking water supply	Insufficient data to evaluate trend, extent under investigation
Nitrate	Intermediate groundwater in Mortandad Canyon, alluvial and intermediate groundwater in Pueblo Canyon	Yes, in Pueblo Canyon	Above NM groundwater standards in Mortandad Canyon intermediate groundwater; in Pueblo Canyon, may be due to LA County's Bayo Sewage Treatment Plant; just below EPA drinking water risk level	Insufficient data in Mortandad, source eliminated in 1999; values in Pueblo are variable
Barium	Alluvial and intermediate groundwater in Cañon de Valle	No	Exceeds NM groundwater standard by 10 times in alluvial groundwater, not used as drinking water supply	Values seasonably variable but remain high, most sources eliminated
High explosives	Alluvial and intermediate groundwater in Cañon de Valle	No	RDX exceeds EPA drinking water risk levels by 20 to 40 times in intermediate and alluvial groundwater, not used as drinking water supply	Values seasonably variable but remain high, most sources eliminated
Tritium	Intermediate groundwater in Mortandad Canyon	No	Exceeds MCL, not used as a drinking water supply	Insufficient data to evaluate trend, source eliminated in 2001
Other radionuclides	Alluvial groundwater in Mortandad Canyon	No	Not used as a drinking water supply; radionuclides have not moved to deeper groundwater	Some constituents are fixed in location; some are decreasing due to effluent quality improvements in 1999
Molybdenum	Alluvial groundwater in Los Alamos Canyon	No	Near NM groundwater standard, not used as drinking water supply, limited in extent	Fairly steady for over 10 years, source eliminated in 2002

> ▶ *Chromium contamination was recently detected in the regional aquifer at concentrations above drinking water standards.*
>
> ▶ *The contamination is likely the result of discharges made in the 1960s and early 1970s containing chromate in cooling tower discharges.*
>
> ▶ *No drinking water wells have been affected by the contamination.*

Chromium was detected in one well in the regional aquifer under Mortandad Canyon during 2005 at concentrations exceeding drinking water standards, though no drinking water wells are affected. The chromium is most likely from discharges of cooling water containing chromate (used to control corrosion) from TA-3 that took place from the 1960s until 1972. The Laboratory has started investigation of this contamination in cooperation with the NMED. High concentrations of naturally occurring uranium and arsenic are also found in groundwater samples from some regional aquifer wells and springs. Most other metals found at high concentrations (aluminum, manganese, and iron) in groundwater samples at LANL are due to well sampling and well construction issues rather than to LANL contamination. The use of fluids to assist with well drilling and the use of other materials in well completion has affected the chemistry of some groundwater samples.

Dioxane, a volatile organic compound used as a stabilizer for chlorinated organic solvents, was detected during June in two intermediate wells in Mortandad Canyon. The Laboratory has started investigation of this contamination in cooperation with the NMED.

Drainages that in the past received liquid radioactive effluents include Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon from its tributary DP Canyon; only Mortandad currently receives treated radioactive effluent, from the Radioactive Liquid Waste Treatment Facility. For the past six years, the facility has met all DOE radiological discharge standards and all NPDES requirements, and except during two weeks in 2003 (two weekly composite samples exceeded the fluoride standard) has voluntarily met NM groundwater standards for fluoride, nitrate, and total dissolved solids.

Water Canyon and its tributary Cañon de Valle formerly received effluents produced by high explosives (HE) processing and experimentation. In past years, Los Alamos County has operated three sanitary treatment plants in Pueblo Canyon; currently only one plant is operating. The Laboratory also operated many sanitary treatment plants.

Naturally occurring uranium was the main radioactive element detected in the regional aquifer, springs, and wells throughout the Rio Grande Valley. Other naturally occurring radioactivity in groundwater samples comes from members of the uranium isotope decay chains, including isotopes of thorium and radium.

We compared radionuclide levels in all groundwater with drinking water and human health standards even though these standards only apply to drinking water sources. Total LANL-derived radionuclide activity in alluvial groundwater in Mortandad and DP/Los Alamos was above the 4-mrem DOE derived concentration guide (which we use as a screening level) applicable to drinking water. The maximum strontium-90 values in Mortandad Canyon and DP/Los Alamos Canyon alluvial groundwater were also above the EPA drinking water standard.

LANL and the NMED DOE Oversight Bureau have detected perchlorate in most groundwater samples analyzed from across northern New Mexico. Numerous studies now show that perchlorate is formed naturally in the upper atmosphere, is deposited on the earth's surface by precipitation, and accumulates in soils and groundwater of arid regions. The EPA recently set a Drinking Water Equivalent Level of 24.5 micrograms per liter (μg/L) for perchlorate. Perchlorate in arid region groundwater may also arise from other sources such as fertilizers, or from natural sources like mineral weathering or electrochemical reactions. The naturally-occurring perchlorate concentrations range from about nondetect (<0.05 μg/L) to about 0.85 μg/L. Water samples from most LANL locations show low perchlorate concentrations in this range, but samples taken downstream from former perchlorate sources show higher values. Figure ES-4 illustrates the declining perchlorate values found in alluvial groundwater downstream of the radioactive liquid waste treatment facility (RLWTF) discharge

> ▶ *The Radioactive Liquid Waste Treatment Facility, which discharges into Mortandad Canyon, has met all DOE radiological discharge standards for six consecutive years; has met all NPDES requirements for six consecutive years; and has met NM groundwater standards for fluoride, nitrate, and total dissolved solids for six years except for fluoride in two weekly composite samples in 2003.*

in Mortandad Canyon. Discharge of perchlorate from the plant effectively ceased in 2002 with installation of equipment designed to remove perchlorate from the effluent and aggressive pollution prevention efforts to eliminate perchlorate from plant inflow.

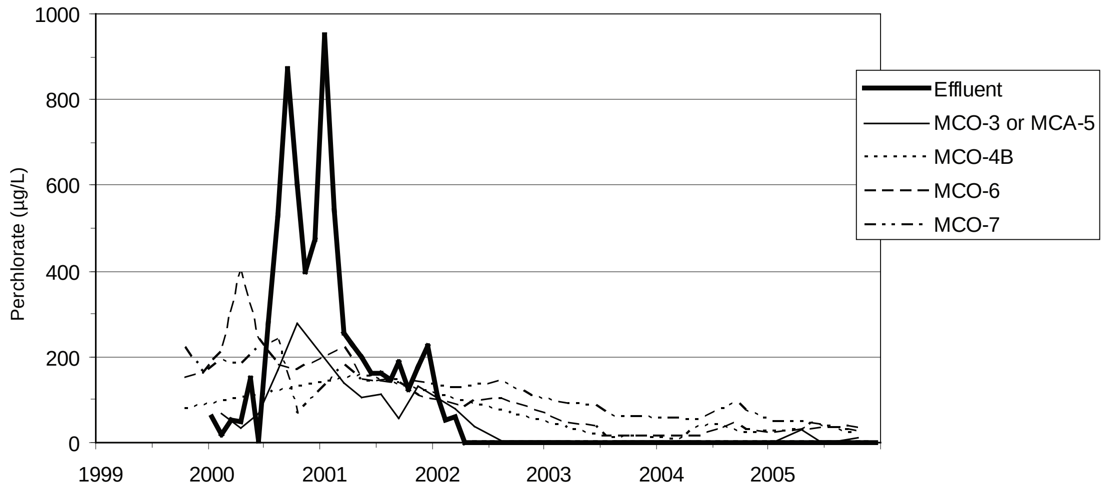


Figure ES-4. Perchlorate in Mortandad Canyon Alluvial Groundwater and RLWTF effluent, 1999–2005. Ion-exchange treatment was started in March 2002 to remove perchlorate to below 1 µg/L.

WATERSHED MONITORING (see Chapter 6)

Watersheds that drain the Laboratory are dry for most of the year. Of the 85 miles of watercourse, approximately two miles are naturally perennial, and approximately three miles are perennial waters created by effluent. No perennial surface water extends completely across the Laboratory in any canyon. Storm runoff occasionally extends across the Laboratory but is short-lived. Wildlife drink from the stream channels when water is present but the water is not used for any other purpose.

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

Hydrologic conditions in all LANL canyons and in Pueblo Canyon have recovered to near pre-fire levels. The overall quality of most surface water in the Los Alamos area is very good, with low levels of dissolved solutes. Of the more than 100 constituents (or "analytes") measured in sediment and surface water within the Laboratory, most are at concentrations far below regulatory standards or risk-based advisory levels. However, nearly every major watershed has some effect from Laboratory operations, often for just a few analytes. More data are available for 2005 than for prior years as a result of monitoring requirements of the Federal Facility Compliance Agreement.

LANL activities have caused contamination of sediments in several canyons, mainly because of past industrial effluent discharges. These discharges and contaminated sediments also affect the quality of storm runoff, which carries much of this sediment for short periods of intense flow. In some cases, sediment contamination is present from Laboratory operations conducted more than 50 years ago. Table ES-4 shows the locations of LANL-impacted surface water and sediments. All radionuclide levels are well below applicable guidelines or standards (Table ES-5).

The overall pattern of radioactivity in channel sediments, such as along lower Los Alamos Canyon, has not greatly changed in 2005. Sediment traps and other methods to slow or control sediment transport in these canyons reduce the potential for further transport down the canyons and potentially to the Rio Grande. Such a sediment trap, the Los Alamos Canyon Weir, decreased transport of sediments from lower Los Alamos Canyon by about two thirds in 2005.

Table ES-4
Where Can We See LANL Impacts on Surface Water and Sediments that Result in Values Near or Above Regulatory Standards or Risk Levels?

LANL Impact	On-Site	Off-Site	Significance	Trends
Radionuclides	Higher than background in sediments and storm runoff in Pueblo, DP, Los Alamos, and Mortandad canyons	Yes, in Los Alamos/Pueblo Canyons; slightly elevated in the Rio Grande and Cochiti Reservoir	Sediments well below recreation screening levels Minimal exposure potential to runoff because events are typically sporadic Concentrations below levels for protection of biota	Sediment concentrations in lower LA Canyon are stable Overall reduced transport in canyons due to post-fire recovery Expect increase in transport in Pueblo and DP Canyons due to new urbanization
Polychlorinated biphenyls (PCBs)	Detected in sediment in nearly every canyon Detected in runoff in several canyons above NM stream standards	Yes, in the Los Alamos/ Pueblo Canyons	Possible wildlife exposure in Los Alamos and Sandia Canyons when water is present. In Rio Grande, LANL contribution indistinguishable from high levels from upstream sources.	Insufficient data
Dissolved copper	Detected in many canyons above NM acute standards	Yes, in Los Alamos Canyon	Most probably of urban origin; Laboratory sources seen on localized basis	Insufficient data
High-explosive residues and barium	Detections near or above screening values in Cañon de Valle base flow and runoff	No	Minimal potential for exposure	Steady
Benzo(a)pyrene	Detections near or above industrial and recreational screening levels in Acid Canyon	Yes, in Los Alamos/ Pueblo/Acid Canyons	Associated with urban runoff; non-LANL sources contribute	Steady

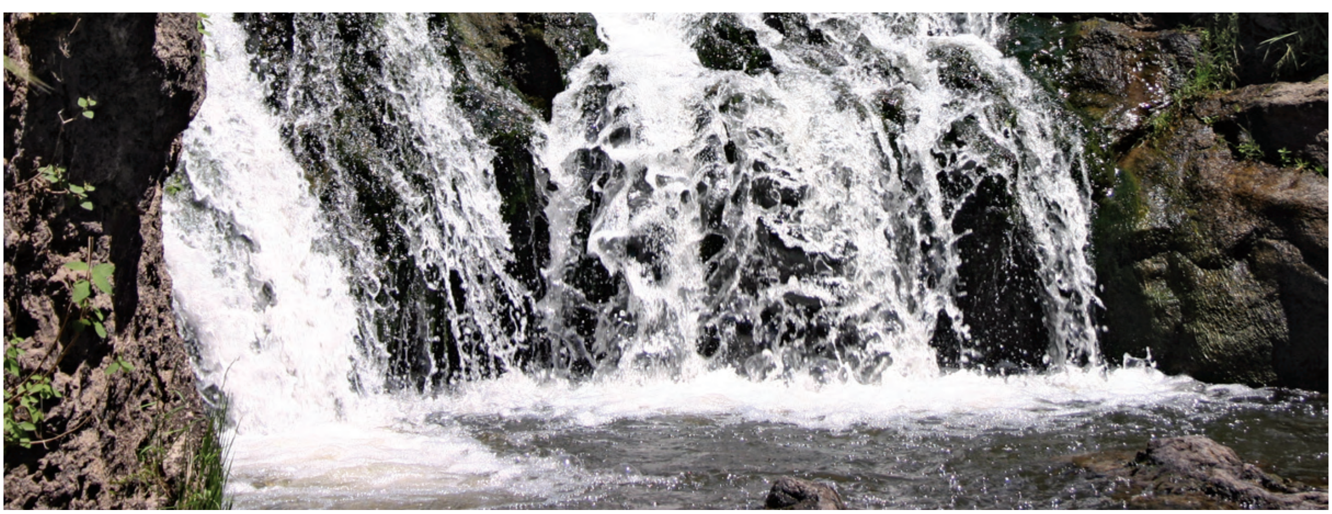
Table ES-5
Estimated Annual Average Unfiltered Surface Water Concentrations (pCi/L) of Radionuclides in Selected Canyons Compared with the Biota Concentration Guides

Radionuclide	Lower Pueblo Canyon	DP Canyon below TA-21	LA Canyon between DP and SR-4	Mortandad Canyon below Effluent Canyon	Pajarito Canyon above SR-4	Max percent of BCG[a]
Am-241	0.4	0.02	3.3	5.1		1%
Cs-137		2	24	20		0.1%
H-3				237		0.0%
Pu-238		0.06	0.17	2.1		1%
Pu-239,240	11	0.4	2.5	2.9		1%
Sr-90	0.4	3.5	1.7	3.4	0.4	1%
U-234	1.7	1.9	7.9	2.0	0.1	4%
U-235,236	0.1	0.1	7.1	1.1		4%
U-238	1.6	1.8	0.5	1.9	0.1	2%

[a] BCG = DOE's Biota Concentration Guides.
Blank cells mean no analytical laboratory detection in 2005.

Figure ES-5 shows the frequency at which concentrations of 16 analytes in surface water samples were greater than the NM water quality standards. Consistent with previous years, most of the higher concentrations were measured in storm runoff samples because of the large sediment load carried by the storm runoff events. Analytes with concentrations above the standards as a result of natural or non-Laboratory causes include aluminum (occurs naturally in all rocks and soil), gross alpha (associated with native soils and sediments), benzo(a)pyrene (associated with urban runoff and possibly created through the Cerro Grande Fire), and selenium (in volcanic soils and ash). For most analytes shown in Figure ES-5, concentrations were above standards by less than five times. As with radionuclides, PCBs adsorb onto sediment particles and thus occur in far higher concentrations in unfiltered samples. Despite the higher PCB concentrations measured in runoff within the Laboratory, monitoring results show no measurable effects in the Rio Grande (see Biota discussion on page 16). No credible pathway to humans exists for the contaminants in streams and sediments on Laboratory property.

- ***Radioactive elements from past Laboratory operations are being transported by runoff events.***
- ***PCBs and radionuclides adsorb onto sediment particles and thus occur in far higher concentrations in unfiltered than filtered samples.***



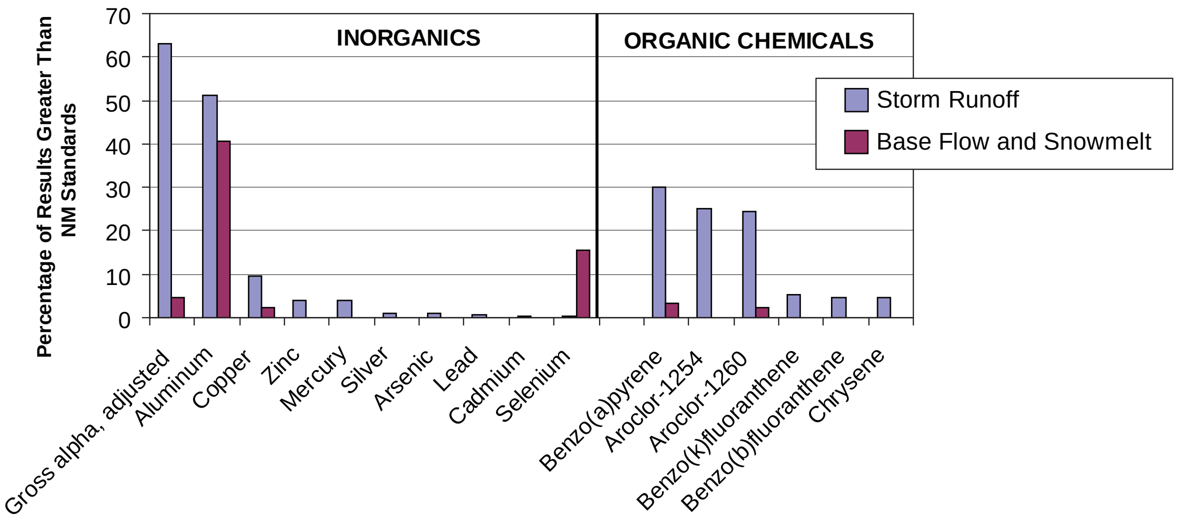


Figure ES-5. Frequency that storm runoff and base flow/snowmelt results were greater than New Mexico water quality standards.

SOIL MONITORING (see Chapter 7)

Soil sampling, as with foodstuffs and biota sampling, is performed on a rotating 3-yr cycle; the next soil sampling will occur in 2006. Data from previous years showed levels either not detectable or consistent with background levels except at some on-site locations where radionuclide contamination is expected.

Two perimeter soil samples were collected from Pueblo de San Ildefonso lands and showed concentrations of most radionuclides below the regional statistical reference levels (average plus three standard deviations). Only uranium in one sample was detected at values slightly above the regional statistical reference level but its isotopic distribution and location indicates it is not from Laboratory operations.

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

Soil samples were collected from around TA-54 Area G, the Laboratory's principal low-level waste disposal area, and TA-15 DARHT, the Laboratory's principal explosive test facility. At Area G, some radionuclides, principally tritium and plutonium, were measured above regional statistical reference levels but below LANL screening levels and are either consistent with levels measured in previous years or declining. Similarly, only a few radionuclides in samples from TA-15 were above regional statistical reference levels but below LANL screening levels and show no increases from levels measured in previous years.

FOODSTUFFS AND NONFOODSTUFFS BIOTA MONITORING (see Chapter 8)

> ▶ ***The levels of radionuclides and metals in soil, vegetation, and mice from the area above the LA Weir were mostly below background and indicate there is no significant impact to the biota in this area.***

Foodstuffs samples that were collected in 2005 included fish from Cochiti Reservoir and purslane, an edible plant, from the Pueblo de San Ildefonso. We also collected nonfoodstuff biota such as native vegetation at Area G and at DARHT. Concentrations, trends, and doses were assessed.

Levels of radionuclides, non-radionuclide inorganic metals, and PCBs in fish upstream and downstream of LANL were similar to each other and support previous studies that imply LANL is not the source of significant contaminants. Radionuclides in the fish from upstream and downstream sources are near detection limits or nondetectable (the result is less than three times the analytical uncertainty), except for one sample from Cochiti Reservoir that contained uranium-234 and uranium-238 just above the regional statistical reference levels (three standard deviations above background averages); however, the isotopic distribution indicates a natural origin of the uranium. Mercury levels in the fish upstream and downstream were similar but are at levels that have triggered fish consumption advisories on the Rio Grande. Similarly, PCB levels in bottom-feeding fish from both upstream and downstream sources exceed safe levels for regular consumption.

▶ ***Radionuclides, non-radionuclide metals, and PCBs in fish upstream and downstream of LANL are similar and do not indicate a measurable contribution to biota from LANL.***

▶ ***Levels of mercury in predator fish and PCBs in bottom-feeding fish upstream and downstream are similar and are above state consumption advisory levels.***

Data from past years on radionuclides in domestic crop plants (vegetables and fruits) from all communities surrounding the Laboratory were indistinguishable from natural or fallout levels. Similarly, all trace element concentrations in vegetable and fruit samples were within or similar to the regional statistical reference levels and showed no increasing trends in concentrations.

Wild edible plants (oak acorns, wild spinach, and purslane) were sampled in past years from Pueblo de San Ildefonso lands near the Laboratory boundary. Some radionuclides in these plants were at higher levels than natural or fallout levels; however, all were below levels that would result in a dose of 0.01 mrem for each pound of each consumed, which is 0.1 percent of the DOE dose limit of 100 mrem/yr. In 2005, additional purslane samples and soil samples were collected to investigate the slightly elevated strontium-90 levels. The results confirmed suspicions that lower calcium levels in the soil results in increased uptake of fallout strontium-90 by the plants.

All non-radionuclide contaminant concentrations, with the exception of barium, in these wild edible plants were either undetected or within the regional statistical reference levels. The additional samples of purslane from background locations confirmed elevated barium concentrations in these plants that are most likely due to bioaccumulation of barium by purslane plants.

Vegetation was collected at Area G and DARHT. All radionuclide concentrations in vegetation were indistinguishable from background reference levels except tritium and plutonium in plants next to the disposal area at Area G.

Honeybees sampled from hives on LANL property near a testing area where depleted uranium is used found only uranium-238 above regional statistical reference levels but at levels far below terrestrial animal dose screening levels (<0.01 rad/d). All other radionuclides and all non-radionuclides were below regional statistical reference levels.

We collected samples of soil, vegetation, and small mammals (deer mice) at the Los Alamos Canyon Weir, a low rock dam designed to trap sediment being transported off Laboratory property in Los Alamos Canyon. The levels of radionuclides and metals in these media were mostly below regional statistical reference levels and indicate that there is no measurable impact to the biota.

A special study of uranium uptake by ponderosa pine trees growing near firing sites at TA-15 was conducted to determine if variations in environmental uranium concentrations from open-air dynamic tests were similar to variations in uranium concentrations in trees. Results indicate that uranium concentrations were statistically similar in off-site and on-site ponderosa pine trees, indicating that dynamic tests conducted at LANL have not significantly impacted uranium concentrations in ponderosa pine pulp.

Moss samples were collected from several springs around northern New Mexico and analyzed for cesium-137 as part of another special study. Levels at two of the sampled springs were similar to those measured by other organizations at those springs. The varying levels of cesium-137 may be attributable to the exposure of the moss to dust or soil that contains fallout levels of cesium-137; the lowest levels were generally found on moss from springs that are relatively sheltered.

ENVIRONMENTAL RESTORATION PROGRAM (see Chapter 9)

> ▶ *Characterization and cleanup of sites contaminated or potentially contaminated by past LANL activities is subject to the Consent Order with the NMED.*
>
> ▶ *Fourteen investigation work plans and five investigation reports were approved by NMED in 2005.*
>
> ▶ *Nine reports were submitted to NMED and are now under review.*

Corrective actions proposed and/or conducted at the Laboratory in 2005 are subject to the Consent Order signed by the NMED, the DOE, LANL, and the State of New Mexico Attorney General in March 2005. The goal of the investigation efforts is to ensure that past operations do not threaten human or environmental health and safety in and around Los Alamos County. Accomplishments include the completion of investigation activities, approvals of proposed investigation activities, and approvals of the work completed at some sites. Under the Consent Order, investigation work plans and investigation reports were submitted to NMED and were approved in 2005 or were under review. Proposed investigation activities were commenced and/or completed in 2005 at a number of complex sites including material disposal areas (MDAs) C, G, L, U, and V; Mortandad Canyon; Pajarito Canyon; TA-19; Mortandad/Ten Site Canyon Aggregate Area; and the TA-16-340 Complex. In addition, several individual sites (solid waste management units [SWMUs] and areas of concern [AOCs]) were investigated and remediated.

A total of 14 investigation work plans were approved by NMED with or without modifications in 2005. Of the work plans approved, seven were submitted in 2005. A total of five investigation reports were approved by NMED with or without modifications, which signifies that either the investigation has been completed or that additional activities are needed in order to complete the investigation. In addition, nine reports were submitted in 2005 and as of the end of the calendar year, are under review by NMED. These reports either recommended that corrective actions are completed or that additional sampling and/or remediation are warranted.

The investigation activities proposed are designed to characterize SWMUs, AOCs, consolidated units, aggregates, and watersheds. The characterization activities conducted include surface and subsurface sampling, drilling boreholes, geophysical studies, and installation of monitoring wells. Corrective actions performed included the removal of structures (e.g., buildings, septic systems, sumps, and drainlines), soil vapor extraction, excavation of contaminated media, and confirmatory sampling. These activities define the nature and extent of contamination and whether there are unacceptable risks to human health and the environment.

> ▶ *Investigations at restoration sites included drilling a substantial number of boreholes, collecting hundreds of samples, and obtaining thousands of analytical results.*
>
> ▶ *Cleanup activities included the removal of structures (e.g., buildings, septic systems, sumps, and drainlines), soil vapor extraction, excavation of contaminated media, and confirmatory sampling.*
>
> ▶ *In 2005, 35 percent of all environmental samples collected and 74 percent of all analyses on the samples were for environmental characterization and remediation work at LANL.*

Major investigations conducted in 2005 included MDA L, MDA G, and the Mortandad/Ten Site Canyons Aggregate Area. The Mortandad/Ten Site Canyon Aggregate Area investigation included SWMUs, AOCs, and consolidated units associated with six technical areas including TA-35, which is a major Laboratory industrial complex. The documents for these sites were among the first major reports submitted under the Consent Order. The investigations included drilling a substantial number of boreholes, collecting hundreds of samples, and obtaining thousands of analytical results. Recommendations for MDAs L and G included the monitoring of subsurface vapors and a corrective measure evaluation. The majority of the aggregate area sites were recommended as having corrective action complete with controls, while some sites require additional sampling and/or remediation. Investigation and/or monitoring activities are continuing at these sites.