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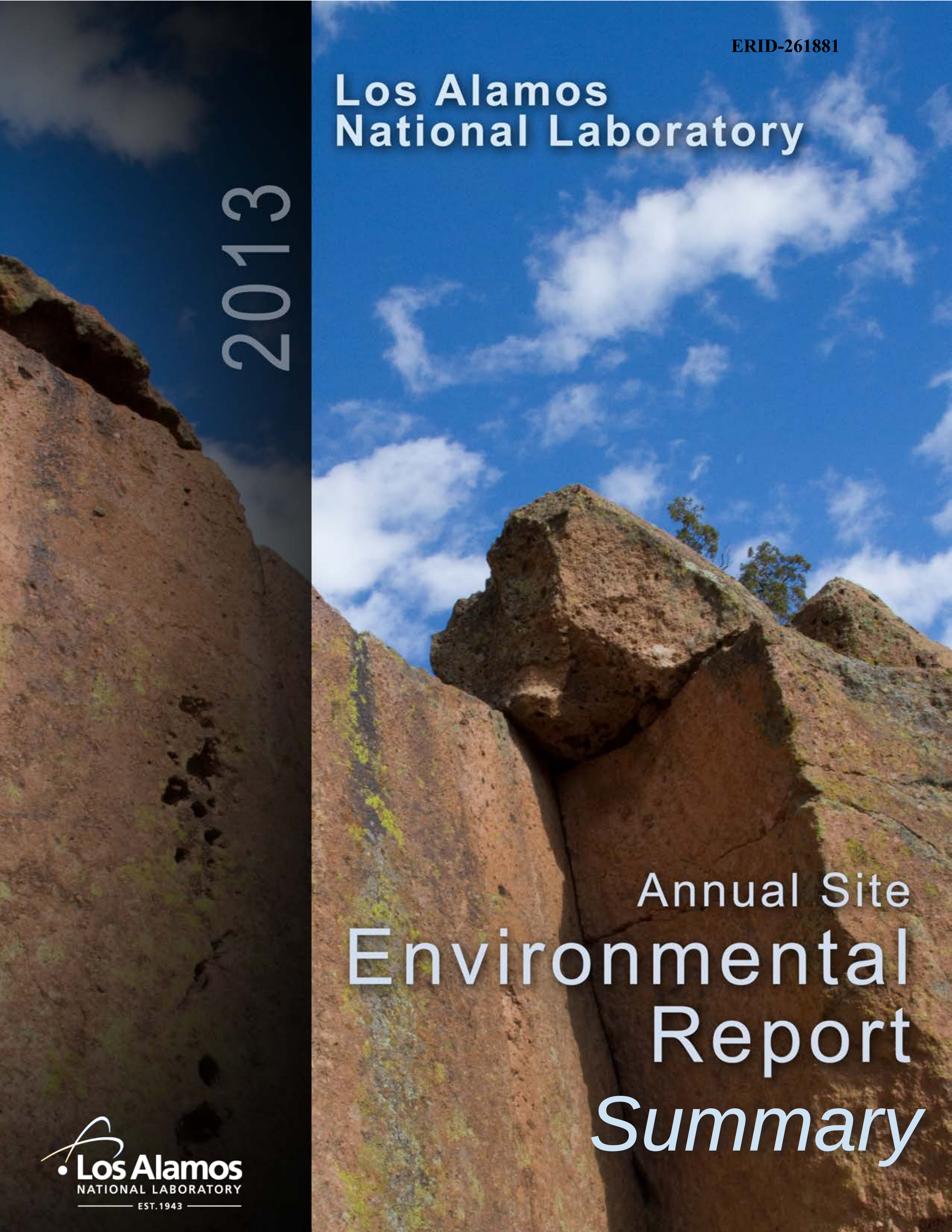


# Los Alamos National Laboratory

2013

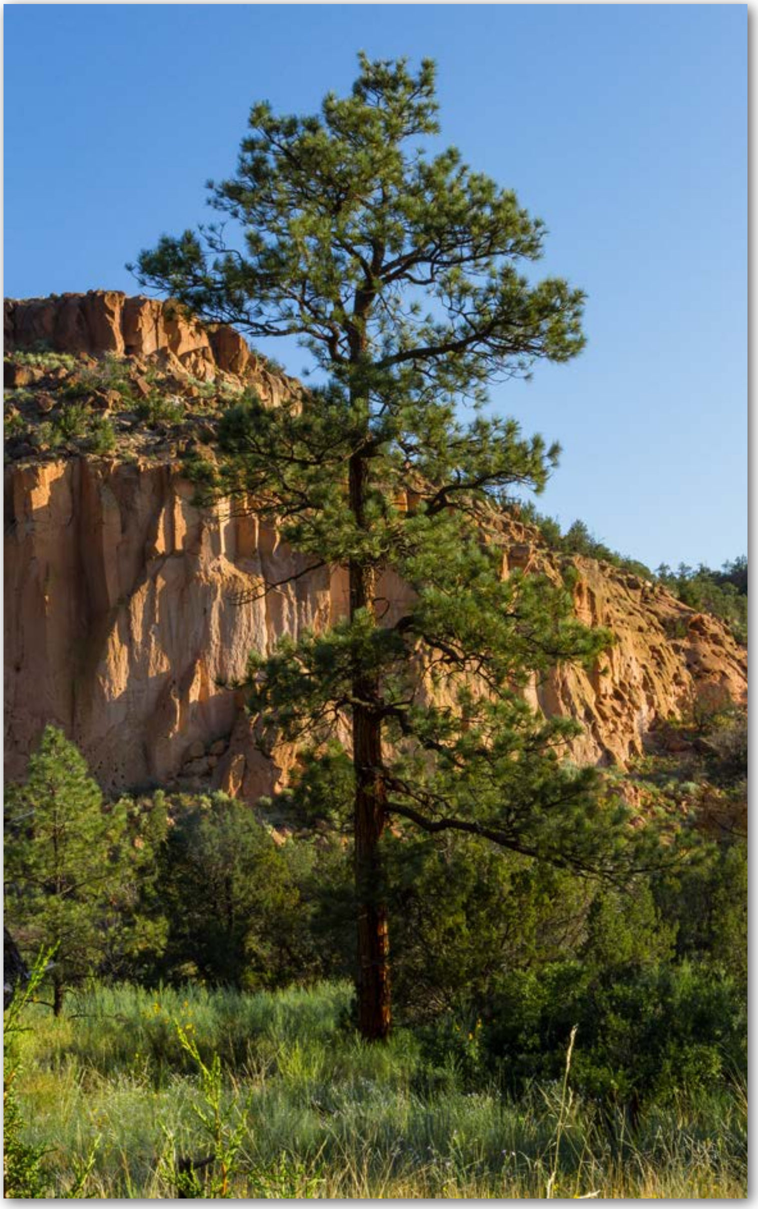
# Annual Site Environmental Report *Summary*

Los Alamos NATIONAL LABORATORY EST. 1943

**Los Alamos National Laboratory**
**Commitment to the Environment**

- We are committed to act as stewards of our environment to achieve our mission in accordance with all applicable environmental requirements.
- We set continual improvement objectives and targets, measure and document our progress, and share our results with our workforce, sponsors, and public.
- We reduce our environmental risk through legacy cleanup, pollution prevention, and long-term sustainability programs.

Front cover: Rock cliff in Mortandad Canyon.
Cover design and photo by Phillip Noll, ENV-ES.



Ponderosa pine (*Pinus ponderosa*) near the Lower Water Canyon Trail.
Photo by Phillip Noll, ENV-ES.

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# Contents



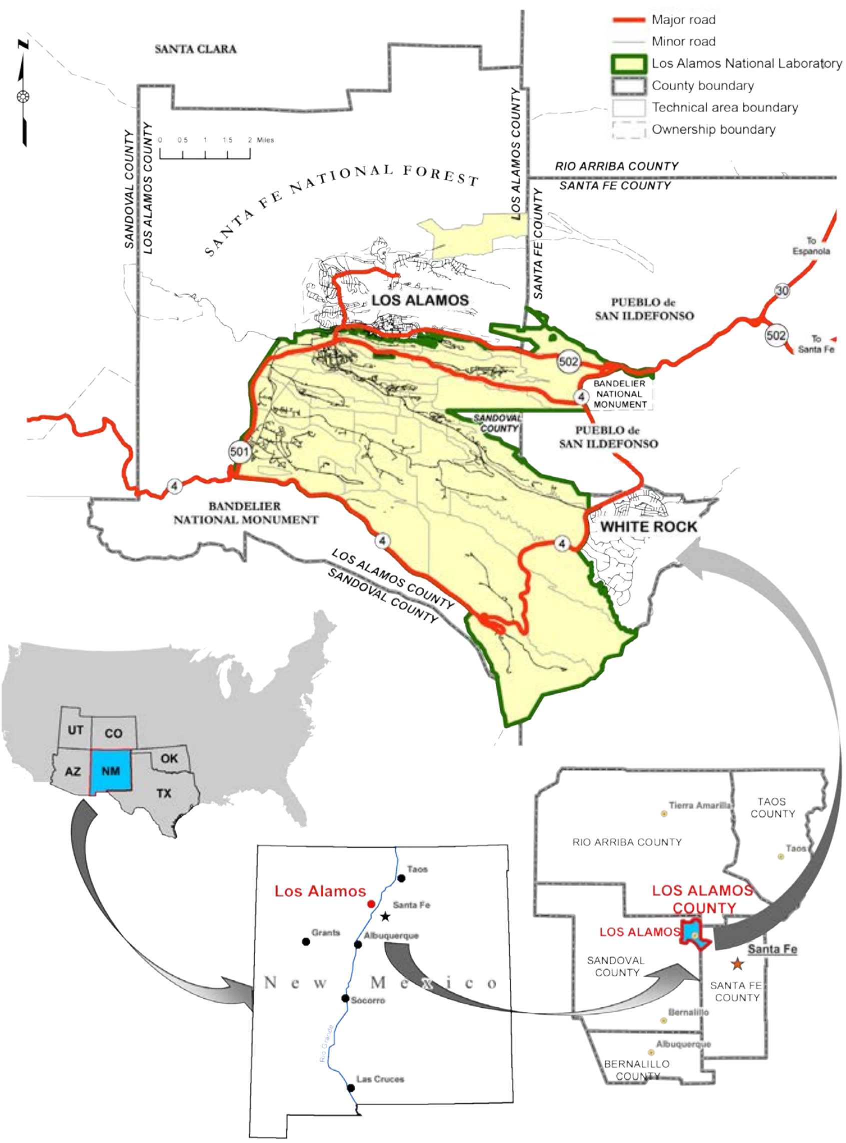
This report is a summary version of the Los Alamos National Laboratory 2013 Annual Site Environmental Report and is compiled by students working at the Laboratory. The full report is available on the web at http://www.lanl.gov/community-environment/environmental-stewardship/environmental-report.php.

Mexican spotted owl (*Strix occidentalis lucida*)

# The Laboratory's commitment to environmental stewardship

Los Alamos National Laboratory (the Laboratory) is committed not only to excellence in science and technology but also to completing all work in an environmentally responsible manner. Every year, the Laboratory produces an environmental report in compliance with a U.S. Department of Energy (DOE) order. This report informs the public of the Laboratory's commitment to excellence in environmental stewardship by

- characterizing site environmental management performance, including effluent releases, environmental monitoring, and estimated radiological doses to the public from releases of radioactive materials;
- summarizing environmental occurrences and responses reported during the calendar year;
- confirming compliance with environmental standards and requirements; and
- highlighting significant programs and efforts, including environmental performance indicators and measures.




Regional location of Los Alamos National Laboratory

# Your neighbor on the Pajarito Plateau

The Laboratory is located in Los Alamos County, in north-central New Mexico. The 36-square-mile Laboratory is situated on the Pajarito Plateau, which is approximately 25 miles northwest of Santa Fe. The plateau, surrounded by the Sangre de Cristo Mountains to the east and the Jemez Mountains to the west, consists of a series of fingerlike mesas separated by deep east-to-west-oriented canyons cut by streams. The surrounding land is largely undeveloped with the exception of the communities of Los Alamos, White Rock, and the Pueblo de San Ildefonso.

Pueblo Canyon, looking west

# The history of the Pajarito Plateau

The Pajarito Plateau formed as the result of a pair of volcanic eruptions from the Valles Caldera that occurred 1.4 million and 1.1 million years ago. Paleoindians used the plateau as an occasional hunting ground approximately 10,000 years ago; much more recently, from the 1150s to 1600s, the plateau was home to ancestral puebloans who are believed to have abandoned the area because of drought. There is little mention of the plateau during the Spanish Colonial period, though it was likely used for seasonal grazing. In 1742, the viceroy of Spain granted a portion of the plateau to Pedro Sanchez, which would later come to be known as the Ramón Vigil Grant. Activity on the remaining portion of the plateau followed a little more than 100 years later, after the annexation of New Mexico in 1846.

In 1887, the "Chili Line" of the Denver and Rio Grande Western Railroad was built, and the homesteading era began. Hispanics already grazing cattle on the plateau laid claim to land by staking out farms and building one-room cabins.

In 1917, a businessman from Detroit named Ashley Pond started the Los Alamos Ranch School. The school aimed to help sickly boys regain their health by participating in outdoor activity away from the pollution of urban areas. The boys spent time building trails, hunting, hiking, horseback riding, and in the winter, skiing. The school was successful in educating more than 600 boys, but the days of the Ranch School came to a close abruptly in December of 1942 when students and faculty received a letter informing them that the U.S. Army would be taking over the school's property. A special schedule was set up so that the boys could complete the school year by February.

By March of 1943, a small group of scientists had moved to Los Alamos for Project Y of the Manhattan Project. Their main objective was to develop the world's first nuclear weapon. It was originally expected the task would require only 100 scientists, but by 1945 more than 6000 civilian and military personnel were living and working in Los Alamos. In 1947, Los Alamos Scientific Laboratory was established, which in turn became Los Alamos National Laboratory in 1981.

Coalition pottery

Cavates with roof beam holes

Romero relatives at Romero Cabin

A homestead in Los Alamos

Ranch School students in front of the Big House

Manhattan-era facilities located near Ashley Pond

# What is the Laboratory's mission today?

With changes in technologies, priorities, and the global community, the Laboratory's original mission to design, develop, and test nuclear weapons has broadened. Today, the Laboratory's 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
- foster energy security by developing clean, sustainable energy sources.

Inseparable from the Laboratory's commitment to excellence in science and technology is its commitment to environmental stewardship and full compliance with environmental protection laws.

# Protecting human health and the environment


Filter changes ensure compliance with air emission standards.


A worker installs energy-efficient T8 bulb in equipment.

Los Alamos National Laboratory environmental policy states

> We are committed to act as stewards of our environment to achieve our mission in accordance with all applicable environmental requirements. We set continual improvement objectives and targets, measure and document our progress, and share our results with our workforce, sponsors, and public. We reduce our environmental risk through legacy cleanup, pollution prevention, and long-term sustainability programs.

The Laboratory uses a tiered process for setting and achieving environmental and sustainability goals.

## Compliance comes first

Achieving environmental and sustainability goals starts with compliance with environmental laws. The Laboratory complies with over 50 different environmental laws, orders, directives, permits, and other regulatory dictates stemming from environmental laws

- Clean Air Act
- Clean Water Act
- Resource Conservation and Recovery Act
- National Environmental Policy Act
- Natural Resource Damage Act
- Endangered Species Act
- Migratory Bird Act
- Antiquities Act
- National Historic Preservation Act
- Native American Graves Protection and Repatriation Act

## Sustainability stems from commitment and follow through

In fiscal year 2013 the Laboratory's focus on DOE's nine sustainability goals achieved significant successes:

- Completed sustainable refits within four facilities and decommissioned eight facilities for an overall energy savings of over 30%
- Operation of Sanitary Effluent Reclamation Facility that sent over 20 million gallons of water for reuse to the Strategic Computing Complex for its cooling towers
- Upgraded lighting to includ light emitting diodes (LEDs) in five facilities, LEDs in two parking areas with photocells for reduced lighting at night, and solar-powered mobile lighting units purchased for ongoing night work

- Established a Data Center/Server Room team and evaluated 130 distributed data centers and server rooms across the site for opportunities to virtualize and consolidate servers, and began requiring data center metering
- Completed thermal metering on all High Performance Sustainable Building candidates
- Completed installation of an energy-management software feature on all eligible computers
- Implemented 33 pollution prevention projects, resulting in a total cost savings to the Laboratory of $4,852,331
- Modified major subcontracts to include Sustainable Acquisition language

Additionally, the Laboratory won the DOE 2013 Sustainability Award for four projects combined to recycle or reuse nearly 72,200 liquid liters of helium, resulting in projected annual cost savings of over $1 million. Reducing the use of helium eliminates shipments of this material from Texas to New Mexico, saving shipping costs, fuel, and avoiding associated greenhouse gas emissions.

## Collaboration ensures that vigorous debate discovers the best solutions

Through our day-to-day work within the northern New Mexico community, our workers establish open working relationships with colleagues and others. Through the DOE we support productive government-to-government relationships with local tribes and pueblos. We set our policies and practices to keep communities and interested members of the public informed of the work we do and to provide a mechanism for learning about Laboratory operations. We welcome and use feedback on the work we do for continuous improvements to our operations and to keep our environmental impact as low as reasonably achievable.

Collaboration between northern New Mexico community members


Students learning about environmental stewardship

## How to learn more and contact us

Visit our environmental website: www.lanl.gov/environment

Sign up for e-mail notification: What is LANL doing?

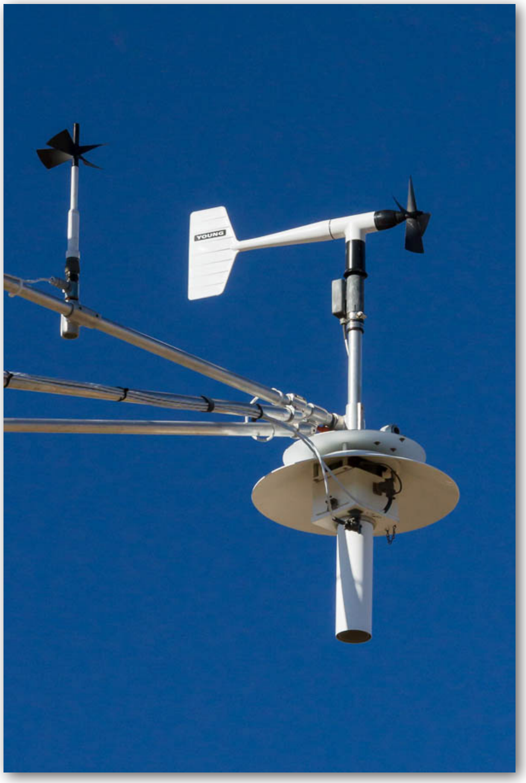
Visit the electronic Public Reading Room: http://eprr.lanl.gov

Visit the print Public Reading Room:
94 Cities of Gold Road, Pojoaque, NM

Call the Environmental Outreach Office: 505-667-0216

E-mail the Environmental Outreach Office: envoutreach@lanl.gov

## Monitoring weather



One of the Laboratory's wind instruments. The propeller on the left measures vertical wind. The wind vane and propeller on the right measure horizontal wind speed and direction. Beneath the wind vane are sun shields to keep the direct sun from the temperature-measuring equipment, which includes a fan that continuously draws air over the temperature sensor.

Meteorological data are essential to many Laboratory activities, such as emergency management and response and environmental surveillance programs. The data are available at the Weather Machine: www.weather.lanl.gov. Data include temperature, wind chill, dew point, relative humidity, wind speed, wind direction, and precipitation.

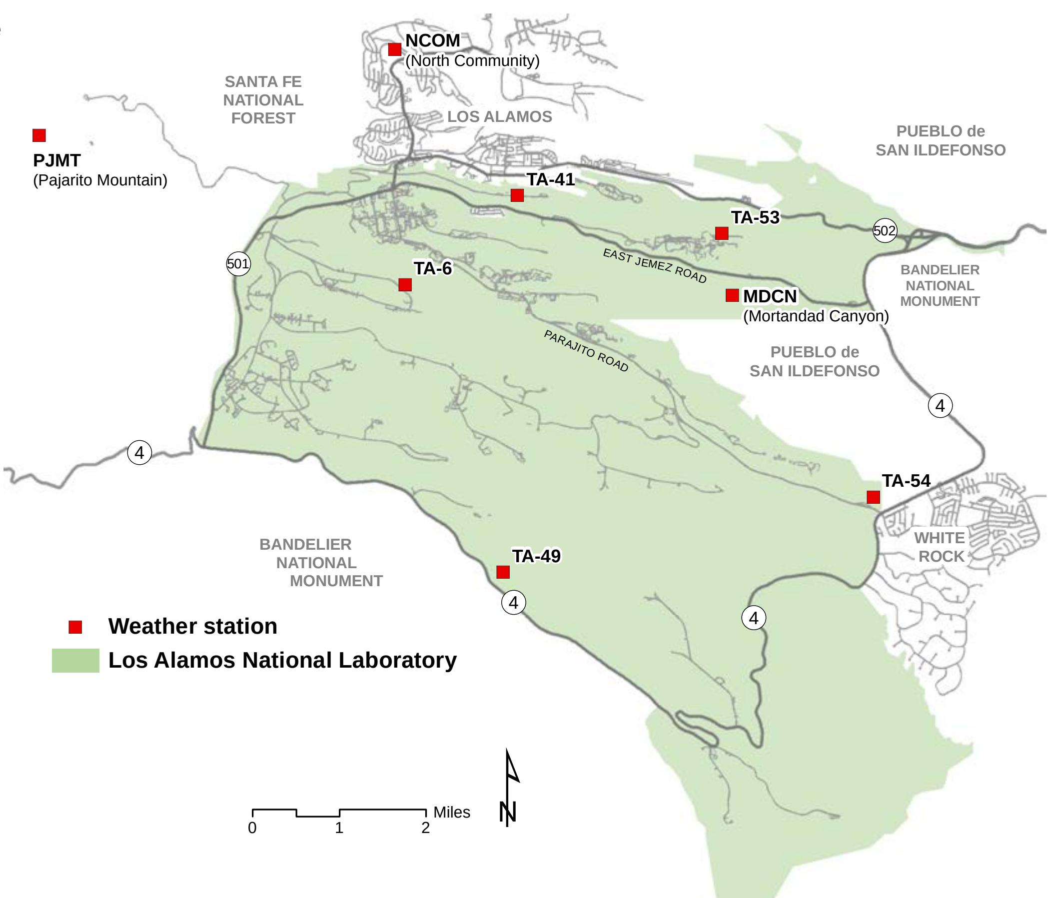
The Weather Machine
LOS ALAMOS NATIONAL LABORATORY

| LANL Current Conditions... | | | | | |
|---|---|---|---|---|---|
| Tower (tower): | TA6 | TA41 | TA49 | TA53 | TA54 |
| Date (mm/dd): | 8/13 | 8/13 | 8/13 | 8/13 | 8/13 |
| Time (hh:mm): | 09:30 | 09:30 | 09:30 | 09:30 | 09:30 |
| Temp (ºF): | 70.5 | 72.0 | 70.5 | 70.5 | 73.0 |
| Wind Chill (ºF): | 70.5 | 72.0 | 70.5 | 70.5 | 73.0 |
| Dew Point (ºF): | 54.0 | - | 53.6 | 54.3 | 53.8 |
| RH (%): | 55 | - | 55 | 56 | 51 |
| Speed (mph): | 7.8 | 2.9 | 7.6 | 6.0 | 7.2 |
| Dir (from): | S | ENE | S | SE | SSW |
| Precip Today (in): | 0.00 | - | 0.00 | 0.00 | 0.00 |
| **Note:** All times are reported in MST. | | | | | |

The Weather Machine is available at www.weather.lanl.gov

### The most dense meteorological monitoring network in New Mexico

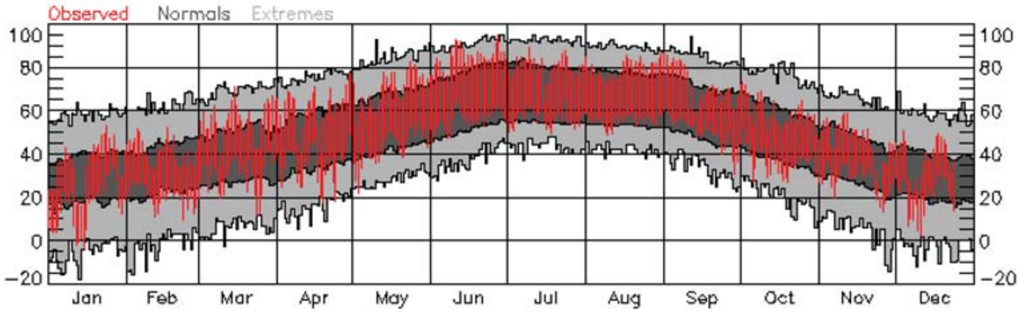
The Weather Machine uses a network of weather stations located in areas with good exposure to the elements.




Locations of meteorological monitoring towers and rain gauges

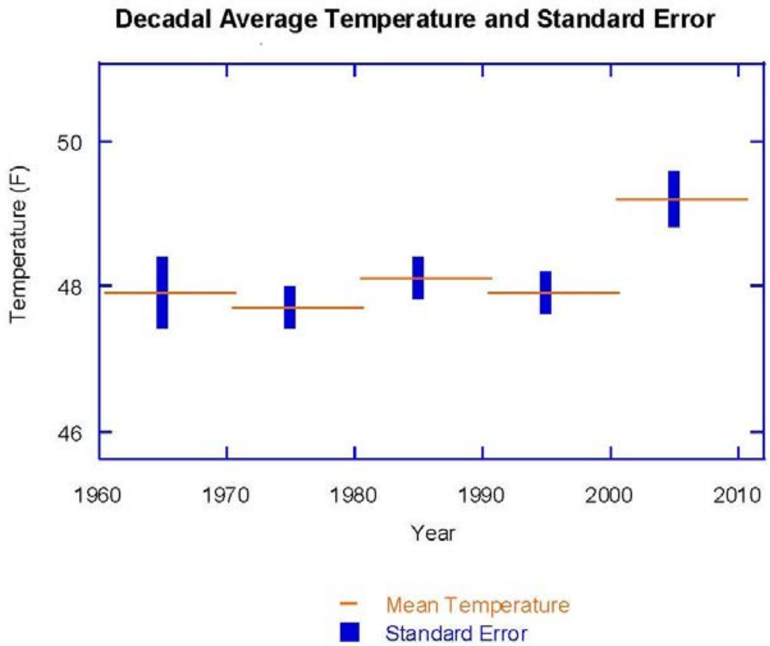
# 2013 temperatures

Temperatures for 2013 were similar to previous years.



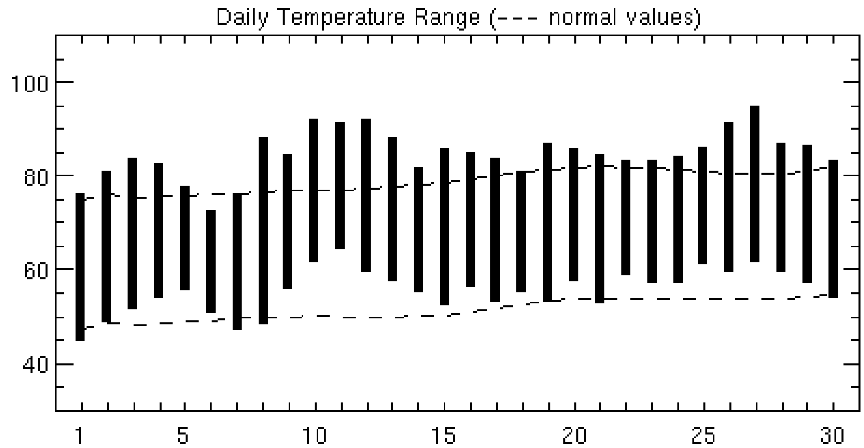

Los Alamos 2013 temperatures (°F)

However, average temperatures during the last decade are consistent with a warming trend and consistent with the national and global warming trends.




Annual average temperatures (°F) for each decade

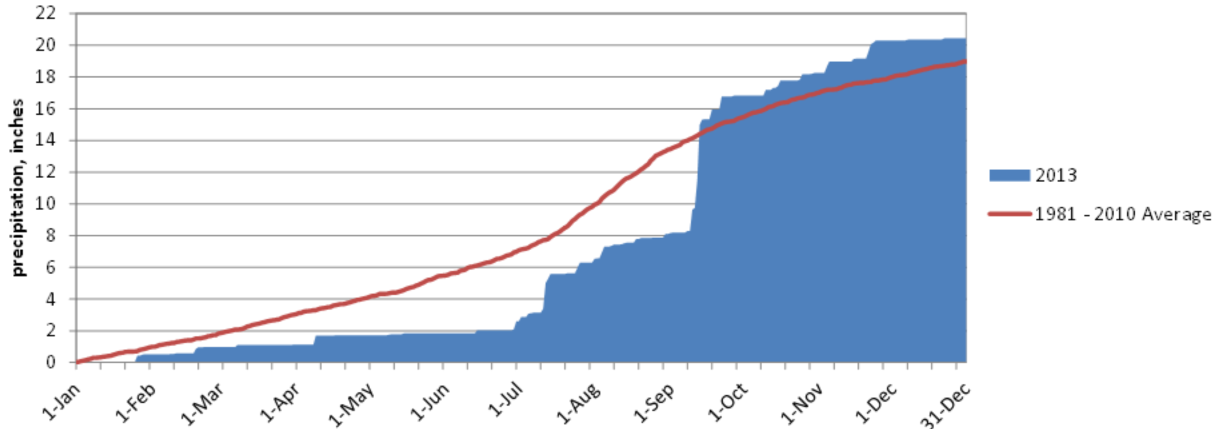
Five of the hottest summers on record have occurred since 2002. During June 2013, most days were warmer than normal.




Daily temperature range (°F) for June 2013 compared with normal values

# 2013 precipitation

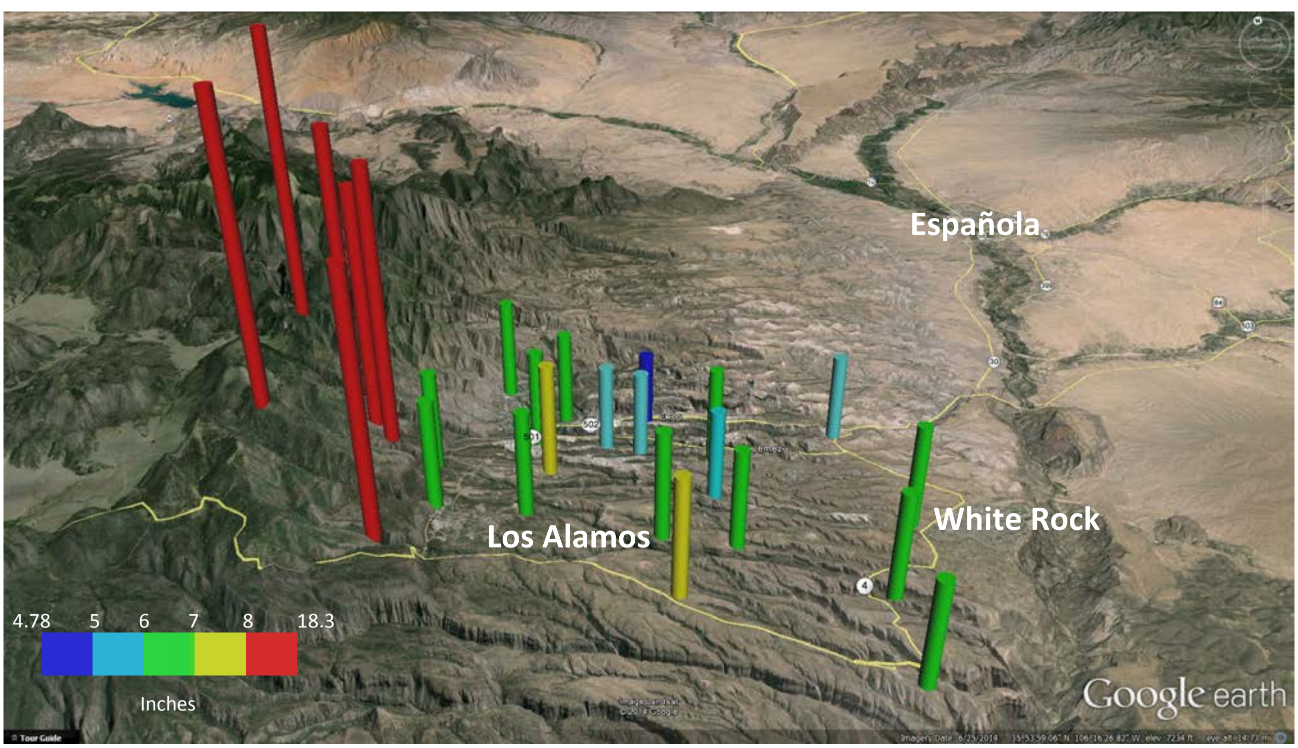
The year started out with a very dry winter and spring; total rainfall through the end of June was 37% of normal, making 2013 the second-driest first half of the year on record, second only to 2011. The summer monsoon arrived in July, though by the end of August, the total precipitation was less than 60% of normal.




Cumulative percipitation for Los Alamos, 2013 versus 30-year average values

## Most remarkable September on record

Then, the most remarkable September on record arrived on September 10, delivering 7 inches of rain in 5 days. At higher elevations, more than 15 inches of rain fell in 5 days.

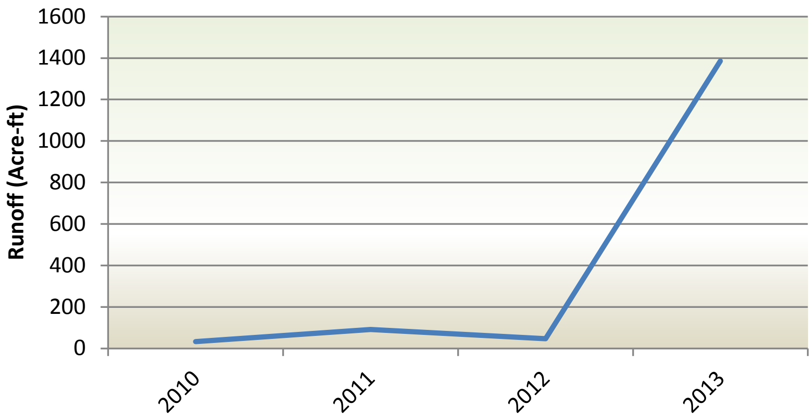



September 10 to 15, 2013, rainfall

# September 2013 rain event

From September 10 through 15, an upper-level low-pressure system parked over the Utah/Nevada border, placing New Mexico and Colorado in a stationary stream of monsoon moisture from the Pacific off the west coast of Mexico and from the Gulf of Mexico. Rainfall totaled 5.5 to 7.5 inches across the Laboratory for these 5 days, a once-in-a-1000-year storm for Los Alamos. In the mountains to the west of the Laboratory, rainfall amounts reached 15 to 18 inches, enhanced by orographic lifting of the easterly winds.

The first part of the storm hit on September 10th. Over 1.25 inches of rain was recorded across most of the Laboratory on September 10th and 11th, saturating the soil. From noon on September 12th through noon on September 13th, 5.08 inches of rain was recorded at the Laboratory Technical Area 06 (TA-6) monitoring station. This heavy rainfall, on top of saturated soils, produced record runoff across the Laboratory and local flooding that damaged Laboratory roads, monitoring wells, gaging stations, and sediment control structures.




Estimated stormwater runoff volume in Laboratory canyons from 2004 to 2013

Mortandad Canyon showing high water levels after September 12 to 13, 2013, rainfall

### Background Radiation

Radioactivity has been present all around us, as well as inside of us, since the formation of the Earth. Each day we receive a radiation dose from various sources, which include the following:

- Potassium—Natural radioactivity. Potassium is essential to every living cell and is found in all natural foods.
- Cosmic Rays—Radiation from space that has been present since the beginning of the universe. Cosmic rays offer insight into the science behind cosmological processes.
- Radon—A natural, radioactive gas that diffuses out of soil
- Global Fallout—Radioactive material dispersed into the atmosphere as the result of nuclear weapons testing from the 1940s to the 1960s
- Medical and Dental Radiation Radiation dose from medical and dental x-rays, which is increasing because of advances in diagnostics

### Radiation and Radioactive Material

Sun = **radioactive material/source**

Sun rays = **radiation**

Person on the beach = **receptor**

Sunburn on skin = **dose**

# Radiation is a part of life

## What is "radiation"?

Radiation is the transfer of energy through space. The radiation of interest is ionizing radiation and is in the form of alpha particles, beta particles, gamma photons, and neutrons. It is measured in units of millirem (mrem).

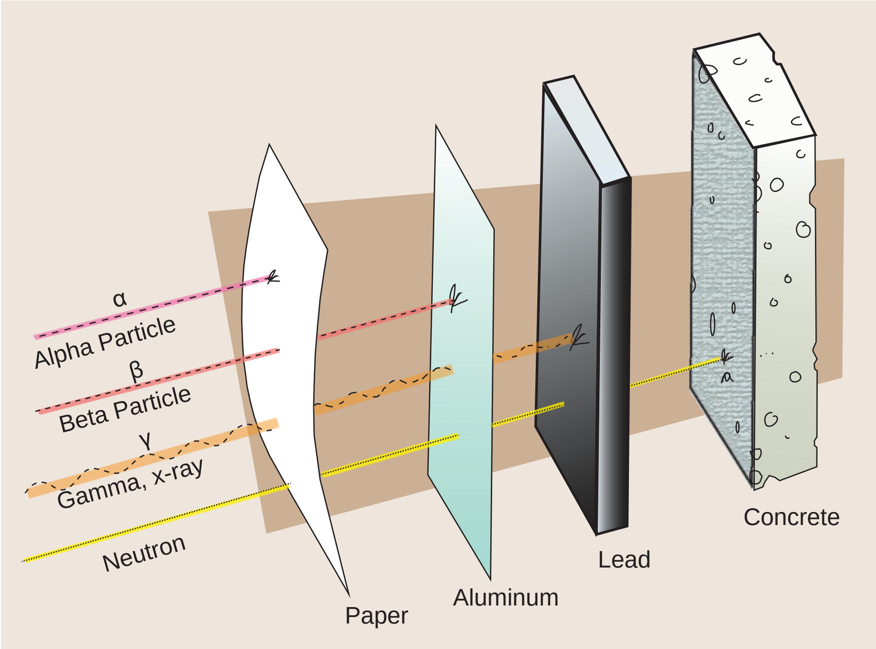
Radiation dose is also measured in mrem. Dose is a measure of the potential risk or harm. Risk or harm is caused by the energy transferred from a radioactive atom to a person, animal, or plant. "Direct-penetrating radiation" is direct because it is the energy of the radiation that directly causes dose, risk, or harm.

## Does all radiation penetrate?

Alpha particles will not penetrate the skin, so they can only do harm if the radioactive material is inside you. Plutonium is an example of a radioactive material that emits alpha particles.

Beta particles will not penetrate more than 7 meters of air, so they can only do harm if the source is close. Tritium is an example of a radioactive material that emits beta particles.

Gamma photons and neutrons, which are emitted from the Los Alamos Neutron Science Center (LANSCE) and are examples of direct-penetrating radiation, can penetrate more than 100 meters of air. Cobalt-60 is an example of a radioactive material that emits gamma photons.




Radiation has varying energies and travels different distances.

## Why do we monitor direct-penetrating radiation?

There are known sources of radiation near Los Alamos. In addition to radiation from natural background sources, there is radiation from current and past operations at locations such as Area G and LANSCE. To ensure the public is protected from these sources, the Laboratory monitors gamma photons and neutrons in the surrounding environment.

## How does the Laboratory monitor radiation?

To monitor gamma photons and neutrons, the Laboratory established the Direct-Penetrating Radiation Monitoring Network (DPRNET). DPRNET uses a series of detectors called thermoluminescent dosimeters (TLDs) to distinguish Laboratory radiation from natural radiation.

TLDs are placed at 98 locations around the Laboratory, near known sources of radiation, and are also worn by many employees. These are analyzed quarterly for dose measurements.

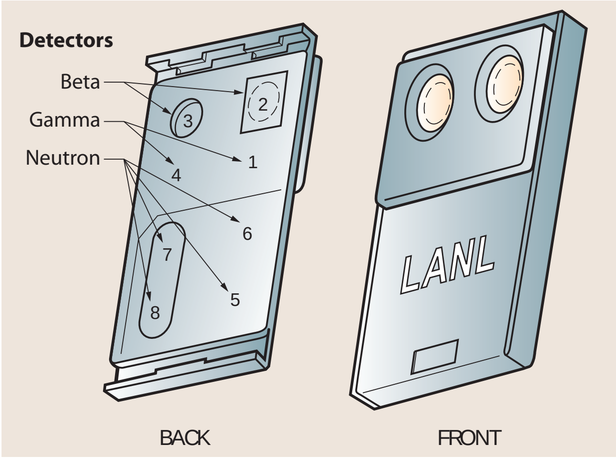
## Protecting our employees

Natural radiation is much higher than the radiation from the Laboratory and is quite variable. A TLD cannot distinguish between the small amount of Laboratory radiation and the large variations of natural radiation if the person is not close to the source of radiation. Depending on work locations and work activities, Laboratory employees may spend time near sources of high radiation that are inaccessible to the public. Such workers could expect to receive a dose from the Laboratory.

## Is this radiation from the Laboratory?

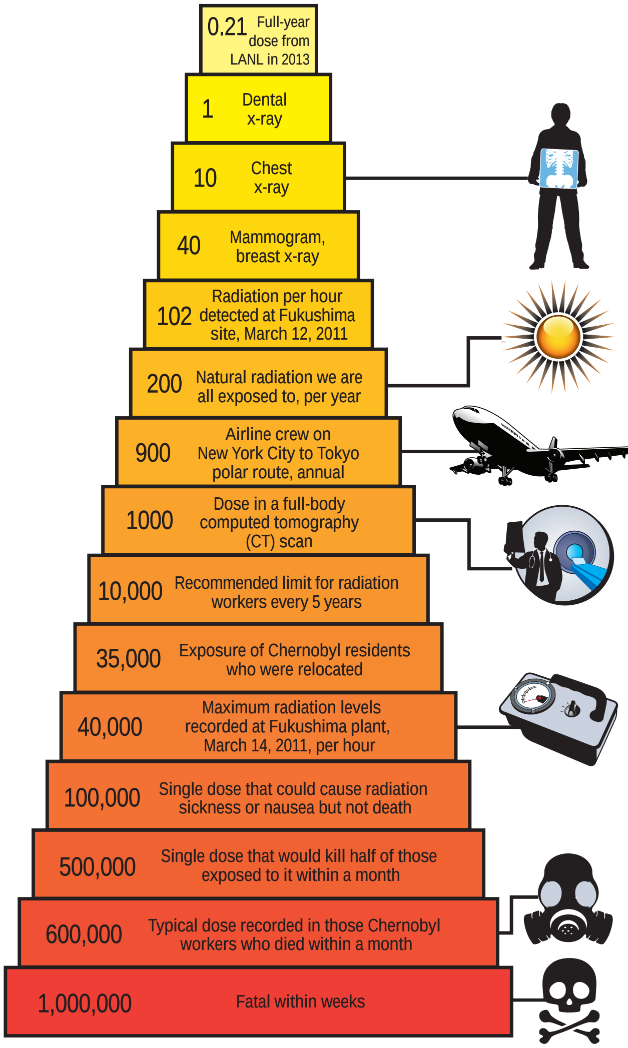
In the case of DPRNET, we measure the dose close to the source in addition to calculating the dose to the public. If the amount of radiation from the source is high, we can measure it at someone's location; if the amount is low, we can calculate the dose to a person.

Some Laboratory radiation is from radioactive material in the air, water, and other media. If we measure the amount of these materials in units of picocuries (pCi), we can then calculate the amount of radiation in units of mrem that comes in contact with people, animals, or plants.

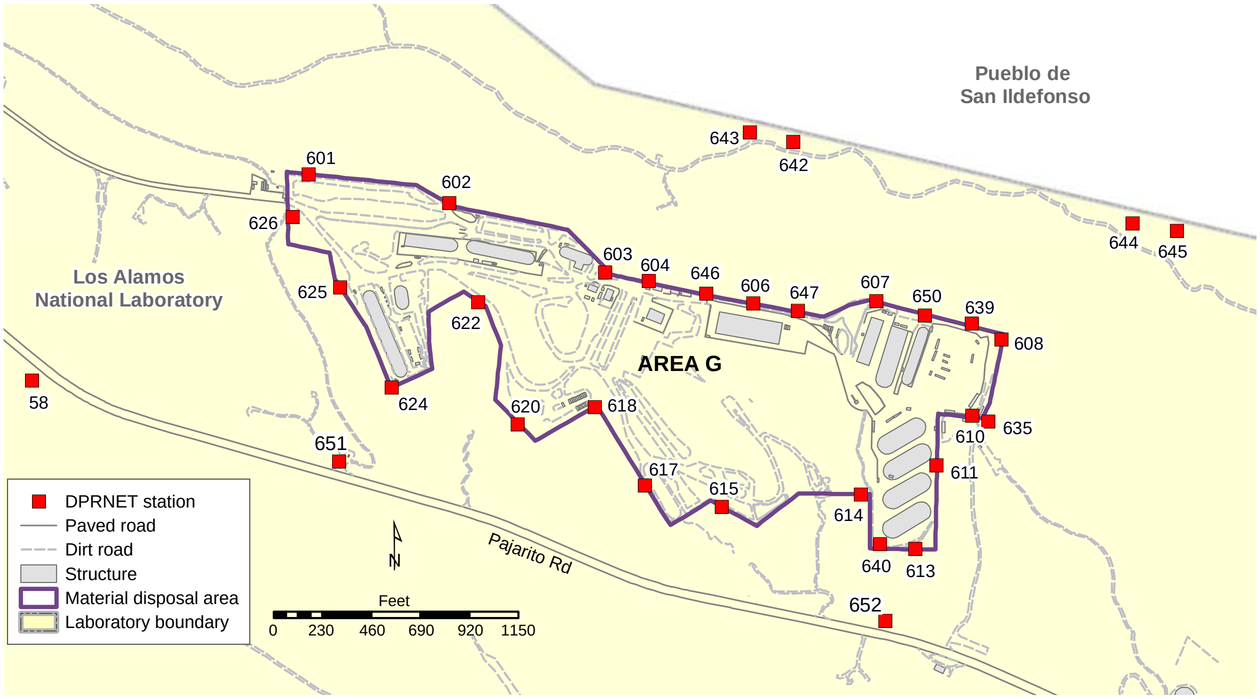



TLDs contain a total of eight detector chips.

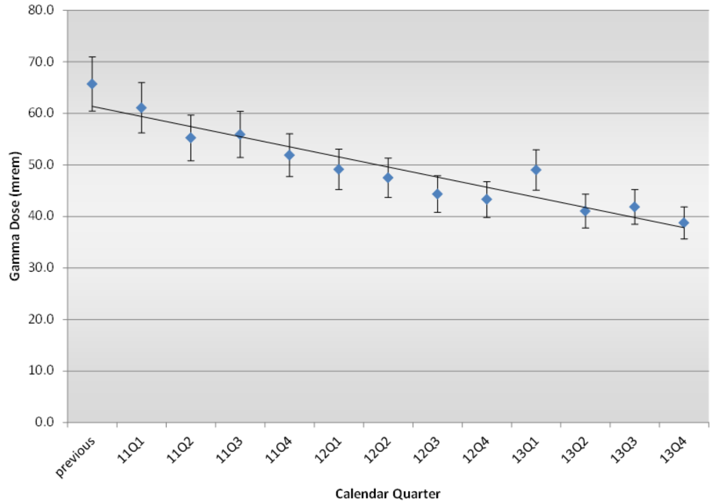
- Two chips detect beta particles: one for high-energy beta particles and one for low-energy beta particles.
- Two chips detect gamma rays: one for high-energy gamma rays and one for low-energy gamma rays.
- Four chips detect neutrons: two for high-energy neutrons and two for low-energy neutrons.



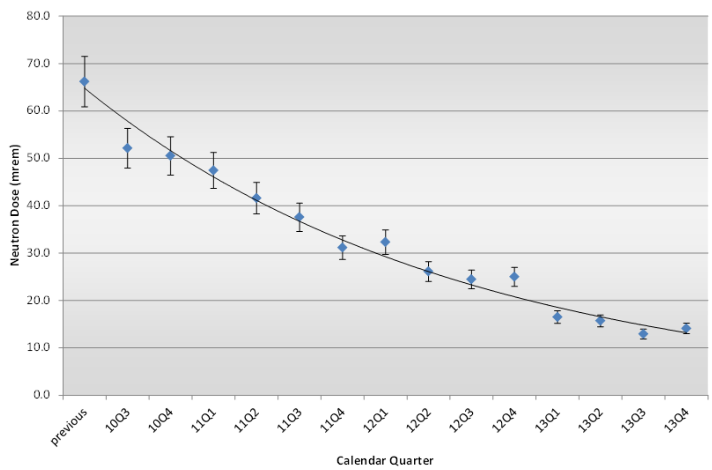

Breakdown of radiation doses (in mrem) and their effects




TLD radiation monitoring stations surround Area G.




Decreasing gamma doses around the perimeter of Area G from the first quarter of 2011 (11Q1) through the fourth quarter of 2013 (13Q4).




Decreasing neutron doses around the perimeter of Area G from the third quarter of 2010 (10Q3) through the fourth quarter of 2013 (13Q4).

## Reducing dose by shipping waste

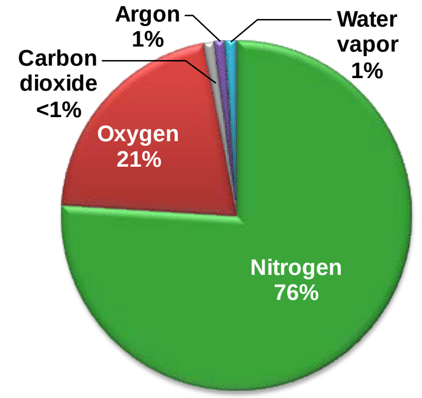
DPRNET monitors the dose around the perimeter of Area G. Area G is the Laboratory's radioactive waste storage and shipping facility. As waste is removed, the gamma and neutron dose rates are decreasing, as shown in the figures.

## Dose reduced

For 2013, the maximum public dose from direct penetrating radiation was 0.2 mrem, which is far below the DOE dose constraint of 25 mrem/year.


TLDs between Area G and Pueblo de San Ildefonso ensure no unacceptable dose reaches tribal lands.

# Protecting the quality of air




Of the different monitoring that takes place at the Laboratory, air monitoring is the most significant. Air monitoring is of great importance because

- it is impossible to contain harmful material released in air,
- material released in air has the potential to move rapidly and to great distances, and
- once material is inhaled into the lungs, it is difficult to remove.

## How does the Laboratory monitor the air?

### Stack monitoring

Stack monitoring measures the amount of radioactive material at the source of the emission (i.e., the stack) to calculate the dose at the location of the receptor.

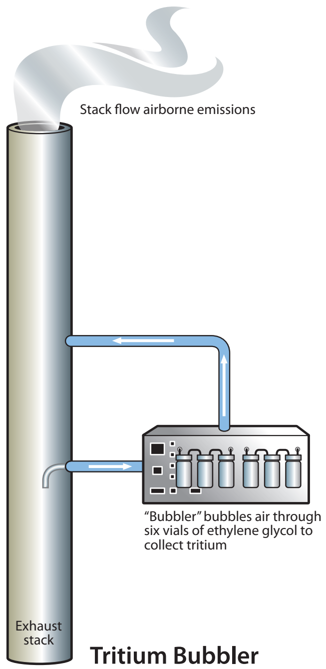
The Laboratory monitors four different types of stack emissions:

1. Particulate matter, such as plutonium and uranium particles
2. Radioactive vapors, such as iodine-131
3. Tritium, an isotope of hydrogen
4. Radioactive gases, such as oxygen-15, nitrogen-13, and carbon-11

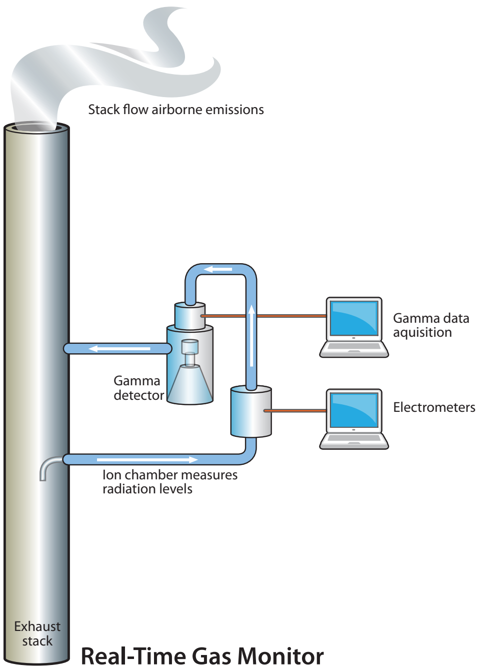
Samples are taken from the air in the stack and analyzed, and a dose to the public is calculated.


Monitoring systems are maintained regularly for optimal functioning.

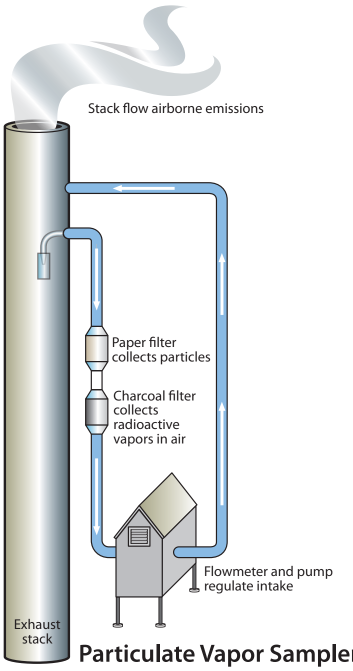
Monitoring systems are selected based on the type of material in the stack.



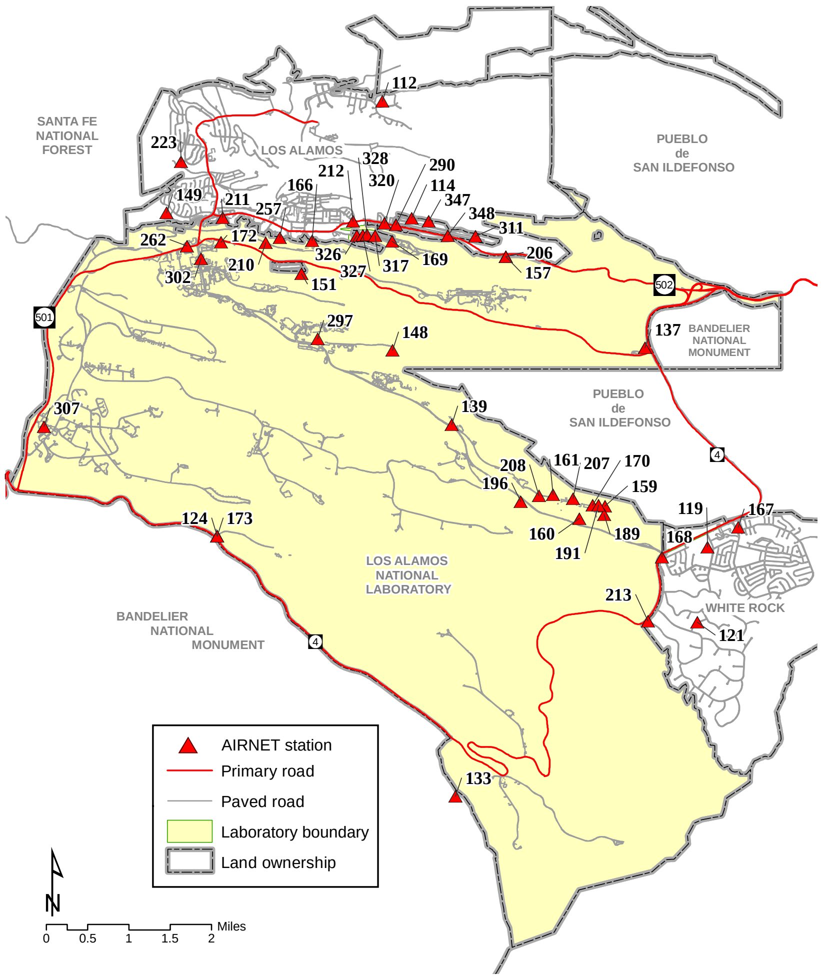
Tritium Bubbler



Real-Time Gas Monitor



Particulate Vapor Sampler




The majority of air-monitoring stations are mounted on pickets between Laboratory operations and population centers.

## Protecting those nearby and downwind

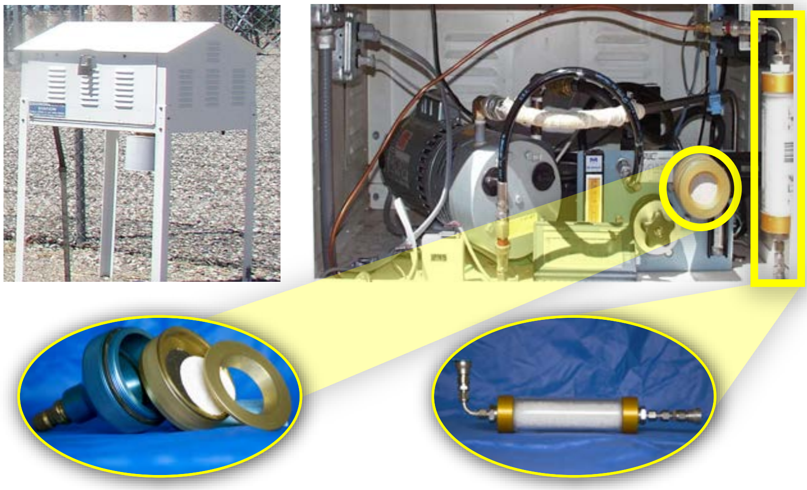
The Los Alamos townsite is downwind of the Laboratory, so many air-monitoring stations are located in and around the town. In 2013, the Laboratory operated 41 air-monitoring network (AIRNET) stations to sample for radionuclides. AIRNET stations monitor 24 hours a day, 365 days a year.

The monitoring stations take in air at 4 cubic feet per minute, which is approximately 10 times the rate at which humans breathe. Because the AIRNET stations are able to sample a large amount of air, the data the Laboratory produces are more accurate.

The Laboratory expects to produce certain materials based on those used at each facility. The materials used include tritium, americium, uranium, and plutonium. Tritium is collected in the form of water vapor, while americium, uranium, and plutonium are found in the air as particulate matter. The samples are collected and analyzed every 2 weeks for identification of analytes and assessment of the potential impact on the public.

A worker checks the air flow of an AIRNET station.

## AIRNET stations monitor ambient air on-site and off-site



Polypropylene filters collect particulate matter; samples are collected every two weeks

Silica gel absorbs water vapor; samples are collected every two weeks and tested for tritium

How an AIRNET station works

AIRNET stations are a common sight around the Laboratory.

## Safe limits maintained

During 2013, the Laboratory detected no airborne radioactivity that exceeded the U.S. Environmental Protection Agency (EPA) standard of 10 mrem/year, with the largest dose to the public being 0.21 mrem. All tritium concentrations were far below EPA standards, with the highest activity occurring at a known source near Area G. Americium levels were similar to those in previous years and remained well below EPA standards. There was also no detection of enriched or depleted uranium in 2013. Plutonium levels (plutonium-239) were similar to previous years and remained far below EPA standards.

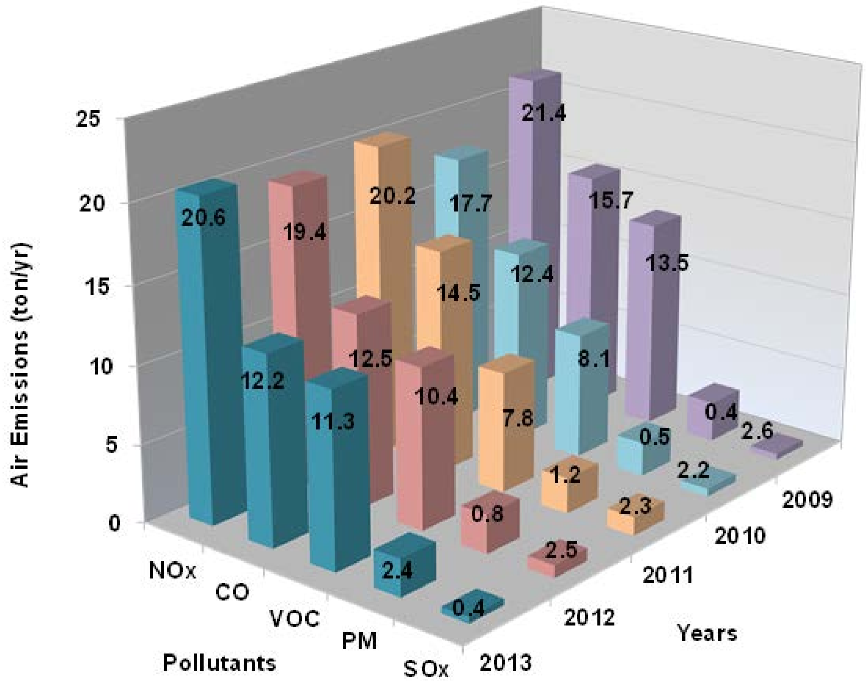
## Monitoring nonradiological materials

In compliance with the Clean Air Act, the Laboratory also monitors nonradiological pollutants, such as carbon monoxide (CO), sulfur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOCs), and particulate matter (PM).

- CO is the product of inefficient burning, such as from a motor vehicle.
- SOx, including sulfur dioxide, is the result of burning coal, which contains sulfur. When sulfur dioxide mixes with water, sulfurous acid is created. Sulfurous acid causes respiratory damage to humans and animals and damages the vegetation in the environment.
- NOx, including nitrogen dioxide, is the result of burning coal, oil, or gasoline at high temperatures. When nitrogen dioxide mixes with water, nitric acid is created. Nitric acid is harmful in similar ways to sulfurous acid.
- VOCs are chemical compounds that vaporize when they are exposed to the air. When VOCs evaporate, they are able to enter the lungs and cause damage. VOCs are produced by motor vehicles and many commonly used solvents.
- PM is a hazard to human health when the particle size becomes small enough to enter the lungs, for example, particles found in smoke.

## Far below health limits

Emissions of these pollutants remain far below permit limits. Meeting the permit limits ensures that the Laboratory meets the EPA's National Ambient Air Quality Standards.




Laboratory criteria pollutant emissions from 2009 through 2013 for annual emissions inventory reporting. Totals from the emissions inventory report do not include small boilers or standby generators.

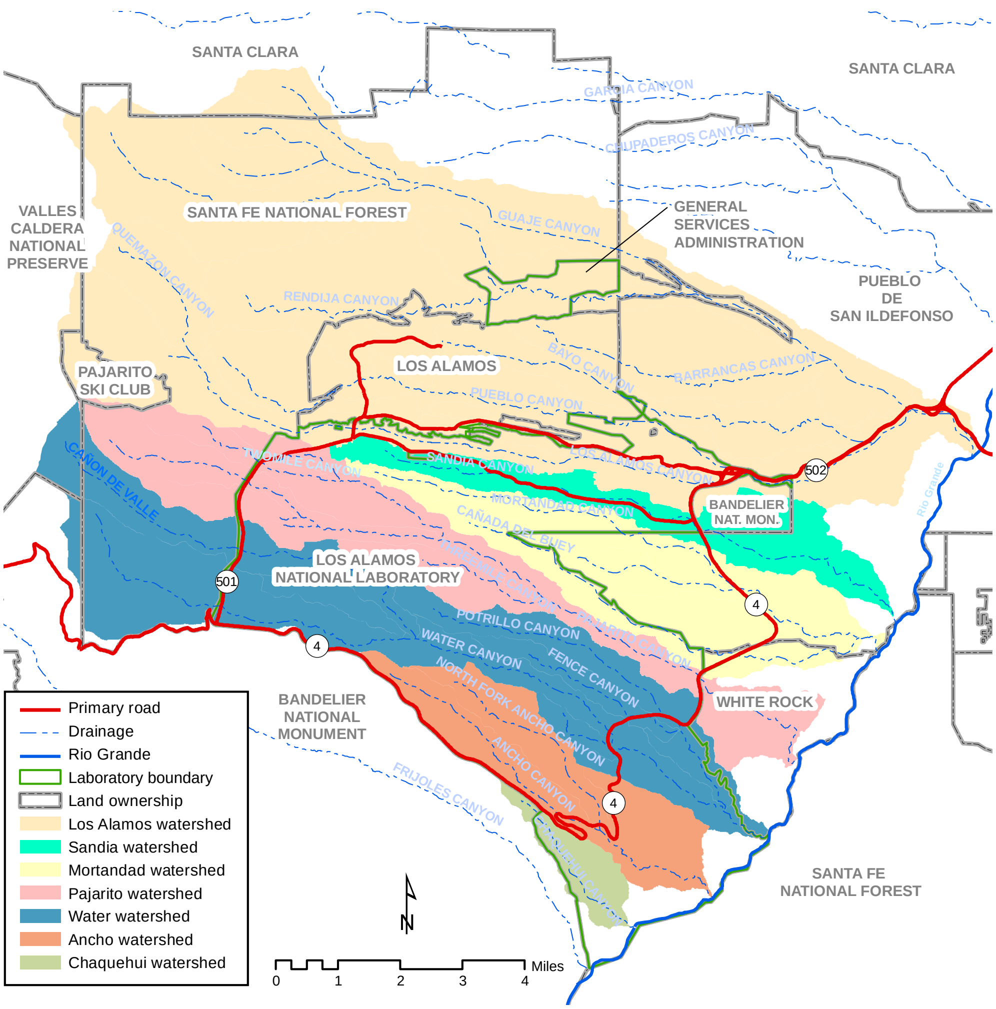
# Monitoring surface water for Laboratory impacts

The Laboratory monitors surface water, including storm water and canyon sediment, to

- evaluate the transport of legacy contamination,
- evaluate potential changes in dose as a result of the transport of contaminants,
- confirm that concentrations are not increasing because of ongoing operations, and
- evaluate the effectiveness of sediment transport mitigation in Los Alamos and Pueblo Canyons.

The flow of surface water on the Pajarito Plateau is limited, and no drinking water systems rely on surface water supplies, so it is not considered a drinking water source for humans. However, because wildlife may use surface waters within and around the Laboratory, standards are set for the protection of wildlife.

Storm water sampling at the Laboratory

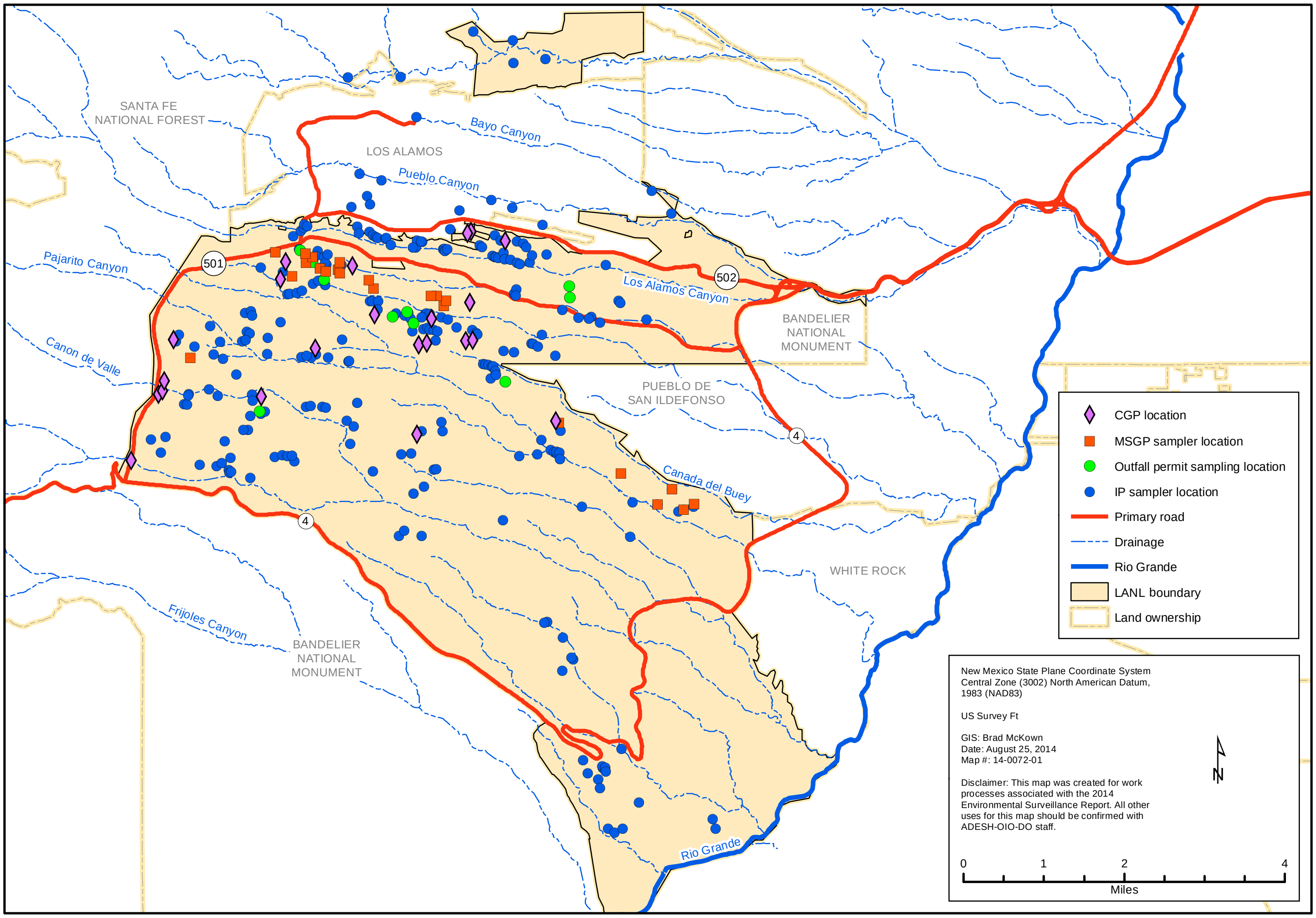



Watershed locations

## How do we monitor surface water?

The Laboratory property encompasses seven primary watersheds, each of which drains directly into the Rio Grande. The watersheds are defined by seven major canyons: Los Alamos, Sandia, Mortandad, Pajarito, Water, Ancho, and Chaquehui.

Surface water and sediment samples are collected in the canyons, with extra monitoring taking place near and downstream of potential sources of Laboratory-produced substances. The samples are collected either manually (grab sampling) or by automated samplers that are activated during periods of high storm water runoff. All surface water and sediment samples are then analyzed for radionuclides and chemicals.



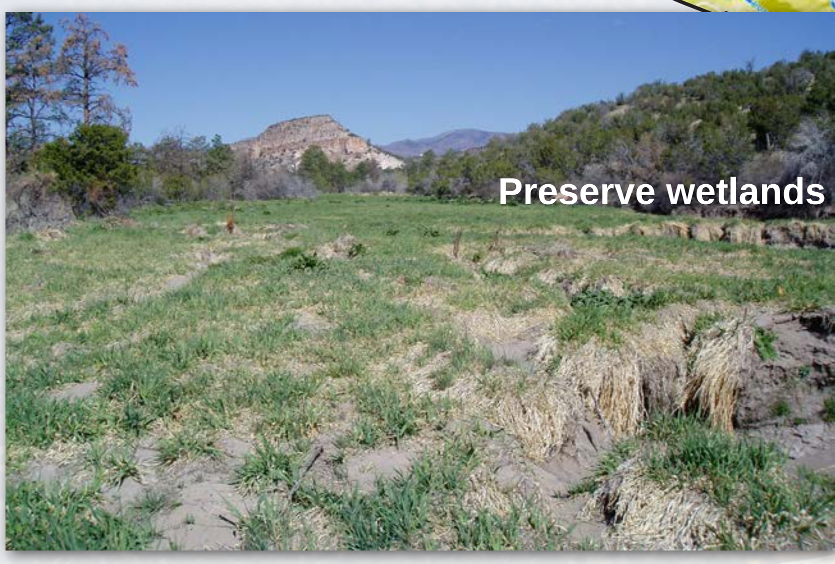

Surface water sampling locations

## Clean Water Act Compliance

The Clean Water Act differentiates between point-source pollutants that originate from discrete sources, such as outfalls, contaminated sites, construction sites, and industrial activities, and non-point-source pollutants. Non-point-source pollutants originate from dispersed sources like atmospheric deposition, runoff from roads and parking lots, and as naturally occurring soil constituents. The Laboratory manages point-source pollutants through compliance with four National Pollutant Discharge Elimination System (NPDES) permits. In 2013, the Industrial Point Source Outfall Permit Program established specific chemical, physical, and biological criteria for discharges from 11 outfalls. The Construction General Permit Program regulated sediment and storm water discharges from 32 construction projects disturbing one or more acres. The Multi-Sector General Permit Program regulated storm water discharges from 13 industrial activities and associated facilities. The Individual Permit for Storm Water Discharges Program was responsible for 405 legacy-waste sites that must be managed to prevent the transport of contaminants to surface waters via storm water runoff.

Outfall sampling

Plant vegetation

Preserve wetlands

Monitor run-on

# Watershed management

Beyond NPDES compliance, the Laboratory maintains an extensive program to manage non-point-source pollutants in surface water and sediment in the major canyon systems. Surface water run-on from above the Laboratory and runoff within and below the Laboratory is sampled from a network of gage stations. Surface water samples are also collected away from the Laboratory to help establish appropriate background concentrations. Sediment samples collected from drainages that have flooded in the past year are used to evaluate potential pollutant transport. Non-point-source sediment and pollutants are managed through a number of sediment-retention and stabilization features such as ponds, weirs, grade-control structures, wetlands, and riparian vegetation. Runoff from areas burned in the Las Conchas fire (2011) continued to impact storm water quality and quantity.




**Types of Groundwater**

**Alluvial—**Water that occupies sediment in canyon bottoms

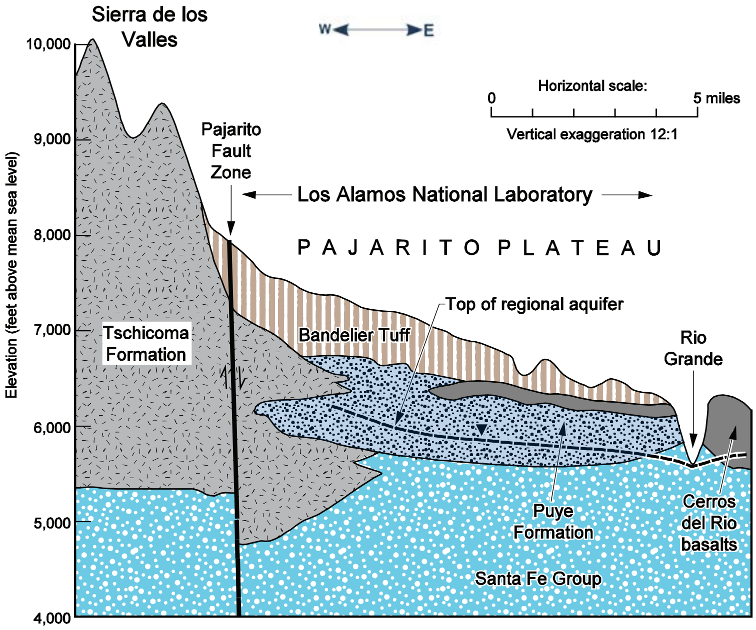
**Intermediate—**Water found at various depths, settled on rocks that it cannot easily travel through

**Regional Aquifer—**Water located 600 to 1200 feet below the surface, separated from alluvial and intermediate groundwater by several layers of rock and dry tuff, and a source of public drinking water

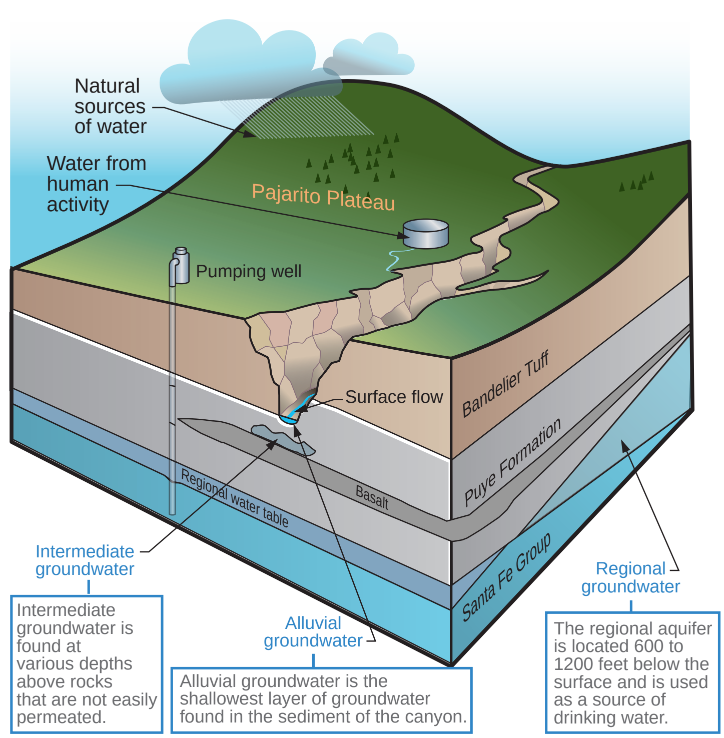
# Protecting our aquifer

There are three different forms of groundwater that occur beneath the Pajarito Plateau: alluvial groundwater, intermediate groundwater, and the regional aquifer. Los Alamos County's drinking water supply consists of water pumped from the regional aquifer.

To determine the impact of past and present liquid waste discharges from Laboratory facilities on groundwater quality, the Laboratory collects and analyzes samples from the three different modes of groundwater.




Geologic cross-section of the Pajarito Plateau




Geologic and hydrologic relationships of the three groundwater levels of the Pajarito Plateau

## Hydrogeological setting of the Pajarito Plateau

The Laboratory is located on the Pajarito Plateau, which is bordered to the west by the range of the Jemez Mountains known as Sierra de los Valles, and to the east by the Rio Grande. The plateau is capped by Bandelier Tuff, which formed as the result of a volcanic eruption that occurred in the Jemez Mountains 1.2 to 1.6 million years ago. Underlying the Bandelier Tuff is a combination of Tschicoma Formation, Puye Formation conglomerate, and Cerros del Rio basalt. Beneath these formations lie the sediments of the Santa Fe Group.

The three modes of groundwater are separated by layers of unsaturated rock. The alluvial groundwater situated in the bottoms of canyons is separated from the intermediate groundwater by a thick layer of Bandelier Tuff. Intermediate groundwater occurs within the lower part of Bandelier Tuff as well as in the Puye Formation and Cerros del Rio basalt. Approximately 350 to 600 feet of unsaturated tuff, basalt, and sediments separates the perched and intermediate groundwater from the regional aquifer. Because the rock has such low permeability, groundwater moves between the different modes only where cracks are present.

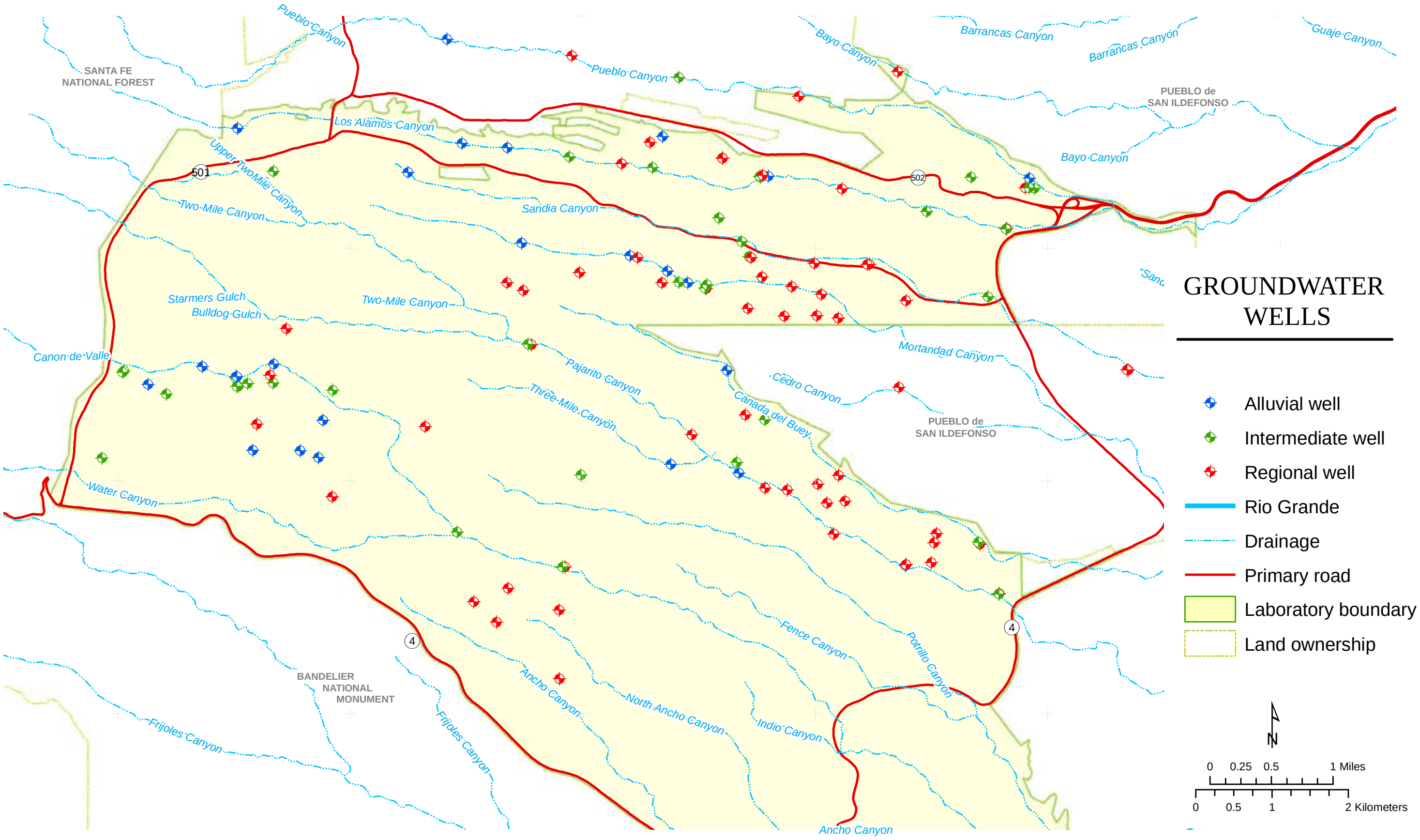
## How do we monitor groundwater?

In 2013, the Laboratory used a total of 173 wells and springs to collect groundwater samples. Deep wells, such as monitoring and supply wells, were used to collect water from the regional aquifer and intermediate groundwater, while alluvial groundwater samples were taken from shallow wells. Because groundwater is monitored at various depths, the Laboratory is able to track the movement of materials through each of the levels of groundwater. This monitoring system allows the Laboratory to prepare for and minimize any potential impact to public drinking water.

Checking the water depth of well R-13, near the Pueblo de San Ildefonso boundary

Taking samples at well R-37, above Cañada del Buey

For example, the movement of chromium has been tracked from the alluvial groundwater in Sandia Canyon to the intermediate groundwater that extends from Sandia Canyon to Mortandad Canyon and from there to the regional aquifer beneath Mortandad Canyon. The concentrations are monitored closely, and treatment options are being evaluated to prepare for the possibility of chromium reaching the public drinking water supply.



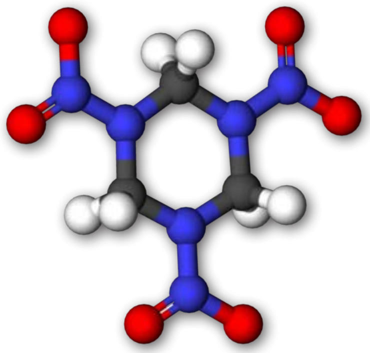

Groundwater monitoring well locations

## What materials move easily in groundwater?

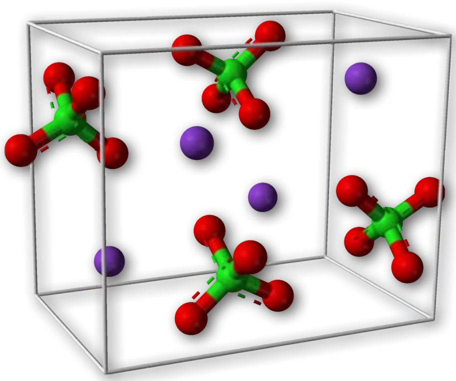
Materials that are soluble in water move readily with the groundwater, while insoluble materials usually bind to soil particles and only move if the sediment moves. The Laboratory expects to see certain materials, based on the work being done at each facility.

- **Chromium**—Chromium is widely used as a corrosion inhibitor. Until 1972, the Laboratory used potassium dichromate in a cooling tower at TA-03. The water was discharged into Sandia Canyon after use. The chromium at surface in soils and sediment is now in the form of relatively immobile trivalent chromium and remains in the wetlands of upper Sandia Canyon. However, much of the chromium has migrated downstream as soluble hexavalent chromium and has infiltrated the intermediate and deep groundwater under Mortandad Canyon.
- **Research Department Explosive (RDX)**—RDX was widely used during World War II. At the Laboratory, RDX has been used as part of explosives research and development. RDX is soluble in water, and so it moves easily in groundwater. From 1951 to 1996, the Laboratory discharged RDX into Cañon de Valle. As a result, low levels of RDX have been detected in the groundwater under Cañon de Valle at TA-16. The Laboratory is currently working on the removal of contaminated soil and sediment in this area to reduce the impact to groundwater.
- **Perchlorate**—Perchlorates are salts that are derived from perchloric acid. They are produced through both natural and artificial processes. Perchlorate-based materials are often used in explosives, solid fuel for rockets, vehicle air bags, and batteries. Most perchlorates are soluble in water, and so they travel easily in groundwater. Perchlorate has been detected in the groundwater in Mortandad Canyon, but concentrations are decreasing as a result of reduced discharges from TA-50.

The word chromium comes from the Greek word chroma, meaning color. Different oxidation states of chromium are different colors and have different solubilities.



An RDX molecule contains three carbon atoms (black), six nitrogen atoms (blue), six oxygen atoms (red), and six hydrogen atoms (white).



A perchlorate ion contains a chlorine molecule (green) surrounded by four oxygen atoms (red); the purple spheres represent atoms such as potassium.

## Water supply wells meet all standards

In 2013, the water samples collected from the Los Alamos County water supply wells were in compliance with both federal and state standards.

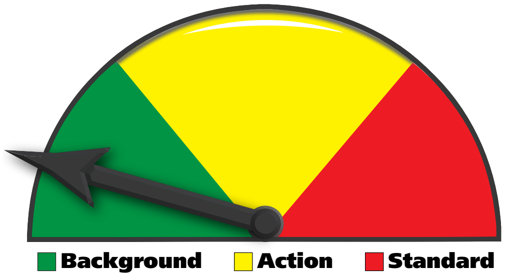
### Groundwater Standards and Cleanup Levels

EPA maximum contaminant levels are the maximum allowed levels of a contaminant delivered to any user by a public water system. They are used as cleanup levels for groundwater in the event that corrective actions are implemented. For radionuclides, the levels are equivalent to a 4-mrem/year dose. Compliance with these levels may be evaluated after water treatment; therefore, measurements in a water supply well may be higher.

# Checking food for safety

Foodstuffs are products edible to humans such as fruits, vegetables, and various animal tissues. To assess the potential impact of Laboratory operations on human health via the food chain, foodstuffs are collected within and around the Laboratory perimeter and analyzed for radionuclides and chemicals.

In 2013, the Laboratory collected 98 samples of foodstuffs from communities surrounding Laboratory property, including fruit, vegetables, eggs, honey, milk, and road killed deer and elk. Samples were analyzed for radionuclides, metals, and organic chemicals. The results from close to the Laboratory were consistent with regional results, indicating no measurable contamination from the Laboratory.




## Foodstuffs Comparison Levels

Concentrations of radionuclides and chemicals in foodstuffs samples are compared with three reference levels to help identify and prevent any potential impact to human health.

**Background**—Regional background levels of radionuclides and chemical concentrations are calculated from foodstuffs collected at locations away from the influence of the Laboratory. Radionuclide and chemical concentrations in foodstuffs collected from background locations are the result of natural processes and global fallout.

**Action Limits**—Action limits for radionuclides in foodstuffs are set by the Laboratory at a 1-mrem/year single-pathway dose limit and serve as a "yellow flag," so that potential human health concerns may be identified in advance. For other chemicals, such as mercury and polychlorinated biphenyls (PCBs), EPA action limits are used.

**Standards**—If radionuclide or chemical concentrations in foodstuffs exceed action limits, the concentration levels are compared with the appropriate standards. In the case of radionuclides, the potential dose to a person is calculated and compared with the DOE single-pathway dose constraint of 25 mrem/year. For mercury and PCBs, the concentrations are compared with the Food and Drug Administration action limits of 1 milligram per kilogram (mg/kg) in fish, and 3 mg/kg in red meat and poultry.

## Special monitoring

### Wild edible foods—purslane, lambsquarters, amaranth, prickly pear

Wild edible plants were collected and analyzed for radionuclides, metals, and organic chemicals.

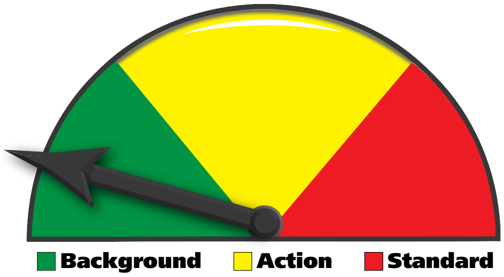
### No Laboratory effects on foodstuffs

All foodstuffs samples collected in 2013 contained concentrations of radionuclides and chemicals far below screening levels. There was no measurable difference between samples collected close to the Laboratory and regional samples.

Prickly pear (Opuntia sp.)

Common purslane (Portulaca oleracea)

# Plants and Animals




### Biota Comparison Levels

The data from biota samples are compared with three reference levels to help identify and prevent any potential impact to species population or diversity of biota species.

**Background**—Regional background levels of radionuclides and chemical concentrations representative of biota samples are collected at locations away from the influence of the Laboratory.

**Action Limits**—Action limits for radionuclides in biota correspond to a dose of 0.01 rad/day for animals and 0.1 rad/day for plants and serve as a “yellow flag,” so that potential concerns may be identified in advance. There are no action limits for chemicals in biota tissue. If the background level is exceeded for a chemical in a biota sample, chemical concentrations in the soil are compared with ecological screening levels (ESLs). ESLs reflect the highest soil concentration of a substance not expected to result in any negative impact to biota.

**Standards**—The dose to biota is calculated using the computer program RESRAD-BIOTA, as well as using radionuclide concentrations found in biota samples. The calculated dose is then compared with the DOE dose standard of 1 rad/day for terrestrial plants and aquatic biota and 0.1 rad/day for terrestrial animals.

Broad-tailed Hummingbird (*Selasphorus platycercus*)

## Does the Laboratory impact plants or animals?

The Laboratory monitors potential impact to the surrounding ecosystems by sampling and analyzing biota. Biota are organisms not normally eaten by humans and include native vegetation, small mammals, reptiles, birds, and bees. Samples are analyzed for radionuclides and chemicals. The Laboratory also looks for changes in population and diversity of biota species.

## Measurements show no impact

All biota samples collected in 2013 contained concentrations of radionuclides and chemicals consistent with background. The populations or diversity of biota species have not been impacted.

Staghorn cholla (*Cylindropuntia versicolor*)

Western fence lizard (*Sceloporus occidentalis*)

# Special monitoring for special populations

As part of the Laboratory's commitment to minimize risk to biological resources, the Laboratory has implemented the Biological Resources Management Plan (BRMP). The BRMP describes objectives, strategies, and actions that fulfill the following goals:

1. **Mission Support**—Ensure and facilitate compliance with biological resource laws and regulations
2. **Site Stewardship**—Identify and mitigate adverse impacts on biological resources
3. **Regional Commitment**—Meet responsibilities as a good neighbor and trustee of natural resources

Species management is an integral part of the BRMP. The Laboratory is committed to protecting special classes of species, including federally listed species, state-listed species, and migratory birds.

## Migratory birds

During the fall of 2013, biologists completed the fourth year of fall migration songbird monitoring at the Laboratory. The long-term monitoring of trends in migratory birds is useful in determining if bird populations are being impacted by Laboratory operations or environmental factors such as drought. A total of 166 songbirds, representing 41 species, were captured, measured, and banded during 2013 at a netting station located in a large wetland on the north side of Pajarito Road in Los Alamos County. The number of birds captured during this monitoring effort has been variable, and fewer birds were captured in 2013 compared with 2012. Variability in bird populations is likely because of changes in the regional climate.

## Jemez Mountains salamander

The Endangered Species Act of 1973 was established to protect rare species and their habitats. The Laboratory currently manages habitat for three species listed under the act; Mexican spotted owls, southwestern willow flycatchers, and most recently, the Jemez Mountains salamander. This small salamander is only found in the Jemez Mountains, and because of disease and habitat degradation, including habitat burned in the Cerro Grande and Las Conchas wildfires, it was classified as endangered on September 10, 2013. Laboratory biologists defined the critical salamander habitat on Laboratory property using computer models and habitat assessments. The Laboratory's Threatened and Endangered Species Habitat Management Plan (HMP) was updated to include the salamander. The HMP provides guidance to ensure that LANL operations do not adversely affect threatened or endangered species or their habitats. One of the primary threats to amphibians worldwide, including the Jemez Mountains salamander, is chytrid fungus. Laboratory biologists test for this fungus regularly, and to date, the fungus has not been detected on Laboratory property.

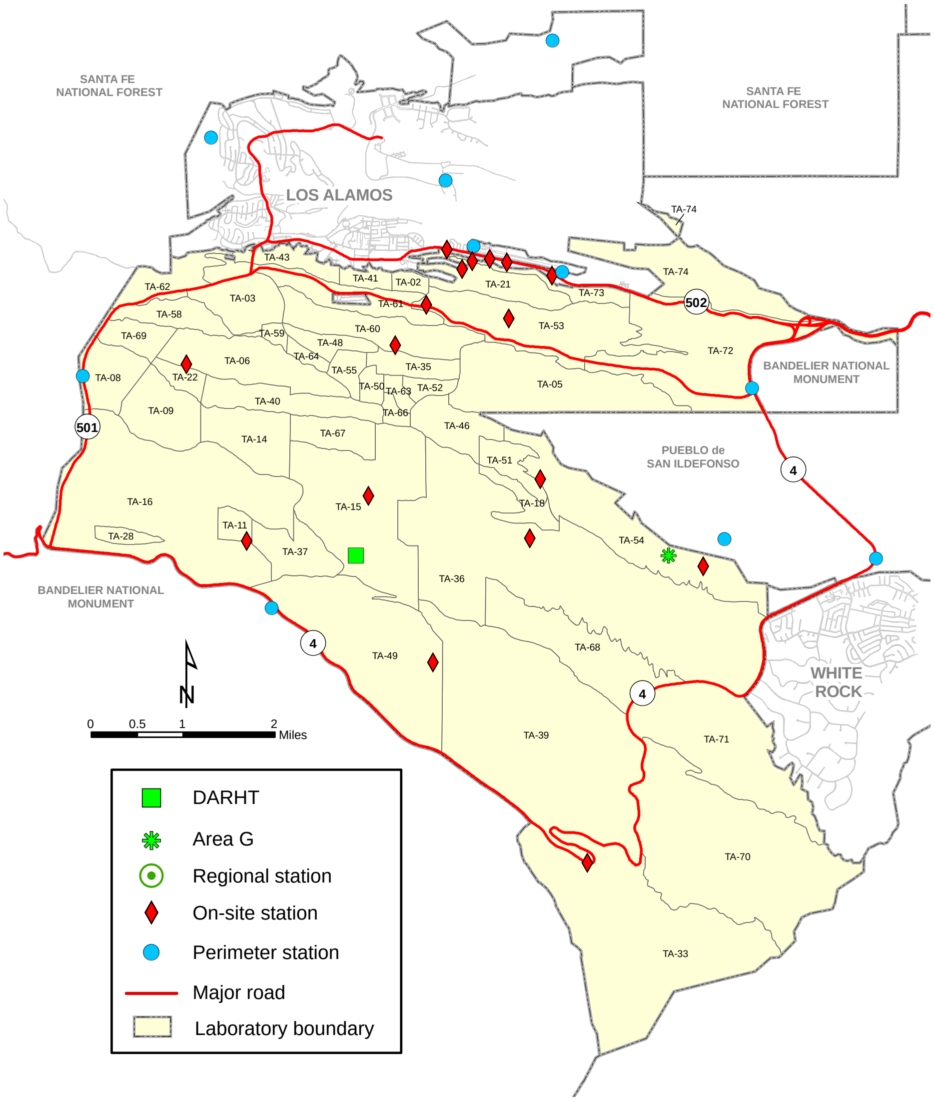
## PCB concentrations decreasing

Current levels of PCBs in field mice collected from around the Los Alamos Canyon Weir are at their lowest since surveys began, indicating that engineering controls upstream of the weir are reducing the PCBs available to biota. Downstream PCB concentrations are even lower than those at the weir.

Ash-throated flycatcher (*Myiarchus cinerascens*)

Jemez Mountains salamander (*Plethodon neomexicanus*)

# Soil Monitoring



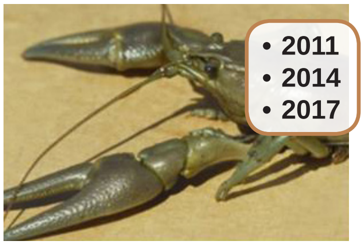

On-site, perimeter, and regional soil-sampling locations

## Why do we monitor soil?

To evaluate the potential impacts of Laboratory operations on human health and the environment, the Laboratory collects and analyzes soil samples for radionuclides and chemicals.

Institutional sampling within and around the Laboratory is conducted once every 3 years, with the last large-scale soil sampling taking place in 2012. The Laboratory also conducts facility-specific sampling on an annual basis to monitor the soil around Area G and the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility. In addition, the Pueblo de San Ildefonso requested that the Laboratory collect two soil samples on an annual basis to test for radionuclides and chemicals on pueblo lands downwind of Area G.

Soil samples taken for the 32nd year of sampling

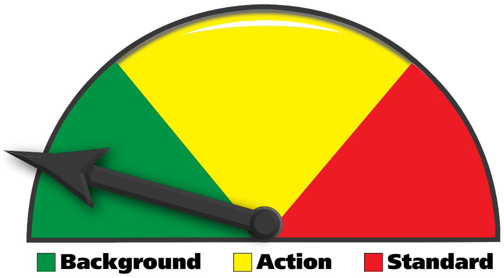
| Agriculture (crops, milk, eggs, and honey) | Rio Grande (fish and invertebrates) | Soil | Biota (plants and animals) |
|---|---|---|---|
|  |  |  |  |



Sampling is conducted triennially, except for biota (plants and animals). In 2003, after 30 years of annual sampling, there was little change in results from year to year. By focusing on one category annually, a broader array of items is sampled, and samples are tested for more contaminants.

# Below action limits

All soil samples taken within and around the perimeter of the Laboratory contained concentrations of radionuclides and chemicals below action limits.



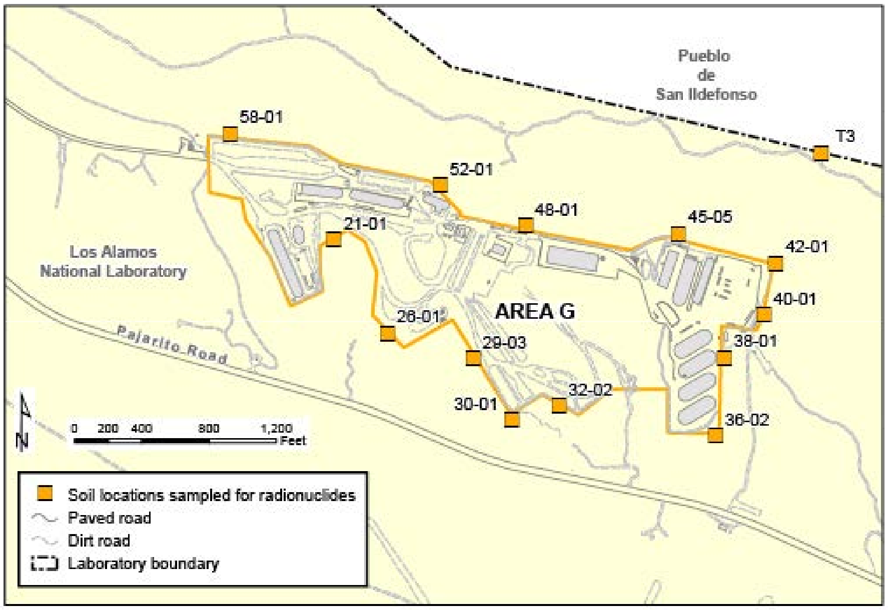

## Soil Data Comparison Levels

The data from soil samples are compared with three reference levels to help identify and prevent any potential impact to human health.

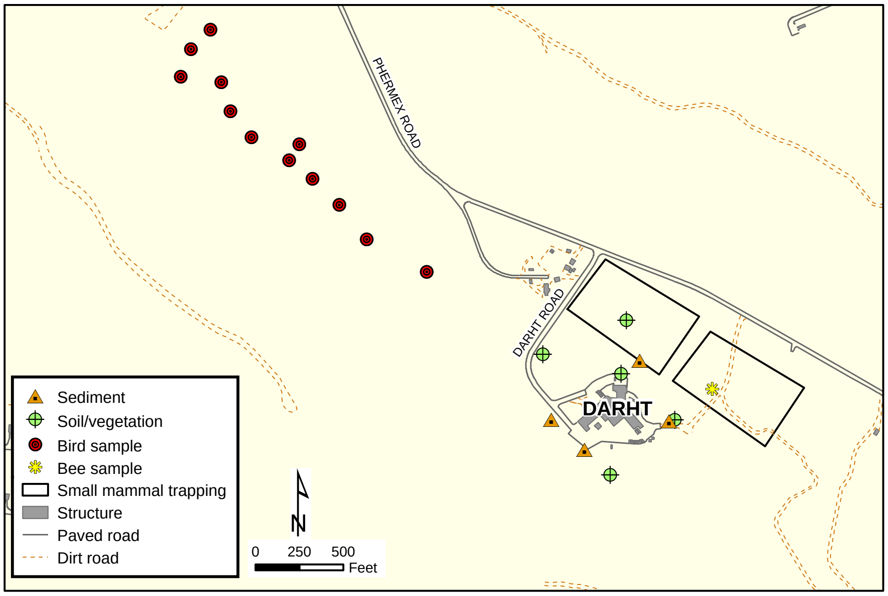
**Background**—Regional background levels of radionuclides and chemical concentrations representative of surface soil are collected at locations away from the influence of the Laboratory.

**Action Limits**—Action limits for radionuclides in soil are set by the Laboratory at a 15-mrem/year single-pathway dose limit and serve as a “yellow flag,” so that potential human health concerns may be identified in advance. For other chemicals, concentrations are compared with New Mexico Environment Department (NMED) screening levels.

**Standards**—When an action limit is exceeded, the potential dose to a person is calculated using the computer program RESRAD, as well as all available soil data for the year. The calculated dose is then compared with the DOE single-pathway dose constraint of 25 mrem/year.



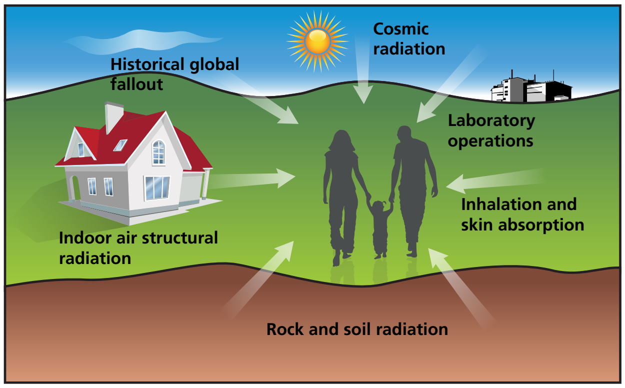

Locations of soil samples collected around Area G in 2013



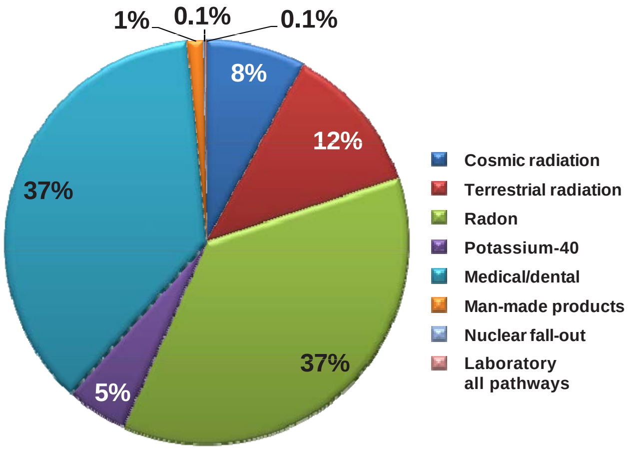

Soil, sediment, and biota sample locations at DARHT in 2013

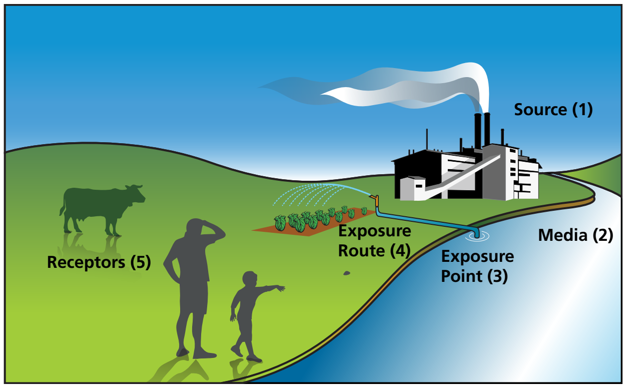
Because of radiological work, annual soil samples are taken at both Area G and DARHT.

Background radiation ~750 mrem/year
Additional from the Laboratory <1 mrem/year




You can calculate the dose you receive in your daily life at http://newnet.lanl.gov/info/dosecalc.asp.




(1) **Source**—The point of origin of the contamination

(2) **Media or Medium**—The means of transportation for contamination

(3) **Exposure Point**—The location of potential contact between a person/animal and contamination

(4) **Exposure Route or Pathway**—The means by which the contamination enters the body

(5) **Receptor**—The exposed individual, plant, or animal

## What is dose?

Dose is a measure of harm or risk. A large dose of any sort has the potential to be harmful. The doses presented in this report are so small that the harm or risk is essentially zero. Radiation dose, measured in mrem, is the amount of energy per gram of living tissue a person receives from a radioactive source. The primary risk of radiation dose is cancer. For low doses of radiation, the risk of cancer is 0.0000008 per mrem received or 8/10,000,000.

For chemicals, dose is a measure of the amount of a chemical per gram of living tissue.

## How do we determine the dose to the public and the environment?

The Laboratory uses DPRNET to make direct measurements of radiation dose near radioactive sources, such as Area G.

For air, water, and food, the dose is not measured directly but instead calculated based on the amount that gets into the body and the given pathway.

## How could materials enter the body?

A "pathway" is a way that a material can get into the body, for example, breathing air, drinking water, or eating food. A pathway may involve several steps.

For the direct exposure pathway, radiation directly penetrates the body.

For the airborne pathway, a material is inhaled directly into the lungs and then moves into the bloodstream.

For the ingestion pathway, there are several different possibilities:

- A contaminant gets into surface water, an animal drinks the water, and a human then eats the animal.
- A contaminant gets into surface water, crops are irrigated with water, and a human then eats the crops.
- A contaminant gets into the aquifer, the aquifer supplies the public drinking water system, and the water is consumed.
- A contaminant gets into the aquifer, the aquifer supplies a natural spring, and the spring water is consumed.

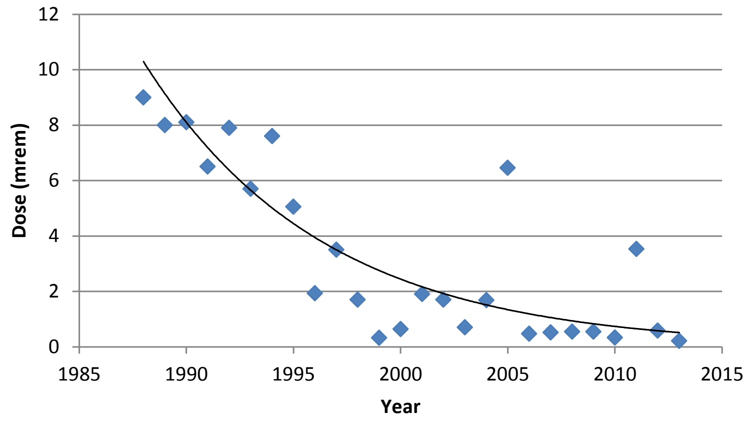
A pathway may be interrupted or incomplete. For example, water from the aquifer is treated before it reaches the public drinking water system, and so contaminants are not ingested by the public.

## What is the MEI?

The Laboratory monitors the potential radiation dose to the public by calculating the dose to the maximally exposed individual (MEI). The MEI is a hypothetical person who receives the greatest radiation dose from Laboratory operations. The dose to the MEI is calculated assuming that the hypothetical person spends 24 hours of every day of the year at the location.

The MEI dose calculation takes into consideration every possible way radiation from Laboratory operations might affect a human. To determine the dose to the MEI, the potential dose to each pathway is calculated. The doses are then added together for a total all-pathways dose.

1. The direct exposure dose is measured and calculated using DPRNET.
2. The airborne pathway dose is calculated using AIRNET data, stack sampling, and computer models.
3. The ingestion pathway dose is calculated using data from food/water samples and computer models.

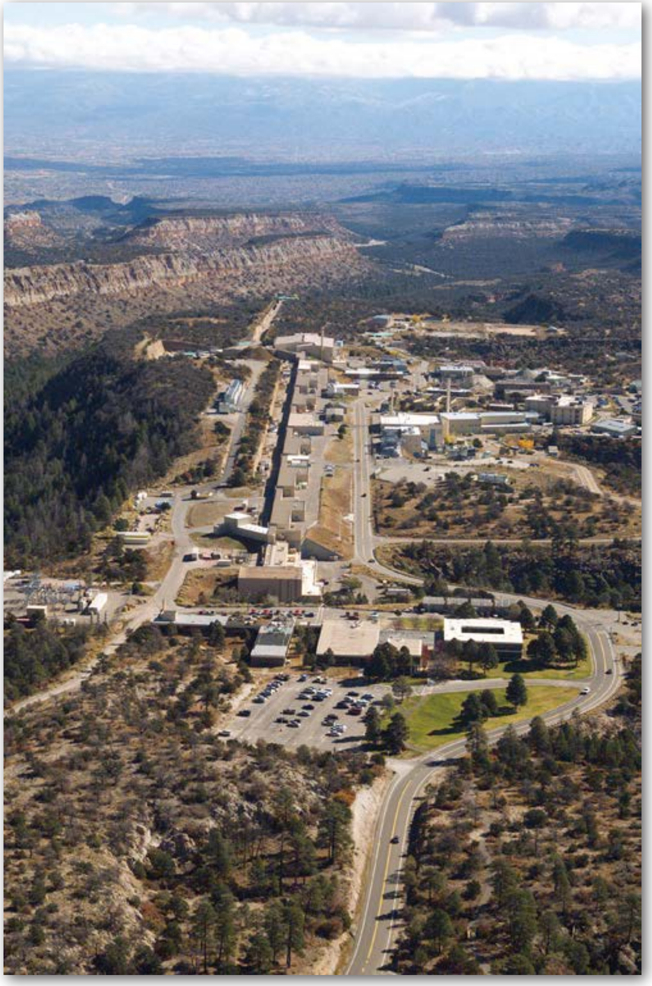



Annual airborne pathway (Rad-NESHAP) dose (mrem) to the MEI over the past 30 years

## Results: Far below dose limit

### MEI located on Laboratory property

The only on-site location with a measurable dose to the public is East Jemez Road near LANSCE. Two doses were reported for the 2013 on-site MEI: a neutron dose of 0.2 mrem and a gamma dose of 0.4 mrem. Members of the public typically spend less than 15 minutes per day at this location, so the on-site MEI dose is much less than 0.1 mrem. The on-site MEI dose is also much less than the off-site MEI dose.



Aerial view of LANSCE

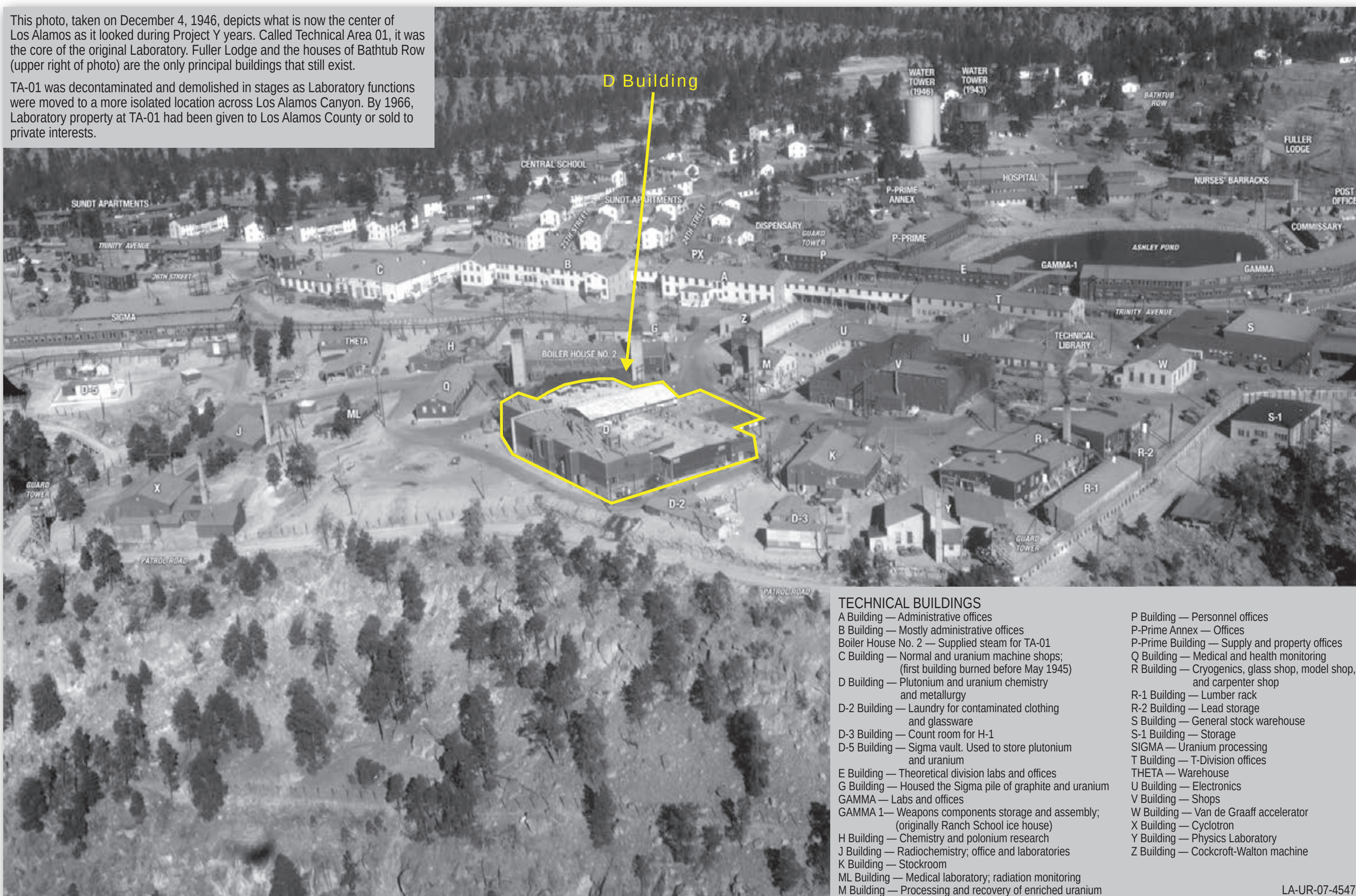
East Jemez Road, the location of the 2013 on-site MEI

## MEI located off Laboratory property

The AIRNET station nearest the location of the 2013 off-site MEI

For 2013, the off-site MEI dose was reported to be 0.21 mrem at the location of Los Alamos Inn on Trinity Drive. The dose is far below the 10-mrem EPA dose limit.

In the early days of Los Alamos (1944–1945), the plutonium facility, known as D Building, was situated just south of Ashley Pond near the location of the 2013 MEI. The buildings were constructed hurriedly and not to standard so as not to delay wartime efforts. Because waste was disposed of through a pipe that led out over the edge of Los Alamos Canyon, legacy plutonium-239 can be found on the surface of the south-facing slope of the canyon. The contamination extends out to approximately 10 yards and is localized, meaning the contamination is located in a specific area and is not moving. When the plutonium on the surface soil is resuspended by the wind, it is detected by a nearby AIRNET station.




Los Alamos, 1946

# Environmental remediation programs

## The corrective action process

To ensure that past operations do not pose a potential risk to human health or the environment, the Laboratory uses the corrective action process to evaluate and remediate sites. The corrective action process identifies and addresses areas of legacy contamination by

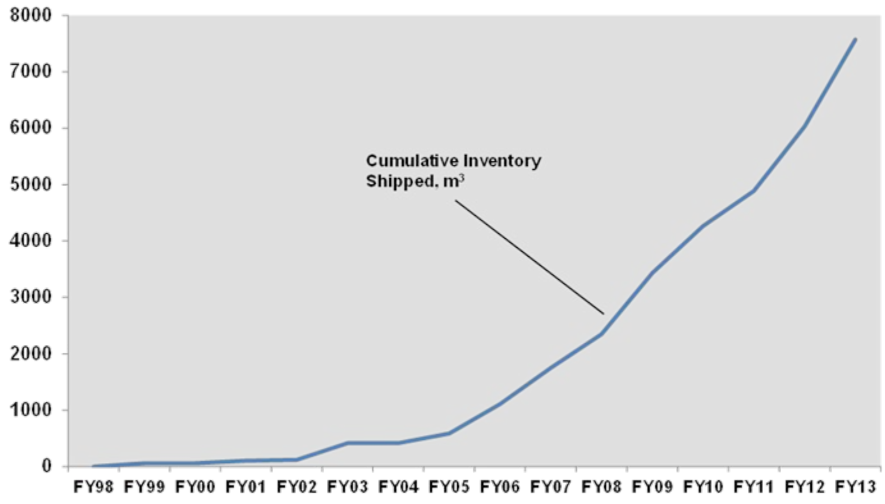
1. removing the contamination,
2. stabilizing the contamination, and/or
3. breaking the pathways between the contamination and the receptor.

A corrective action is complete when the site no longer poses an unacceptable risk to human health or the environment, which is a decision made by NMED. In areas where materials remain, long-term stewardship activities such as surveillance and monitoring are implemented to ensure there are no changes in potential risk or concentrations.

## 1142 cubic meters shipped to WIPP

As part of the Laboratory's long-term stewardship strategy, NMED and the DOE National Nuclear Security Administration created an agreement that calls for the accelerated shipment of transuranic (TRU) wastes from TA-54 to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. To complete the accelerated waste shipments within existing and anticipated budgets, NMED agreed to delay some work that would have normally taken place under the Compliance Order on Consent (Consent Order), such as cleanup and full-scale remediation of some Laboratory sites. As a result, fewer activities than originally scheduled under the Consent Order were performed in 2013.


A truck carrying TRU waste prepares to leave for WIPP.




TRU waste shipping profile

# 2013 progress toward the Grand Challenges

The Long-term Strategy for Environmental Stewardship and Sustainability defines Grand Challenges that address the overarching strategies to clean the past, control the present, and create a sustainable future.

**1. Collaborate with our stakeholders and tribal governments to ensure that the Laboratory's impact on the environment is as low as reasonable achievable**

We facilitated over 500 environmental outreach events and requests in 2013, including 23 technical consultations, 175 meetings and presentations, 56 tours, 174 document requests, and 35 media interactions.

**2. Remove or stabilize pollutants from the Manhattan Project and Cold War eras**

We continued to set records toward completing the goal of sending 3706 square meters of TRU waste to WIPP, completed a pilot project for chromium remediation, and continued to install and maintain control measures on 402 individual site monitoring areas.

**3. Protect water resource quality and reduce water use**

We completed a groundwater permit for the Radioactive Liquid Waste Treatment Facility We proposed a new NPDES Permit for outfalls and began implementing the new Construction General Permit. The Sanitary Effluent Reclamation Facility operation sent over 20 million gallons of water for reuse to the Strategic Computing Complex for its cooling towers

**4. Eliminate industrial emissions, discharges, and releases to the environment**

We achieved over $5 million in cost savings Laboratory-wide by employing pollution prevention techniques. The Laboratory cleaned up four sites, including the removal of over 500 lead bricks and over 1000 unneeded chemicals. We successfully passed a state inspection of Air Quality Permit implementation and submitted a 5-year Air Quality Permit renewal application.

**5. Protect human and environmental health by managing and restoring lands**

We designated protection areas for the newly designated as threatened and endangered Jemez Mountain salamander. The decision support application tool is being used as a key component for environmental management by allowing Laboratory managers to see specific comparisons of various constraints in maps via a geographic information system-based tool.

**6. Produce zero radioactive, hazardous, liquid or solid waste**

We consolidated five institutional waste management systems into one integrated system and obtained a permit for the Transuranic Waste Facility. The waste-handling process improved by eliminating the rework of drums. We avoided, recycled, or reduced 13,698 cubic meters of waste.

**7. Use energy efficiently while creating sustainable energy sources**

In 2013 we focused on retrofitting facilities with energy-saving measures for an overall energy savings of over 30%. We began to evaluate 130 distributed data centers and server rooms for opportunities to consolidate servers. See page 4 for the full list of energy-saving measures.

Collaborating with stakeholders

Protecting our cultural heritage

Laboratory biologist with a Cooper's hawk (*Accipiter cooperii*)


Laboratory technician inspecting a waste container

# A message from the student

Burgandy Brock overlooking the Rio Grande

Over the last few years, I have had the chance to become familiar with the Laboratory's commitment to environmental stewardship and the tools and methods used to fulfill that commitment. I was able to develop a vision for this document and make it come to life—a process that has been extremely rewarding. It is my ultimate goal that the Environmental Report Summary sparks your curiosity and increases your desire to learn. I hope you will want to know more! I am grateful for the opportunity I have been given to really grow and develop through authoring the Environmental Report Summary over the past 4 years, and I am thankful for being given the chance to educate others on subjects that I am so passionate about.

Burgandy Brock

Back cover: Night sky from Los Alamos Canyon during owl survey season. Photo by Phillip Noll, ENV-ES

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**How to learn more and contact us:**

Visit the Laboratory's environmental website and sign up for e-mail notification: www.lanl.gov/environment

Explore the Long-Term Strategy for Environmental Stewardship and Sustainability: www.lanl.gov/projects/envplan

Visit the electronic Public Reading Room: http://eprr.lanl.gov

Visit the print Public Reading Room:

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