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2017 ANNUAL SITE ENVIRONMENTAL REPORT SUMMARY

FEATURING DATA FROM 2016

Los Alamos
NATIONAL LABORATORY

LOS ALAMOS NATIONAL LABORATORY delivers science and technology that promotes world stability while remaining a good steward of the environment. The Laboratory's mission is to solve national security challenges through scientific excellence. Inseparable from the Lab's commitment to excellence in science and technology is its commitment to environmental stewardship and full compliance with environmental regulations.

WHAT ARE THE LABORATORY'S GOALS?

- Deliver national nuclear security and broader global security mission solutions
- Foster excellence in science and engineering disciplines essential for national security missions by:
  - Attracting, inspiring, and developing world-class talent to ensure a vital future workforce
  - Enabling mission delivery through next-generation facilities, infrastructure, and operational excellence

Commitment to ENVIRONMENTAL STEWARDSHIP

Los Alamos 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 Annual Site Environmental Report (ASER) in compliance with U.S. Department of Energy (DOE) Order 231.1b—Environment, Safety, and Health Reporting.

Through the ASER, the Laboratory communicates to the public the impacts its operations might have on the surrounding environment and the approaches used to avoid these impacts. This *ASER Summary* magazine, produced primarily by Laboratory students, provides a nontechnical overview of the ASER and highlights many of the Laboratory's environmental programs. The *ASER Summary* recognizes efforts to:

- Create a sustainable future
- Control present processes to minimize impacts
- Clean up past harms to the environment

This publication summarizes data and findings from 2016 and was published in 2017. Laboratory students and staff hope you find this *ASER Summary* informative and entertaining. Comments are welcome at envoutreach@lanl.gov.

LA-UR-17-29197

Contents

FRONT COVER: A Los Alamos resident tends the community garden on North Mesa. Local produce is sampled by members of the Lab's Soils, Foodstuffs, and Biota Team to ensure that local fare contains low levels of radionuclides and is safe to eat.

BACK COVER: Lesser Goldfinches—as their name implies—have bright, gold chests. Males, such as the one pictured here, have glossy black heads and white stripes running down their wings. These birds typically migrate from Mexico to the Los Alamos area each summer and can be seen feasting on sunflower, millet, and nyjer thistle seed.

The Long-term Strategy for Environmental Stewardship and Sustainability guides decisions for a sustainable future for the Laboratory.

LONG-TERM STRATEGY

BY SHANNON GAUKLER The future of the Laboratory depends on decisions that are made today. That's why the Lab developed the Long-term Strategy for Environmental Stewardship and Sustainability, which establishes goals for protecting human health and the environment. These goals include:

1. Define Laboratory environmental policy and strategies to execute that policy
2. Set goals and objectives for environmental stewardship and establish metrics to accurately monitor and measure environmental performance
3. Integrate stewardship efforts across organizations and programs to assure that the entire lifecycle of work at the Laboratory is designed and executed in a manner that is protective of human health and the environment
4. Provide transparent and relevant communication about the Laboratory's environmental stewardship performance

The Long-term Strategy for Environmental Stewardship and Sustainability also sets forth seven environmental "grand challenges" (see page 3) that address the overarching strategies to clean the past, control the present, and create a sustainable future. ✦

Hello! I'm Honey, and I'm the *bearer* of good news: the Laboratory is committed to maintaining a healthy ecosystem—for me and you and all of our animal and human friends. This issue of the *ASER Summary* highlights the ways the Lab protects our environment. Federal and state laws guide many of these efforts, but don't worry if that sounds complicated, I'll help you find your *bearings*.

FIRST CHALLENGE
COLLABORATE
Collaborate with Laboratory stakeholders and tribal governments to ensure that the Lab's impact on the environment is as low as reasonably achievable

THIRD CHALLENGE
PROTECT
Protect water resource quality and reduce water use


Photo: Mark Schraad

Grand Challenges

FOURTH CHALLENGE
ELIMINATE
Eliminate industrial emissions, discharges, and releases to the environment

SECOND CHALLENGE
REMOVE
Remove or stabilize pollutants from the Manhattan Project and Cold War eras

SIXTH CHALLENGE
PRODUCE ZERO
Produce zero radioactive, hazardous, liquid, or solid wastes


Photo: Mark Schraad

SEVENTH CHALLENGE
SUSTAINABILITY
Use energy efficiently while creating sustainable energy resources

FIFTH CHALLENGE
PROTECT
Protect human and environmental health by managing and restoring lands

COMPLIANCE

The Hazardous Waste Facility Permit changes while adhering to the Resource Conservation and Recovery Act.

Treatment of hazardous waste evolves with mission needs

BY ABBY SCHMALZ In 1976, the U.S. Congress passed the Resource Conservation and Recovery Act (RCRA), which established regulations for the management and disposal of hazardous waste. The RCRA defines hazardous waste as any solid waste that is:

- listed as hazardous by the Environmental Protection Agency (EPA)
- ignitable, corrosive, reactive, or toxic
- batteries, pesticides, lamp bulbs, or contains mercury
- any of the above that has been mixed with a radiological waste

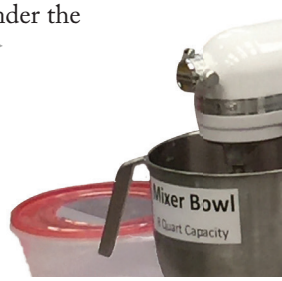
"The Lab strives to have as small of an impact on the environment as it possibly can while staying in compliance and working for mission success." —JOHN TYMKOWYCH

The Laboratory, of course, deals with all of these substances in some capacity, and so in 1989, the New Mexico Environment Department (NMED) (via the EPA), issued a Hazardous Waste Facility Permit that allowed the Lab to store and treat hazardous waste. "The permit is a contract between LANL and the state of New Mexico that both parties agree to but that the state has authority to grant," explains John Tymkowych of Environmental Compliance Programs. "With agreement and oversight, the Lab strives to have as small of an impact on the environment as it possibly can while staying in compliance and working for mission success."

The permit, which has to be renewed every 10 years, has been modified over the years to meet the Lab's evolving mission needs. In 2016, the Laboratory submitted 11 nontechnical permit modification packages. At that time, the permit covered 21 hazardous waste storage units, one hazardous waste storage and treatment unit, one liquid hazardous waste tank system, and one hazardous waste stabilization unit.

The Lab publishes several documents each year that keep the public informed about its environmental stewardship efforts. In August 2016, the Community Relations Plan detailed permit compliance. In November 2016, the Waste Minimization and the Annual Compliance reports discussed the Laboratory's mission to reduce or minimize waste generation and how waste has been managed under the Hazardous Waste Facility Permit. ✦

Black bears have five toes and five short, curved claws that are helpful for climbing, digging, and cutting—but we don't want to do any of that near hazardous waste! Thank goodness for the RCRA.



New treatment plan implemented at Technical Area 50.

Developing best practices for nitrate salt-bearing waste

BY ABBY SCHMALZ In February 2014, a major accident at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, involving a drum from the Laboratory released radiological waste. The drum rupture was caused by nitrate salts mixing with an organic kitty litter absorbent, causing a chemical reaction that pressurized the drum and caused the lid to fail.

The accident was severe enough to shut down the plant and halt transuranic waste shipments from the Laboratory through 2016.

A solution for properly dealing with nitrate salt-bearing waste was needed, and on May 29, 2014, the LANL Nitrate Salt-bearing Waste Container Isolation Plan was created. The Isolation Plan requires all nitrate salt-bearing waste at the Lab to be isolated, secured, and treated. Recent revisions to the Isolation Plan allow for pressure-relieving devices to be installed on containers. The updates also include new requirements and controls for transporting remediated nitrate salt-bearing wastes and for treatment of the wastes.

To stabilize nitrate salt-bearing waste for safe off-site disposal, the Laboratory assembled a team of subject matter experts that included scientific, operational, safety, and regulatory specialists. Treatments including zeolite addition, zeolite addition with cementation, and wet and dry options were evaluated by the team. After evaluating all of the options, the addition of zeolite, a natural mineral, was found to be the most effective in deactivating the dangerous ignitability and corrosivity characteristics in the nitrate salt-bearing waste.

To stabilize nitrate salt-bearing waste for safe off-site disposal, the Laboratory assembled a team of subject matter experts that included scientific, operational, safety, and regulatory specialists.

On July 25, 2016, the NMED approved a permit modification request that allowed the treatment of nitrate salt-bearing waste by stabilization in containers at the Waste Characterization, Reduction, and Repackaging Facility (WCRRF) at Technical Area 50.

After the approval of the facility, a mock glovebox was set up at Technical Area 50 to further develop and practice the process of stabilizing nitrate salt-bearing wastes.

"WCRRF contains a capability for the processing and safing of this waste," explains Dave Funk, deputy associate director for environmental management. "This unique facility has a glove box with enough space to set up a processing line to handle and treat the remediated nitrate salt waste, and it can potentially be used in the future for treating other nitrate bearing wastes, if needed." ✦

An operator uses a standard kitchen mixer to blend batches of zeolite and non-radioactive surrogate mixtures of organic/salt material to evaluate treatment methods for the stabilization of nitrate salt wastes.

FIGURE 1: The SWheat and rock salt are blended to create a surrogate mixture of organic/salt material.

FIGURE 2: The separate components of the surrogate tests include Zeolite, SWheat, and rock salt.

FIGURE 3: Zeolite is added at different ratios to the organic/salt mixture and evaluated for treatment effectiveness.

Figure 3

Figure 1

Figure 2

Road- and water-related projects will be implemented by 2019.

Five new environmental protection projects

BY JUSTINE DOMBROWSKI In 2016, a settlement agreement was established between the DOE and the NMED regarding improperly treated transuranic waste shipped from the Laboratory to WIPP in Carlsbad, New Mexico.

The agreement includes five projects that address roads, watersheds, surface water, and potable water. According to New Mexico Governor Susana Martinez, "the funds New Mexico will receive through this agreement will help ensure the future safety and success of these facilities, the people who work at them, and their local communities."

"The funds New Mexico will receive through this agreement will help ensure the future safety and success of these facilities, the people who work at them, and their local communities." —SUSANA MARTINEZ

A wetlands stabilization structure was built in Pueblo Canyon in response to a September 2013 flooding event.

Projects that will be implemented by 2019:

- The Watershed Enhancement Project will implement green infrastructure and low-impact development strategies in Mortandad, Sandia, Cañon de Valle, and Ancho canyon watersheds. According to subject matter expert Karla Sartor, "these practices address storm water issues at the source, usually using native plants and locally sourced or natural materials to capture, filter, and slow down water. By modeling these areas after naturally occurring structures, simple alterations to the landscape can significantly decrease erosion, landscape contamination, and sediment transport."
- The Roads Project will improve routes used for the transportation of transuranic waste to WIPP.
- The Triennial Review Project will conduct an independent, external review every three years of environmental regulatory compliance and operations.
- The Surface Water Sampling Project will conduct increased sampling and monitoring of storm water runoff in and around the Laboratory.
- The Potable Water Line Replacement Project will replace aging potable water lines and install metering equipment for Laboratory potable water systems. These improvements will reduce potable water losses, minimize spills, and enhance water conservation. ✦

The Compliance Order on Consent details requirements for safely disposing of dangerous substances.

Cleaning up hazardous waste

BY KAREN MUSGRAVE If the Laboratory doesn't clean up after itself, there are consequences. That's the gist of the Compliance Order on Consent, which was issued in 2005 by the NMED and updated in 2016.

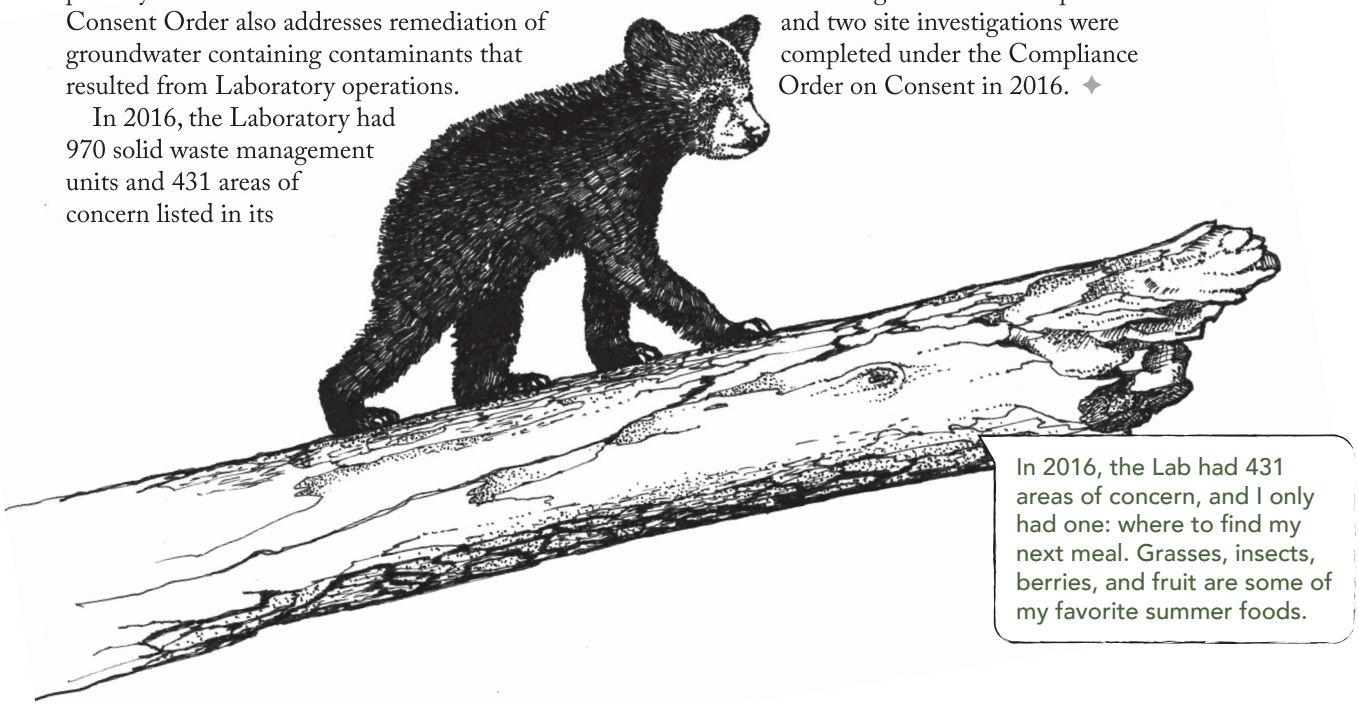
"The 2016 Consent Order is recognized by the Laboratory and NMED as providing a solid and efficient framework for implementation of the important investigation and cleanup work necessary to protect human health and the environment," says Danny Katzman of the Environmental Remediation Program.

In the interest of human and environmental health, the order provides requirements for corrective actions.

In other words, in the interest of human and environmental health, the order provides requirements for corrective actions at the Laboratory's solid waste management units and areas of concern. A solid waste management unit is any site at Los Alamos where solid wastes have been placed. Areas of concern are areas that possibly had a release of hazardous waste. The Consent Order also addresses remediation of groundwater containing contaminants that resulted from Laboratory operations.

In 2016, the Laboratory had 970 solid waste management units and 431 areas of concern listed in its Hazardous Waste Facility Permit. Of these, 155 required no further action by the Laboratory, and 275 had certificates of completion. The remaining solid waste management units and areas of concern had investigations or corrective actions in progress, pending, or deferred until the sites are no longer active. Five reports and two site investigations were completed under the Compliance Order on Consent in 2016. ✦

A former outfall in Los Alamos Canyon is excavated.



In 2016, the Lab had 431 areas of concern, and I only had one: where to find my next meal. Grasses, insects, berries, and fruit are some of my favorite summer foods.

National Environmental Policy Act protects and preserves resources.

Environmental impact considered as Lab expands

BY KAREN MUSGRAVE Whether the Laboratory is constructing a waste treatment facility or simply repairing a drain, each new project must be reviewed for its environmental consequences. Since 1970, the National Environmental Policy Act (NEPA) has ensured that environmental impacts on biological, socioeconomic, and cultural resources are considered as activities and projects are planned at the Laboratory.

"The NEPA process helps make decisions that are based on scientific understanding of environmental consequences and helps to assist projects that take actions to protect, restore, and enhance the environment," says Jennifer Payne, group leader in the Environmental Protection and Compliance Division.

NEPA staff at the Laboratory review proposed projects to analyze potential environmental impacts and to determine if the activities have existing coverage under current NEPA documents issued by the DOE. If the proposed activities pose no impact to the environment and have been previously evaluated by existing NEPA documents, NEPA staff will approve the proposed activities.

The NEPA process helps make decisions that are based on scientific understanding of environmental consequences.

In 2016, Laboratory staff reviewed approximately 1,190 proposed projects for NEPA coverage. If projects are not covered under an existing NEPA document, further analysis and documentation—such as an environmental assessment—are required to obtain NEPA coverage.

A supplement analysis evaluates whether the existing NEPA document is sufficient, or if additional evaluation and documentation is required. Two supplement analyses were prepared in 2016, and no additional NEPA documentation was required. ✦

CLOCKWISE FROM TOP LEFT: In 2016, a categorical exclusion was written for the proposed use of unmanned aerial systems (such as drones and remote control aircrafts) for security, research, and emergency management within Laboratory restricted airspace. A categorical exclusion means the proposed actions do not require further environmental analysis because they do not pose a significant effect on the human environment.

To protect and preserve the environment we live and work in, the Laboratory considers environmental impacts when making decisions.

In 2016, the DOE determined proposed modifications to the Metropolis Center supercomputers would not adversely affect the environment and would in fact support the next generation of supercomputers at the Laboratory.

The Environmental Management System sets guidelines.

A healthier environment

BY MICHAEL MOSS The Lab's Environmental Management System provides a framework to protect the environment and allows Lab employees to take actions to improve the Lab's environmental performance.

The international standard (ISO 14001 Environmental Management Systems) to which the Laboratory is held is well known throughout the world as the foremost system to mitigate or reduce impacts on the environment and to improve environmental performance overall.

"Maintaining a commitment to the environment is essential to the success of the Laboratory." —MICHAEL BRANDT

Twice a year, the Laboratory is rigorously audited by an external certification body to ensure that it is meeting the requirements of this system. The Laboratory's ISO Registrar, National Science Foundation International, completed its audits for 2016.

System requirements include developing and implementing objectives and targets to improve current conditions and implementing corrective actions where environmental improvement is necessary.

In 2016, one of the many objectives and targets was to convert chemical film processing to digital radiographic processing, which eliminates this chemical waste stream. Objectives and targets such as this one are monitored regularly to ensure completion by established deadlines.

"Maintaining a commitment to the environment is essential to the success of the Laboratory," says Environment, Safety, and Health Associate Director Michael Brandt. "We are proud of our robust environmental system and will use the results of the audit to further our role as stewards of Northern New Mexico's environment." ✦

I'm *beary* happy that the Lab reads and follows compliance regulations to ensure that my home is safe. Adhering to federal and state laws ensures that the Lab is properly disposing of waste and protecting our biological and cultural resources, air, soil, and water. With this in mind, I can forage freely, drink liberally, and go into hibernation not worried about how my world will look come springtime.

2016 COMPLIANCE AT A GLANCE

To protect human health and the environment, federal and state laws, regulations, and orders are in place to regulate the handling, transportation, and disposal of materials and wastes, regulate impacts to biological and cultural resources, air, soils, and water, and require environmental impact analyses of new or changed operations.

HAZARDOUS, SOLID, AND MIXED WASTES

RESOURCE CONSERVATION AND RECOVERY ACT
Regulates hazardous wastes from generation to disposal; mandates a hazardous waste facility permit

2016 COMPLIANCE ORDER ON CONSENT
Process for remediation of solid waste management units

FEDERAL FACILITIES COMPLIANCE ACT
Regulates mixed wastes (radioactive and hazardous)

RADIATION PROTECTION AND RADIOLOGICAL WASTES

DOE ORDER 458.1
Radiation Protection of the Public and the Environment
Establishes limits for radiological releases from DOE facilities

DOE ORDER 435.1 CHG 1
Radioactive Waste Management
Regulates storage and disposal of radioactive wastes

CLEAN AIR ACT
Radionuclide National Emission Standard for Hazardous Air Pollutants
Sets dose limit for air emissions

AIR QUALITY AND PROTECTION

CLEAN AIR ACT
Title V Operating Permit
Sets limits for emissions of regulated air pollutants

CLEAN AIR ACT
Title VI
Regulates ozone-depleting substances

NEW MEXICO AIR QUALITY CONTROL ACT
Requires evaluation of new or modified sources of air emissions

2016 Highlights

- Efforts to characterize and develop treatment paths for nitrate salt-bearing wastes progressed in 2016.
- Tests determined zeolite blending to be the most effective method for removing the hazardous characteristics of ignitability and corrosivity from the nitrate salt-bearing waste (see page 5).
- A Class 1 permit modification to allow treatment of nitrate salt-bearing waste by stabilization was approved in July 2016.
- Corrective remediation actions were complete or no further action was needed at 430 sites—about 31 percent of the total solid waste management units and areas of concern listed in the Hazardous Waste Facility Permit (see page 7).

- The maximum estimated radiological dose to a member of the public from Laboratory operations was 0.12 millirem, about 1.2 percent of the limit (see page 29).
- More than 2,600 metric tons of low-level radioactive waste were processed and shipped off-site. No low-level radioactive waste was disposed of at Area G.
- No transuranic waste was shipped for disposal because of a hold on all shipping at WIPP.

- The highest levels of air pollutant emissions at the Laboratory were significantly below Title V Permit limits.
- Greenhouse gas emissions totaled approximately 43,838 metric tons of carbon dioxide equivalents.
- The Laboratory removed approximately 560 kilograms of Class II ozone-depleting substances from refrigeration and re-suppression systems.

SURFACE WATER QUALITY AND PROTECTION

CLEAN WATER ACT
Requires National Pollutant Discharge Elimination System permits for several types of effluent and storm water discharges; the Act also has requirements for aboveground storage tanks

NEW MEXICO WATER QUALITY ACT
Establishes water quality goals for state surface waters by designating uses and setting standards

GROUNDWATER QUALTITY AND PROTECTION

NEW MEXICO WATER QUALITY ACT
Establishes maximum allowable concentrations of specified contaminants

NEW MEXICO GROUNDWATER DISCHARGE REGULATIONS
Regulates liquid discharges onto or below the ground surface

2016 COMPLIANCE ORDER ON CONSENT
Process for remediation of groundwater contaminant plumes

OTHER ENVIRONMENTAL STATUTES AND ORDERS

NATIONAL ENVIRONMENTAL POLICY ACT
Requires federal agencies to consider environmental impacts of proposed actions

MIGRATORY BIRD TREATY ACT
Makes it unlawful to harm any migratory bird, except as permitted by regulation

FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT
Protects workers using these substances

DOE ORDER 231.2
Occurrence Reporting and Processing of Operations Information
Requires reporting of off-normal events or conditions

NATIONAL HISTORIC PRESERVATION ACT
Requires federal agencies to consider effects of actions on historic properties

FLOODPLAIN AND WETLAND EXECUTIVE ORDERS
Requires federal agencies to assess project impacts in floodplains and to wetlands

ENDANGERED SPECIES ACT
Requires federal agencies to protect federally listed species and their habitats

TOXIC SUBSTANCE CONTROL ACT
Addresses the production, use, and disposal of specific chemicals, including PCBs

EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT
Requires emergency plans for hazardous substances

- Fewer than one percent of samples at permitted outfalls exceeded limits in the Laboratory's National Pollutant Discharge Elimination System Industrial Outfall Permit.
- In 2016, 99.5 percent of projects inspected for storm water compliance were found to be in compliance with applicable regulations.
- Installation of 112 enhanced storm water control measures was completed at 34 site monitoring areas for solid waste management units and areas of concern.

- Four discharge permits allow for discharging clean water onto or below ground surfaces; one permit application is pending.
- The Laboratory continued investigating the chromium and RDX (royal demolition explosive) groundwater plumes, and sampling groundwater site-wide for general monitoring of groundwater quality.
- In August 2016, the NMED issued a discharge permit for groundwater from Mortandad Canyon. The permit allowed the Laboratory to withdraw, purify with ion exchange resins, and inject the groundwater back into the ground (see page 23).

- Approximately 1,190 Laboratory projects were reviewed for National Environmental Policy Act compliance (see page 8).
- Two Mexican spotted owl nests were found on Laboratory property in 2016, with a total of two fledged young.
- Biologists banded migratory birds in two Laboratory wetland areas as part of nationwide monitoring protocols (see page 25).
- The Laboratory shipped 2,005 kilograms of PCB wastes off-site for disposal or recycling at a U.S. EPA–authorized treatment and disposal facility in Veolia, Colorado.

Note: A light gray box indicates a federal regulator; a beige background indicates a state of New Mexico regulator.

ENVIRONMENT

Sustainability enhances performance and protects the future.

Sustainable practices support Laboratory growth

BY KEVIN PARKINSON AND MACKENZIE MATHEWS The mission of the Site Sustainability Team is to ensure that the Laboratory can advance sustainably into the future by mindfully and efficiently using resources such as new technology and interdisciplinary communication.

"Diversifying the energy portfolio is key to supporting the Lab's mission in a sustainable way." —MONICA WITT

The five-person team manages, implements, and tracks goals set by presidential executive orders and DOE policies. Such objectives include improving operations to maximize sustainable resource use, developing energy efficiency and renewable energy projects, improving existing facility performance, and planning for climate resiliency (the ability to adapt and respond to the region's changing climate, including fires and droughts), and net-zero consumption and net-zero waste in facilities.

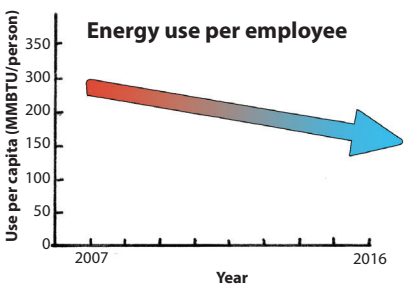
"Diversifying the energy portfolio is key to supporting the Lab's mission in a sustainable way," says Monica Witt, the Laboratory's Site Sustainability Manager. "Diversification positions the Laboratory to enhance its current capabilities, readiness, and performance and support operations to better prepare our nation for the future."

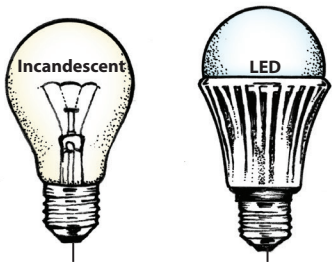
In 2016, sustainable, Lab-wide improvements included upgrading a number of building heating, ventilation, and air conditioning systems; monitoring energy consumption in real time via a cloud network; and installing efficient LED lights. In addition, 23 million gallons of reclaimed wastewater were reused in computer cooling towers. Despite the continuous growth of the Laboratory, energy and water use per employee is trending down, with plans to maintain steady reduction in coming years.

However, as the Laboratory continues to grow, its demand for energy and water cannot be met without major infrastructure and utility investments. Sustainability workers are rising to meet this challenge through several major projects, such as replacing a central heating and power generating plant with a more efficient facility and installing a 10-megawatt solar panel array that will support increasing power needs. ✦

LEFT: Although the Laboratory continues to expand, the Lab has consistently reduced the amount of energy it uses per employee. In 2016, the Lab used 171 British thermal units per employee.

RIGHT: Simple swaps such as light bulb upgrades can reduce a building's energy use by a significant amount. LED lighting is much more efficient than other bulb types because LED bulbs last longer and waste little energy as heat.





	Incandescent	LED
Life span	1,000 hours	50,000
Watts	40W	6W
Operating cost	$219.06 per year	$22.76 per year

Site Cleanup and Workplace Stewardship Program funds projects.

Getting clean, one job at a time

BY ALISON LIVESAY To be better stewards of the land and pass along fewer environmental problems to future generations, the Site Cleanup and Workplace Stewardship Program funded more than 25 projects across the Lab in 2016.

The program staff added an initiative to the Enduring Mission Waste Management Plan to improve management of storage structures such as sheds and transportainers. By confirming the owning organization of approximately 1,400 structures, attaching barcodes that correlate to an assigned custodian, and updating maps and signage to include points of contact, the program hopes to avoid confusion and safety concerns for unknown container contents.

In 2016, the program cleared about 500,000 pounds of potentially activated metal.

In 2016, the program also cleared about 500,000 pounds of potentially activated metal and released it for recycling. Around one million tons of metal and safety shielding was moved to controlled staging areas, and several large metal objects (40–60 tons each) were dismantled into manageable pieces for eventual release for recycling.

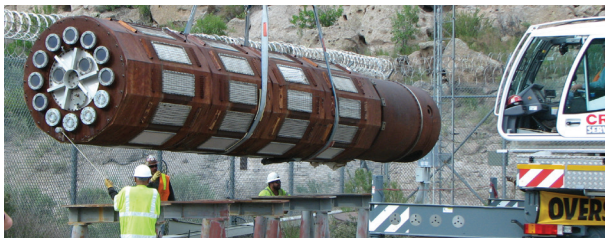
Lab staff cleaned out transportainers, semitrailers, utility trailers, and buildings that contained legacy equipment, and removed some structures. These clean-outs allow for more current programmatic equipment to be installed in support of new and growing programs at the Lab.

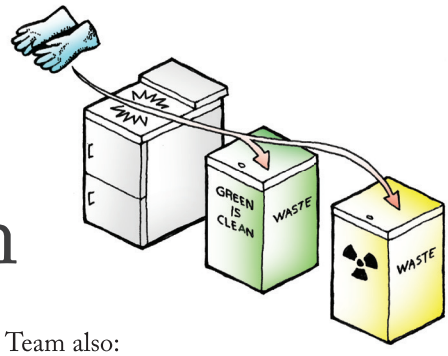
Not only is the program working to lessen the environmental impact of Lab operations, but it is also working to preserve historical and archaeological resources. For example, program staff moved the historic Antares Laser from a weed lot to a safer controlled staging area, thereby preserving a piece of Laboratory history from the Cold War era.

"Part of the 72-beam Antares Laser was moved down to Technical Area 18 to preserve this unique historical artifact of technology," explains historic buildings expert Jeremy Brunette. "At the time of its completion in 1983, the Antares Laser was the largest carbon-dioxide laser in the world." ✦

Commissioned in 1975 at a cost of about $62 million, the Antares Laser was used for experiments in controlled fusion reactions, which many scientists believed were a key to future production of clean, abundant, and inexpensive energy.

In 2016, part of Antares, which is no longer in use, was relocated to Technical Area 18 using a flatbed truck.





Reducing waste has environmental, economic, and societal benefits.

Pollution prevention

BY SYDNEY SHELTON For more than 20 years, the Lab's Pollution Prevention (P2) Team has supported projects that invest in the elimination of the production of waste—also called source reduction.

"Pollution prevention tools include wastewater treatment, recycling, and using less toxic materials," explains Terence Foecke, P2 program lead. "Source reduction is the pollution prevention tool that tries to completely eliminate the creation of a waste through changes in design, materials selection, and operations. Processes that are 'right' from the start are inherently safer and more efficient."

"Source reduction is the pollution prevention tool that tries to completely eliminate the creation of a waste." —TERENCE FOECKE

The Pollution Prevention Team focuses on preventing waste and promoting sustainability. The team works to divert items from the landfill by recycling products.

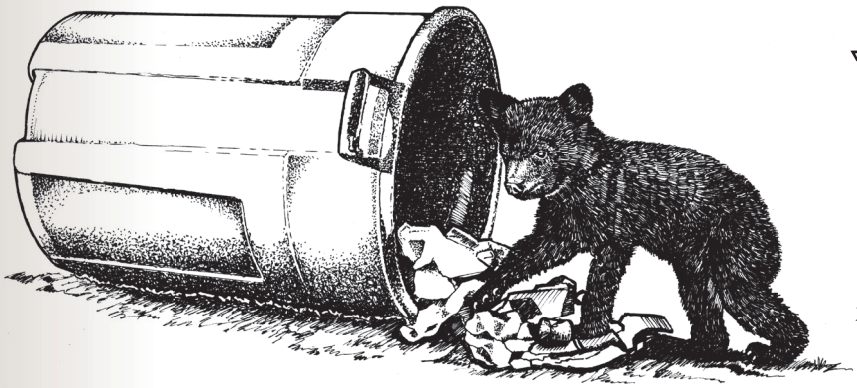
In fiscal year 2016, the P2 Team provided funding to 17 projects totaling $317,000. In addition to having an environmental benefit, funded projects typically also have economic and societal benefits that will last long after funding ends. For example, Green is Clean is a P2-funded project in which researchers test their waste to see if it is radioactive. This process assures that the waste gets disposed of properly, often in a less hazardous category. Green is Clean not only provides the environmental benefit associated with producing less radioactive waste but also eliminates the extra costs associated with disposing of radioactive waste.

Similarly, P2-funded research in green chemistry encouraged scientists to stop using hazardous chemicals such as nitric acid and instead use alternative, less dangerous chemicals in their research. This change was not only beneficial to the environment but also to Lab employees who are no longer exposed to such dangerous substances.

In 2016 the P2 Team also:

- Saved more than 32,000 liters of liquid nitrogen by replacing gas cylinders
- Recycled more than 1,000 tons of concrete and asphalt from construction sites
- Compiled the Hazardous Waste Minimization Report, investigating where the Lab is producing hazardous waste and how it could be reduced
- Hosted the P2 Awards to recognize Lab employees for their sustainability achievements. Forty-one projects and almost 300 employees were honored for their sustainability achievements. The projects saved an estimated $3.2 million
- Encouraged sustainable procurement, the purchasing of environmentally friendly products, and zero-waste events
- Continued to educate Lab employees and surrounding community about recycling
- Researched site-wide placement for LED lighting
- Identified all uses of sulfur hexafluoride, a potent greenhouse gas, at the Laboratory and identified ways to decrease usage
- Conducted financial analyses of P2 funded projects
- Installed an on-site composter, which is currently processing bio-solid waste and will eventually also process food scraps and paper towels

The P2 Team looks forward to continue assisting the Lab achieve its mission in a more sustainable way. ✦



Although I love snacking from a trash can, I think all people should practice pollution prevention. Help me stay out of trouble by disposing of waste properly.

Prehistoric and historic sites receive federal protection.

Preserving the past for future generations

BY VICTORIA LOVATO Those mounds of volcanic tuff blocks scattered around Laboratory property are more than just piles of rock—they are what's left of the Ancestral Puebloan people who lived on the Pajarito Plateau during the 13th–15th centuries. Ranging from one-room structures to multiroom villages, these structures amount to approximately 73 percent of the known historic sites on Lab property.

The remaining 27 percent are comprised of structures from the Homestead period (1887–1942) and Laboratory buildings from the Manhattan Project and Cold War (1943–1991).

"Preserving the places of this history at Los Alamos allows for a more immediate personal connection to significant Manhattan Project and Cold War events." —ELLEN McGEHEE

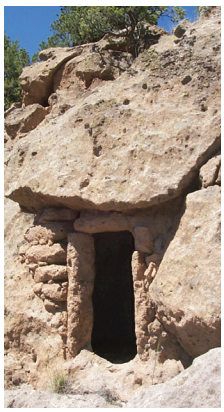
Both prehistoric and historic sites on Laboratory property are managed under the National Historic Preservation Act, which empowers federal agencies to act as responsible stewards of the nation's cultural resources.

Some Laboratory properties received additional protection on December 19, 2014, when President Barak Obama signed legislation that created the Manhattan Project National Historical Park. The park is comprised of sites in Los Alamos, New Mexico; Oak Ridge, Tennessee; and Hanford, Washington. The proposed portion of the park in New Mexico contains buildings in downtown Los Alamos as well as 17 sites at the Laboratory, which are not currently accessible to the public. These sites include buildings used in development of the Gadget tested at Trinity Site; Little Boy, which was detonated over Hiroshima; and Fat Man, which was detonated above Nagasaki.

"Preserving the complex narrative of our country's history is important," says Laboratory historian Ellen McGehee. "Preserving the places of this history at Los Alamos allows for a more immediate personal connection to significant Manhattan Project and Cold War events, giving individual meaning to a scientific, cultural, and geopolitical legacy that continues to resonate today."

In addition to making sure Laboratory sites are officially protected, the Lab's Cultural Resources Team is also dedicated to documenting, assessing, and photographing historic sites, such as Nake'muu Pueblo, which dates back to the Ancestral Puebloan period (A.D. 600–1600). Area pueblos—including Santa Clara Pueblo, Pueblo de San Ildefonso, Pueblo de Cochiti, and Jemez Pueblo—are incorporated into this process and other cultural resource projects via regular meetings.

In 2016, five members of the Cultural Resources Team received Wildland Fire Red Card Training, which allows them to work with firefighters to protect archaeological sites and historic buildings during a fire event. ✦



LEFT AND CENTER: Nake'muu Pueblo is located on a narrow mesa; its name means "village on the edge" in the Tewa language.

RIGHT: Lab historian Ellen McGehee stands in front of Pond Cabin. Part of Manhattan Project National Historical Park, Pond Cabin is the only surviving log structure at the Laboratory dating to the Homestead period.

5 ENDANGERED SPECIES

in Northern New Mexico

NEW MEXICO MEADOW JUMPING MOUSE

The New Mexico Meadow Jumping Mouse is endemic to New Mexico, Arizona, and a small portion of southern Colorado.

JEMEZ MOUNTAINS SALAMANDER

The Jemez Mountains Salamander is one of two endemic, lungless salamanders in New Mexico. It is strictly terrestrial and as such resides in moist canyons with a mixed conifer habitat.

YELLOW-BILLED CUCKOO

The Yellow-billed Cuckoo is a long distance neo-tropical migrant. It is an obligate riparian breeding species and prefers large tracts of uneven aged trees for breeding and foraging.

MEXICAN SPOTTED OWL

The Mexican Spotted Owl generally inhabits mixed conifer and ponderosa pine forests in mountains and canyons. A mated pair of adult spotted owls may use the same general nesting areas throughout their lives.

Photo: Mark Schraad

SOUTHWESTERN WILLOW FLYCATCHER

The southwestern subspecies of the Willow Flycatcher breeds only in dense riparian habitats in the southwestern United States. In New Mexico, the species is found primarily along the Gila River and Rio Grande drainages.

Biologists document and protect five species annually.

Safeguarding threatened and endangered animals

BY AARON SKINNER Five threatened or endangered species may be found on Laboratory property for at least part of their lifecycles: the Mexican Spotted Owl, Southwestern Willow Flycatcher, Jemez Mountains Salamander, New Mexico Meadow Jumping Mouse, and the Yellow-billed Cuckoo. All but the jumping mouse have recovery plans created by the U.S. Fish and Wildlife Service, which means that Laboratory biologists conduct presence or absence surveys for the other four species.

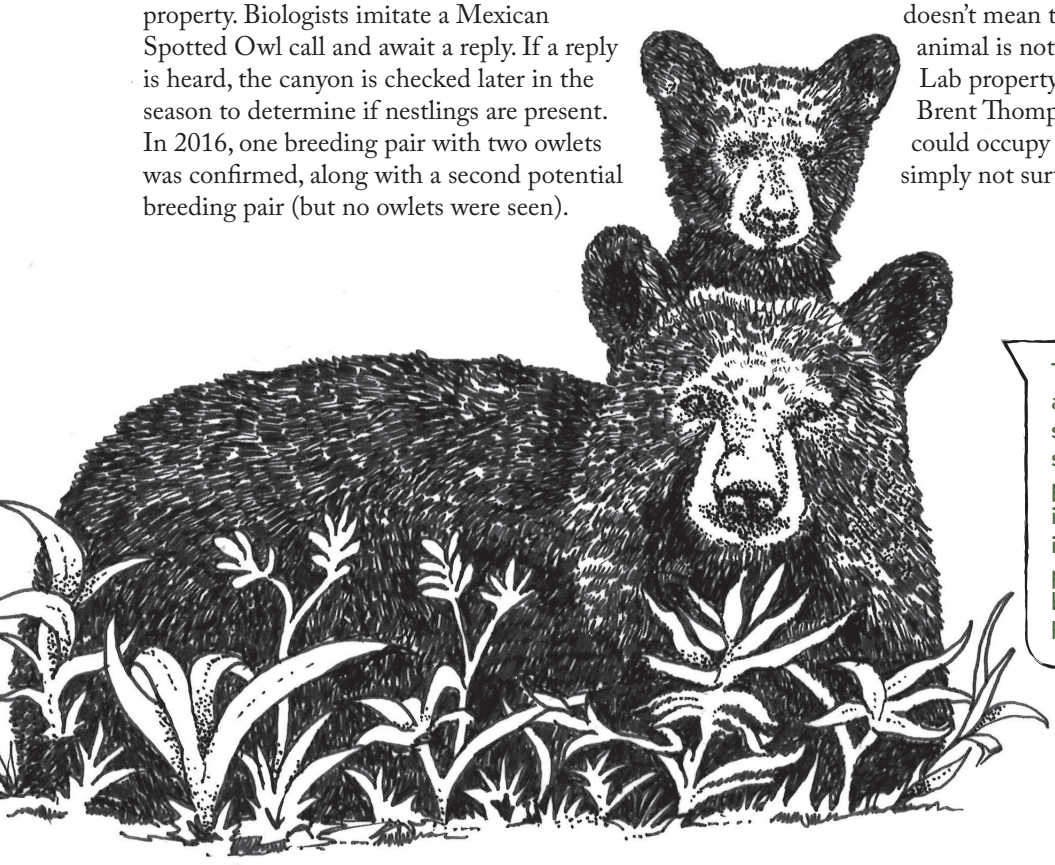
Small portions of logs are torn up, and rocks are flipped in search of the reclusive salamander.

Each spring, Mexican Spotted Owl surveys are completed in six canyons across Laboratory property. Biologists imitate a Mexican Spotted Owl call and await a reply. If a reply is heard, the canyon is checked later in the season to determine if nestlings are present. In 2016, one breeding pair with two owlets was confirmed, along with a second potential breeding pair (but no owlets were seen).

Biologists perform Jemez Mountains Salamander surveys from mid-summer to early fall with hopes that summer monsoons will have created wet enough conditions for the salamanders to be above ground. Small portions of logs are torn up, and rocks are flipped in search of the reclusive salamander. No salamanders were found on Lab property in 2016.

During the late spring and summer months, Southwestern Willow Flycatchers and Yellow-billed Cuckoos stake out breeding territories in wetland-riparian habitats, and surveys are conducted for their presence. Lab biologists play the unique call of the bird of interest and listen for a response. No Southwestern Willow Flycatchers or Yellow-billed Cuckoos were recorded at the Laboratory in 2016.

"An absence of these species on our surveys doesn't mean that the given animal is not present on Lab property," says biologist Brent Thompson. "They could occupy habitat that was simply not surveyed." ✦



The American black bear is not a threatened or endangered species, but all Asian bear species—like my cousin the panda—are endangered, and international trade of their parts is banned. New Mexico law also prohibits the sale or barter of bear internal organs (although hunting black bears is allowed).

Bradbury Science Museum

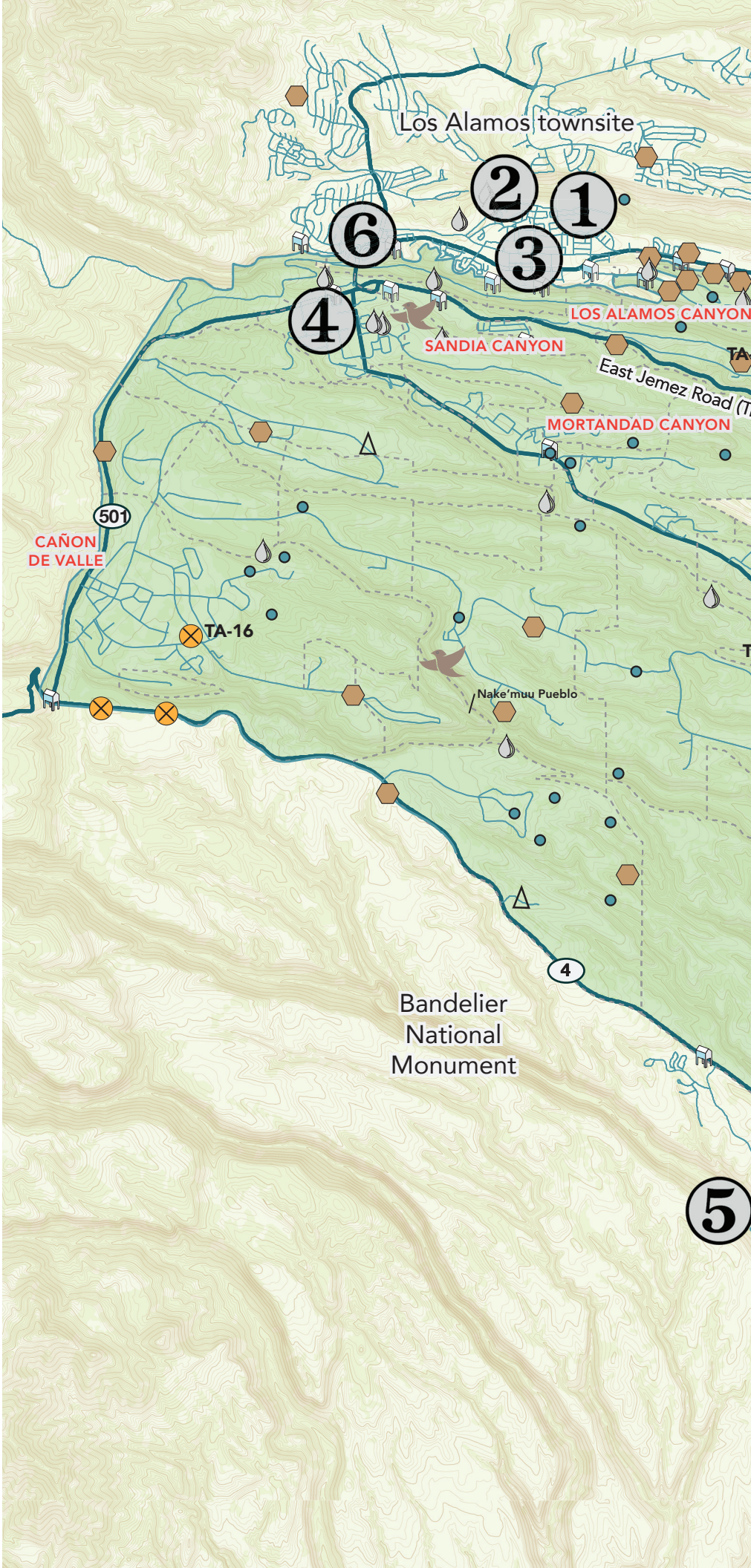
Fuller Lodge

Ashley Pond

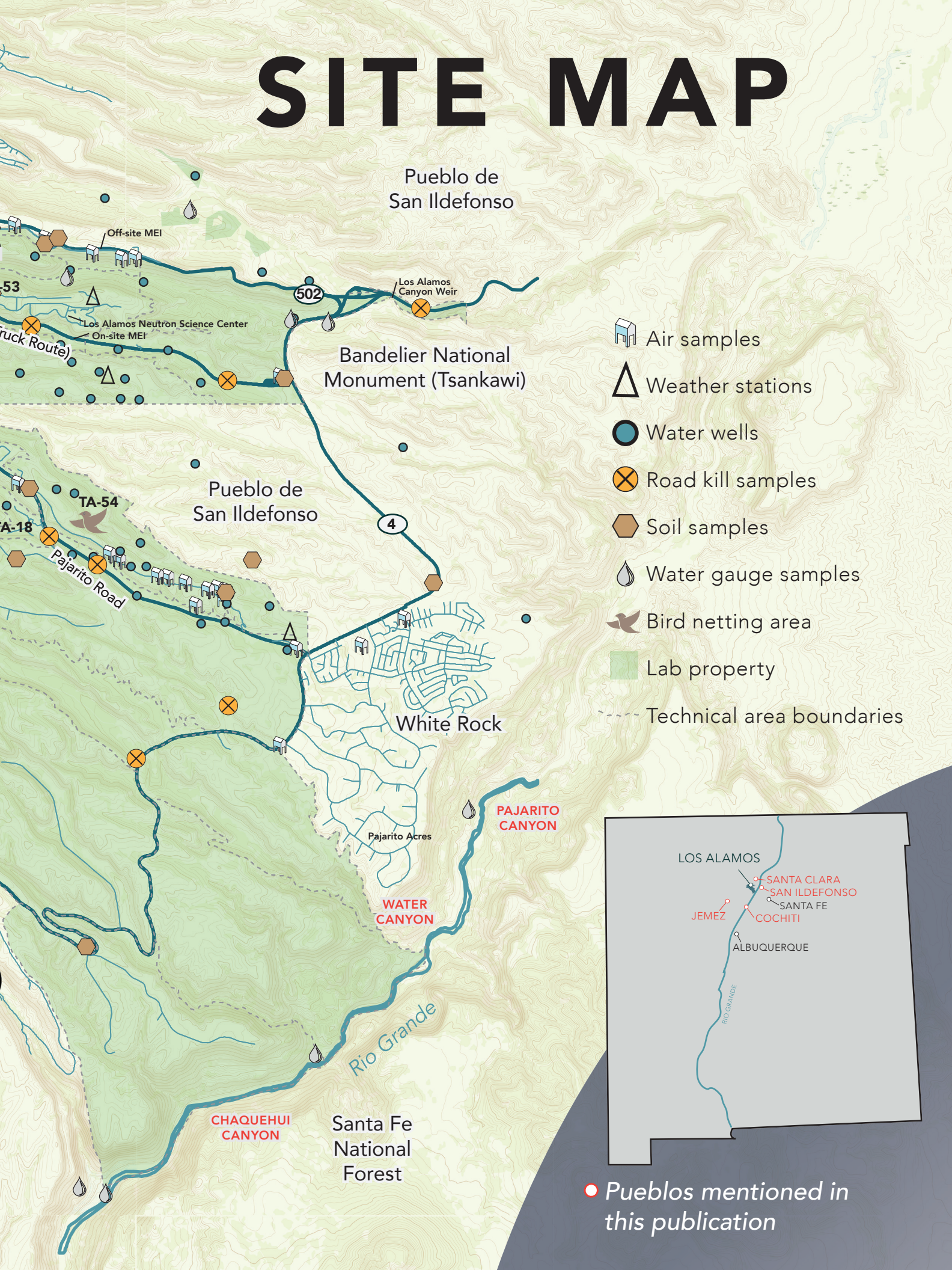
Laboratory Technical Area 3

Bandelier National Monument

Omega Bridge



SITE MAP


Pueblo de
San Ildefonso
Off-site MEI
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Los Alamos
Canyon Weir
Los Alamos Neutron Science Center
On-site MEI
ruck Route)
Bandelier National
Monument (Tsankawi)
Pueblo de
San Ildefonso
TA-54
A-18
Pajarito Road
4
White Rock
Pajarito Acres
PAJARITO
CANYON
WATER
CANYON
Rio Grande
CHAQUEHUI
CANYON
Santa Fe
National
Forest
Air samples
Weather stations
Water wells
Road kill samples
Soil samples
Water gauge samples
Bird netting area
Lab property
Technical area boundaries
LOS ALAMOS
SANTA CLARA
SAN ILDEFONSO
SANTA FE
JEMEZ
COCHITI
ALBUQUERQUE
RIO GRANDE
Pueblos mentioned in
this publication

AIR

Radionuclide air emissions are nothing to worry about.

Air quality monitoring

Environmental scientists collect ambient air samples that will be sent to an external analytical lab for analysis.

BY REBECCA LATTIN At the Laboratory, radionuclides can be dispersed into the air through exhaust stacks. Facilities without exhaust stacks are considered to be diffuse sources—their radionuclide emissions come from non-point sources such as doors and windows. Open-air activities such as demolition, environmental remediation, and water evaporation are also considered diffuse sources.

Radionuclide air emissions are accounted for in three ways: ambient air sampling, exhaust stack sampling, and emissions calculations.

Radionuclide air emissions from all types of sources are accounted for in three ways: ambient air sampling, exhaust stack sampling, and emissions calculations.

Ambient air sampling

In 2016, the ambient air sampling program, called Airnet, continuously operated 38 air-monitoring stations. Filters are used to capture radionuclides in airborne particulate matter and are sent to an external analytical lab for analysis. The total dose measured by the ambient air-sampling program for 2016 was 0.011 millirem.

Exhaust stack sampling

Every stack that has the potential to result in a public dose greater than 0.1 millirem in a single year is considered to be a "major" source and is continuously sampled for radionuclide emissions. Depending on the processes taking place in the facility, stacks can be monitored for any combination of the following: particulate matter, vapor activation products, tritium, or gaseous mixed activation products. The total dose for 2016 measured from the exhaust stacks was 0.068 millirem.

Emissions calculations

The Radioactive Materials Usage Survey is used to track potential radioactive output by unmonitored stacks that do not meet the 0.1 millirem threshold and are considered "minor" sources. Facilities that work with radioactive isotopes provide information about their processes. Using EPA methods, radionuclide emissions are calculated to provide the dose for the year in question. The total dose for unmonitored stacks for 2016 was 0.038 millirem.

The EPA requires that the Laboratory does not exceed the dose limit of 10 millirem per year. Since monitoring has begun, the Laboratory has never exceeded this limit. In 2016, the off-site effective dose equivalent for all methods of tracking radionuclides was 0.12 millirem—the lowest dose since 1998. Compared with the average background radiation a person in the U.S. receives from the air (228 millirem per year), the dose from the Laboratory is nearly negligible. ✦

A rain gauge sensor is inspected to ensure it is free from debris. The surrounding slatted "fence" blocks wind so that precipitation measurements are more accurate.

Temperature and precipitation impact emergency management and environmental surveillance programs.

Long-term effects of weather

BY DAVID BRUGGEMAN The topography of Los Alamos creates multiple weather conditions—such as rain, clear skies, and wind—in a small area. At the Laboratory, six meteorology stations effectively capture this variability, and weather data is available to the public at environweb.lanl.gov/weathermachine.

Weather at a glance

Precipitation at the Laboratory was 3.88 inches lower in 2016 than the 30-year average (1981–2010). Snowfall totals were 59 percent of the 30-year average and have been below average since 2010.

Temperatures in 2016 were 2.8 degrees Fahrenheit warmer than the 30-year average. The maximum temperature record for the Lab was broken on June 19, 2016, at 95.5 degrees Fahrenheit. Recent data shows the annual average temperatures during the past eight years are warmer than the previous 30-year averages.

The current warming trend in Los Alamos is consistent with national warming trends.

Globally, surface temperatures were the warmest since official records began in 1880. The potential long-term effects of global climate change include warmer temperatures and more extreme weather events. At the Laboratory, warmer temperatures could increase air conditioning costs, and more frequent extreme heat waves could lead to an increase in health effects. ✦

Curious about the weather in Los Alamos County? Visit environweb.lanl.gov/weathermachine on a computer or mobile device to see the most recent data from the Lab's six meteorology stations.

WATER

The Clean Water Act helps ensure human health is not at risk.

Protecting surface water

BY KAREN MUSGRAVE During the initial years of the Manhattan Project, liquid wastes were released into Los Alamos watersheds and canyons. With the passing of the Clean Water Act of 1972, the Laboratory began monitoring and remediating the canyons and water runoff. The main objectives of surface water monitoring at the Laboratory include:

1. Document the surface water quality within and downstream of the Laboratory
2. Evaluate risks to human and ecosystem health

How is surface water monitored and protected?

The Laboratory samples surface water in seven watersheds crossing Laboratory property that drain into the Rio Grande. The major canyons for these watersheds are Los Alamos, Sandia, Mortandad, Pajarito, Water, Ancho, and Chaquehui. In 2016, results from the surface water and sediment samples were below levels that pose a risk to human health. In addition to efforts to reduce contamination from Laboratory operations, engineers design a number of watershed controls to ensure the continued safety of the watersheds including, ponds, weirs, grade control structures, wetlands, berms, and vegetation.

Engineers design watershed controls, such as the Los Alamos Canyon weir, to ensure the continued safety of Los Alamos and surrounding counties' watersheds.

The Laboratory also maintains 39 stream gaging stations on or near the Laboratory property. The number and locations of samples are adjusted in response to events such as forest fires, major floods, and changes to stream impairment classifications by the state of New Mexico.

Although water quality monitoring occurs year-round, the busiest time for storm water sampling is during the summer monsoon (June to September) when rainfall is frequent. Surface water, storm water, and sediment samples are collected in canyons, active stream channels, floodplains, and springs. The samples are analyzed for potential pollutants such as radionuclides, polychlorinated biphenyls (PCBs), and metals. Extra monitoring occurs in areas that have known historical contamination to ensure the water resources are protected to EPA and NMED standards.

In 2016, results from the surface water and sediment samples were below levels that pose a risk to human health.

In conjunction with the National Pollutant Discharge Elimination System, the Laboratory has four permits: the Industrial and Sanitary Permit, the Individual Permit for Storm Water, the Construction General Permit, and the Multi-Sector General Permit. These permits ensure that water released from Laboratory outfalls and storm water that flows off or through Laboratory sites does not degrade surface water quality.

According to Steve Veenis of the Lab's Environmental Remediation Program, "The Individual Permit covers storm water discharges from over 400 Solid Waste Management Units and Areas of Concern around the Laboratory and helps to mitigate contaminant transport from past legacy activities." ✦

Three aquifers are tested for contaminants.

Monitoring ensures safe drinking water

BY BEATRICE NISOLI "Groundwater monitoring involves collection of information such as water levels and analytical data from wells to track how groundwater flows, how groundwater flow might respond to surrounding activities such as pumping from large water-supply wells, and how contaminants that may be present in groundwater are moving," explains Danny Katzman, technical program manager for Environmental Management. "It is vital information for developing remediation strategies where necessary and for being able to demonstrate and communicate our commitment to protection of our valuable resource."

Groundwater monitoring is conducted at various locations and depths in and around Lab property. Wells have been drilled to allow the collection of groundwater from alluvial, perched-intermediate, and deep regional aquifer locations. Sampling is accomplished via pumps, which transport water from wells to the surface.

Aquifer awareness

At fewer than 50 feet below ground surface, the alluvial aquifer is the shallowest occurrence of groundwater and is often located just beneath the surface of canyons, making it the first groundwater zone susceptible to surface contamination. The alluvial aquifer is often formed from permitted Laboratory outfalls but is sometimes natural. Because the alluvial aquifer is so shallow, its water supply can be vulnerable to depletion in years with little precipitation.

Perched-intermediate aquifers are found below the alluvial aquifer at depths ranging from approximately 350–900 feet below ground surface. They generally have very limited lateral extent and typically occur directly beneath canyons with persistent alluvial aquifers. They are partially formed from water moving down from the alluvial aquifer above them.

The regional aquifer is the deepest aquifer in Los Alamos and can be found approximately 600–1,200 feet below ground surface, depending on the geographical location of the well. The regional aquifer is the source of drinking water in Los Alamos and water supply for the Laboratory; therefore, it is closely monitored by both Los Alamos County and the Lab.

All three aquifers are critical to groundwater monitoring because the wells drilled in them form a comprehensive network used to monitor and track potential contaminants. All three groundwater aquifers have areas that have been affected by contamination from historical Laboratory activities. For example, as a result of past power plant operations, chromium has migrated into the regional aquifer beneath Mortandad Canyon.

Groundwater monitoring is conducted at various locations and depths in and around Lab property.

Sources of contamination

Non-dissolvable chemicals and radionuclides rarely impact groundwater because they attach to soil particles and do not move into an aquifer. On the other hand, dissolvable constituents can contaminate groundwater by seeping through rock layers directly into the water.

The Chromium Groundwater Project

Decades ago, a corrosion inhibitor known as potassium dichromate was used in cooling towers at a Lab power plant. Water in the cooling towers was periodically discharged to an outfall. The effluent traveled as surface water then migrated through three groundwater zones, resulting in chromium contamination in the regional aquifer. The Laboratory has taken several preventative measures to ensure the safety of the public and remedy this issue. With the aid of extraction wells (used to remove contaminated groundwater) and injection wells (which pump treated water back into the ground), the Lab is working to prevent further chromium migration and protect the County's drinking water wells. The Laboratory is currently conducting various studies to identify a preferred approach to a final remedy for the chromium.

Is drinking water safe?

In 2016, water-supply wells owned by Los Alamos County met all federal and state drinking water standards. Through consistent joint efforts of the Laboratory and regulatory agencies, the County's water is safe to drink. ✦

In addition to being good climbers, black bears are also decent swimmers, and we have no hesitations about plunging into a stream or reservoir for a quick swim, drink, or bite to eat. Good thing the Laboratory makes sure the local drinking, surface, and ground water is clean.

ECOSYSTEM

Chemical concentrations in sediment remain at safe levels.

Small mammals thrive in Sandia Canyon wetland

Small mammal species are becoming more common in Sandia Canyon, despite higher (but safe) chemical concentrations.

BY TATIANA ESPINOZA Sandia Canyon wetland is a three-acre marsh dominated by cattails and supplemented by industrial and sanitary wastewater from nearby Technical Area 3.

Because Technical Area 3 is a hub for Laboratory operations, Los Alamos scientists have monitored the wetland since the early 1990s. Past studies found levels of inorganic elements and polychlorinated biphenyls (PCBs) in the sediment and biota that were above background concentrations found in nature. In 2013, in an effort to prevent erosion and contaminated sediments from flowing out of the wetland, a grade control structure was built at the end of the wetland.

In 2016, scientists measured the population of small mammals in the wetland and inorganic chemical and PCB concentrations in deer mice and sediment.

Approximately 169 small mammals were found in the wetland in 2016, which was higher than in past years. The concentrations of barium, cadmium, chromium, copper, lead, silver, sodium, zinc, and total PCBs were higher in mice at the wetland compared with mice collected from various background locations.

The restored wetland still provides a productive habitat for small mammals.

Concentrations of cadmium, chromium, cobalt, copper, mercury, nickel, silver, zinc, and PCBs were also higher in sediments from the wetland compared with concentrations in sediments from Fenton Lake, located 40 miles west of the Laboratory.

Most chemical concentrations were below the no-effect ecological screening level, which means that despite the accumulation of some chemicals in the sediment of Sandia Canyon wetland, the restored wetland still provides a productive habitat for small mammals.

According to environmental scientist Phil Fresquez, "Laboratory scientists will continue to monitor the area to ensure it remains a healthy and viable habitat for years to come." ✦

Assessing the health of animals and their habitats ensures a healthy ecosystem.

Environmental sampling

BY KYLIE GALLEGOS The open space in and around Los Alamos National Laboratory is home to hundreds of animal species. Many of these areas and species are monitored by the Lab's Environmental Stewardship Group.

"Keeping an eye on the ecosystem through routine sampling projects is the best way to ensure its health." —SHANNON GAULKER

"Keeping an eye on the ecosystem through routine sampling projects is the best way to ensure its health," says scientist Shannon Gaukler. "The health of the wildlife and their habitat, along with the public's safety and awareness, is a major priority at Los Alamos."

Sampling of soil, vegetation, and small mammals is routinely performed at or near high-interest areas at the Laboratory. For example, sediment retention structures in Los Alamos and Pajarito canyons, which were constructed after the 2000 Cerro Grande fire to keep potentially contaminated sediment and water from flowing downstream to off-site locations, are sampled annually to determine if small mammals or vegetation are contaminated.

Areas outside of the Lab with similar geographical qualities to on-site sampling locations are also sampled to determine how many of the on-site results are from naturally occurring materials.

After samples are collected, processed, and labeled, they are sent to an independent laboratory. Small mammal and bird samples are submitted as a whole-body samples, while roadkill (such as deer and elk) are submitted as tissue and bone samples. Soils and vegetation are collected in a bag and submitted as is.

Each sample is tested for inorganic elements (such as metals), polychlorinated biphenyls (PCBs), and radionuclides. Some soils are additionally tested for high explosives and chemicals such as dioxins and furans, which tend to occur around firing and explosive sites.

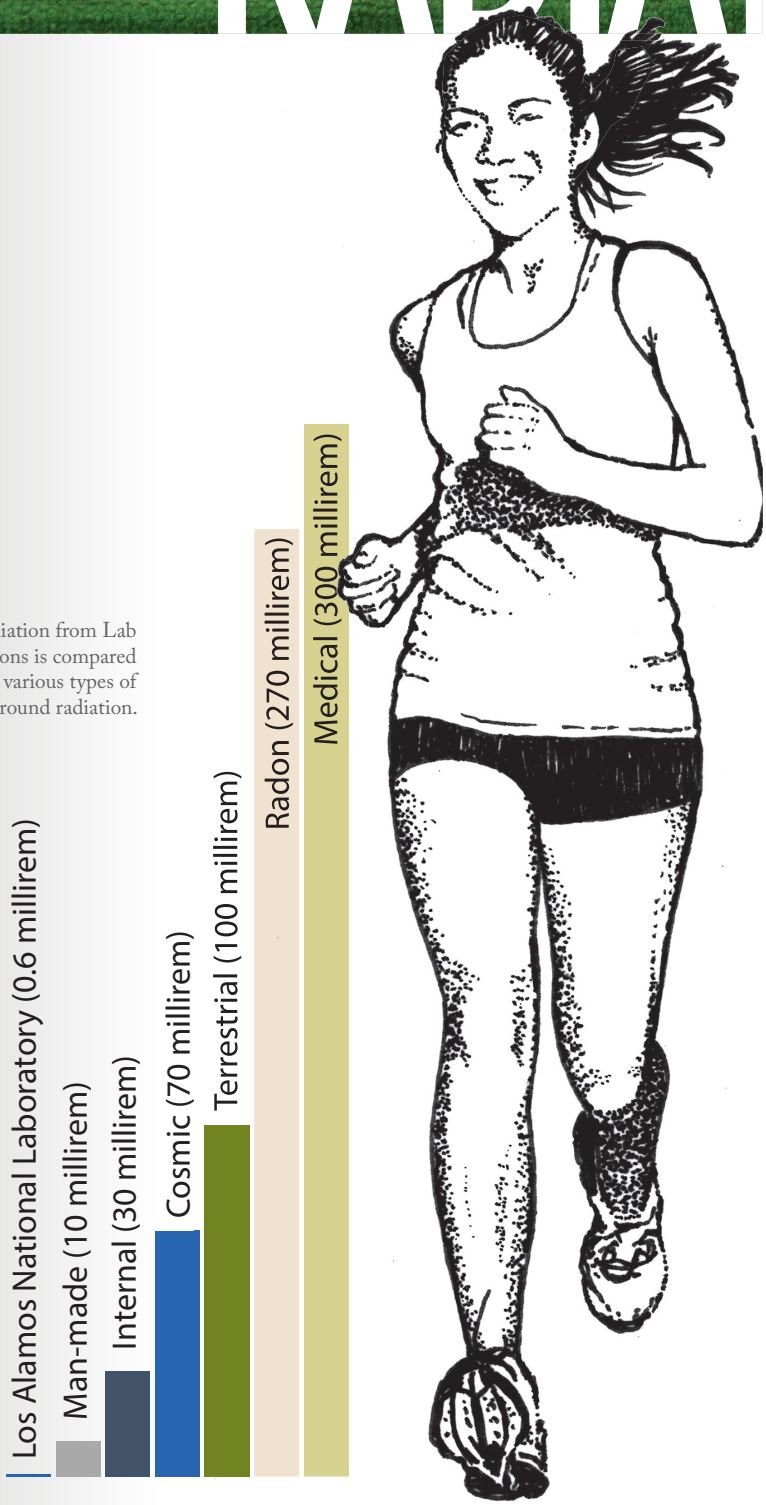
In 2016, contaminants were either not detected, similar to background levels, or below screening levels in samples of soils, vegetation, small mammals, avian species, and roadkill. Results that are below screening levels have little to no adverse effects on the environment.

Because the health of the ecosystem will always be a high priority, the Laboratory will continue to sample soils and biota to ensure pollutants from Los Alamos don't harm our environment. ✦

Lab biologists examine the wing of a Red-shafted Flicker (left) and the tail of a Dusky Flycatcher (right).

BOTTOM: A soil sample is collected before it is processed, labeled, and sent to an independent laboratory for analysis.

RADIATION



Radiation from Lab operations is compared to various types of background radiation.

Everything you need to know.

Radiation 101

BY IAN MCNABB To be a responsible steward of the land, the Laboratory must limit its radiation emissions. But what exactly is radiation?

Lesson 1: Background radiation

The typical Los Alamos resident gets a yearly radiation dose of 800 millirem. One might think this dose is due to the nuclear weapons laboratory located near the heart of town, but in fact the dose from the Lab accounts for less than one percent.

"We live in a sea of radiation yet life continues to thrive on the planet." —JEFFREY WHICKER

The vast majority of radiation in Los Alamos County comes from background radiation. Background radiation is all naturally occurring radiation that people encounter everyday here on Earth. Radiation is ubiquitous; it comes from the sun, rocks, airplanes, and even food. This radiation is nothing new—in fact, the earth has been radioactive since it was formed, and therefore all life has adapted to these conditions.

"We live in a sea of radiation yet life continues to thrive on the planet," says Jeffrey Whicker, senior Laboratory health physicist. This is true because humans and all other living organisms have evolved efficient repair mechanisms to negate most of the damage caused by the constant bombardment of natural radiation.

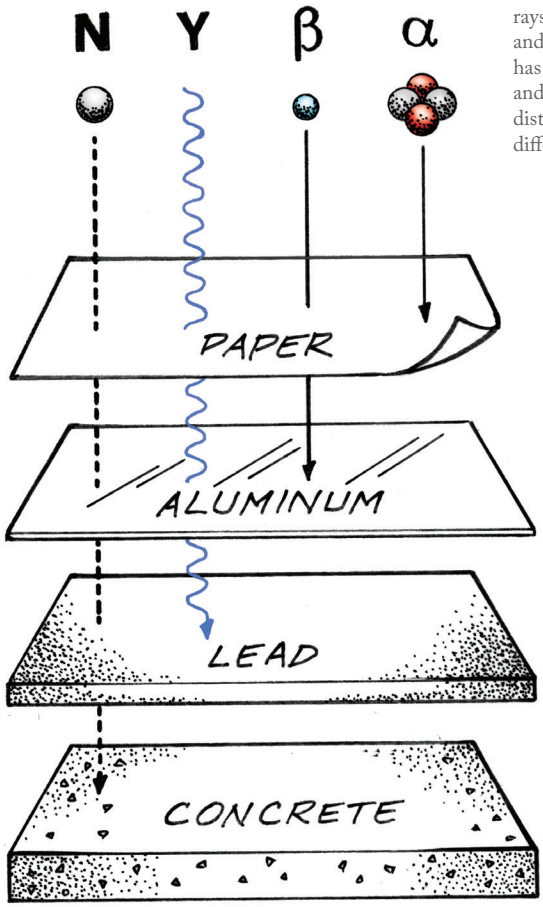
Lesson 2: Ionizing radiation

Ionizing radiation is the energy released as a particle or wave from unstable (radioactive) isotopes in an effort to achieve a more stable state. Alpha, beta, gamma, and neutron radiation are the main forms of ionizing radiation, and each has its own distinguishing characteristics. For example, alpha particles have a low penetration ability and can be stopped by a piece of paper. Gamma particles, on the other hand, travel well through matter and stop only when hitting something dense like a cement wall.

Despite such differences, all forms of ionizing radiation have similar effects when they come into contact with matter: they all work to strip electrons from stable atoms—a process called ionization.

Living cells that are exposed to ionizing radiation demand attention. This is because radiation can ionize the atoms that make up proteins, DNA, or other important molecules contained in the cell. This ionization can damage, mutate, or even kill parts of the cell, which can then decrease cell function or even cause cell death. This biological damage due to radiation exposure is deemed the equivalent dose and is quantified using the unit of a millirem. Just as a person would use pounds to quantify his weight, health physicists use millirem to quantify radiation dose.

The DOE requires the Laboratory to comply with two regulatory standards. The first is to keep the yearly radiation dose to the public less than 100 millirem. The second is to comply with the as low as reasonably achievable (ALARA) principle, which encourages facilities to keep their emission as low as possible. In 2016, the Lab's total dose to the public was less than 1 millirem. ✦



Radiation (shown here as neutrons, gamma rays, beta particles, and alpha particles) has varying energies and travels different distances through different materials.

Area food shows low levels of radionuclides.

Local fare is safe to eat

BY CLARA MAXAM Green chile from the farmers' market, tomatoes from a neighbor's garden, meat from an elk hunt, eggs from a backyard chicken coop—opportunities to consume local food abound in the Los Alamos area. To ensure that such items are safe to eat, the Lab tests local food for radionuclides and assesses the radiological dose of these goods (radiological dose is the primary measure of harm from radiation and is determined in millirems per year).

"After extensive testing, consuming locally harvested food from the surrounding areas around the Laboratory causes virtually no ingestion dose to public consumers." —PHILIP FRESQUEZ

In 2016, food was collected from areas around the Laboratory including Los Alamos, White Rock, Pajarito Acres, Pueblo de Cochiti, and Pueblo de San Ildefonso. Fruits, vegetables, eggs, milk, and meat were then measured for radionuclide concentrations at an independent analytical laboratory in Colorado. These results were compared with radionuclide concentrations in foodstuffs collected from around the region.

Results show that local samples were statistically similar to regional samples. Doses from area produce were below 0.1 millirem per year, which falls well below the 100 millirem limit set by the DOE. Local goat milk, goose eggs, and chicken eggs also measured at well below 0.1 millirem and showed no significant differences with regional levels.

Meat and bones from road-killed deer and elk were collected from the Lab and surrounding areas and analyzed for radionuclides. At below 0.1 millirem per year, the results indicate no significant difference between local and regional deer and elk.

"After extensive testing, consuming locally harvested food from the surrounding areas around the Laboratory causes virtually no ingestion dose to public consumers," says environmental scientist Philip Fresquez. "Please continue to support your farmers' market and enjoy the large variety of local goods Northern New Mexico has to offer." ✦

A variety of fruits and vegetables, goose and chicken eggs, goat milk, and meat from deer and elk were collected and analyzed for radionuclides. Produce samples included 10 varieties of fruit and vegetables such as green chile, tomatoes, squash, pumpkin, potatoes, kale, and corn.

Health physics professionals determine the most radioactive locations on and off Lab property.

The maximally exposed individual

BY IAN MCNABB If two people were to spend 24 hours a day, 365 days a year in the most radioactive places on and near the Laboratory, how much radiation would those people—known as the maximally exposed individuals—receive annually?

Calculations for both MEIs are very conservative in an effort to represent worst-case scenarios.

To answer that question, the Lab's health physics professionals do three things. First, they determine the most radioactive locations on and off Laboratory property that are accessible to the general public. Second, they calculate the resulting radiation dose received by those hypothetical people who spend 100 percent of their time at the selected locations. And thirdly, they report their findings, which are called the on-site maximally exposed individual (MEI) and off-site MEI.

On-site MEI

In 2016, the on-site MEI location was determined to be on East Jemez Road near Technical Area 53. The calculated annual radiation dose for a member of the public spending all of his time in this location was 0.6 millirem. This dose is due to indirect exposure to gamma and neutron radiation from the Los Alamos Neutron Science Center. It is important to note that actual members of the public such as cyclists, joggers, and bus drivers who frequent this stretch of road spend a very small fraction of their time here, which makes their resulting doses less than 1 percent of the calculated value. Needless to say, this dose is safe and has no measurable effects on public health.

Off-site MEI

In 2016, the location of the off-site MEI was 2470 East Road in the general area known as East Gate. The total dose calculated for an individual at this location was 0.12 millirem. This small dose is also in part due to radioactive gas emissions generated from normal operations at the Los Alamos Neutron Science Center, which is located just across Los Alamos Canyon. An annual dose of 0.12 millirem is far less than what is annually received from all sources of radiation (800 millirem), and thus is well within safe limits and merits no concern.

Calculations for both MEIs are very conservative in an effort to represent worst-case scenarios. Nonetheless these calculations are important. "By calculating a conservative dose to a hypothetical MEI, we can ensure that every member of the public is protected," says environmental health physicist Elizabeth Ruedig. "Actual individuals receive but a small fraction of the radiation attributed to the MEI and should feel safe both at work and at home in the Los Alamos area." ✦

The location of the off-site maximally exposed individual is East Gate tower on East Jemez Road, which dates back to the early Cold War era.

Lab employees surveying a storm water retention structure.

Laboratory ensures a safe environment for employees and county residents.

Monitoring radiation

BY CARINA ECHAVE People are exposed to low doses of radiation every day without negative consequences, but too much exposure can be harmful. That is why the Laboratory monitors the three pathways in which radiation can enter and affect humans: direct exposure, inhalation, and ingestion.

"There is no significant risk from radiation and chemicals, even for the most exposed members of the public." —MICHAEL McNAUGHTON

Direct exposure is measured by a network of 80 dosimeters around the Laboratory. Each dosimeter is a case containing metal chips that, if hit by direct gamma and neutron radiation, detect and record the amount of radiation. Technical Areas 53 and 54 are the only locations that produce off-site radiation in detectable amounts.

Local air monitors measure airborne radioactivity, which can travel more than one kilometer on particles. Often times, however, the airborne radioactivity is too small to measure, or it decays too quickly to be counted. Because of this, the Laboratory takes weather data and measurements of air coming out of its filtered stacks to calculate the off-site dose. The highest airborne Laboratory dose to a member of the public in 2016 was a safe 0.12 millirem. The DOE requires that the maximum dose to the public from Lab operations is less than 10 millirem per year.

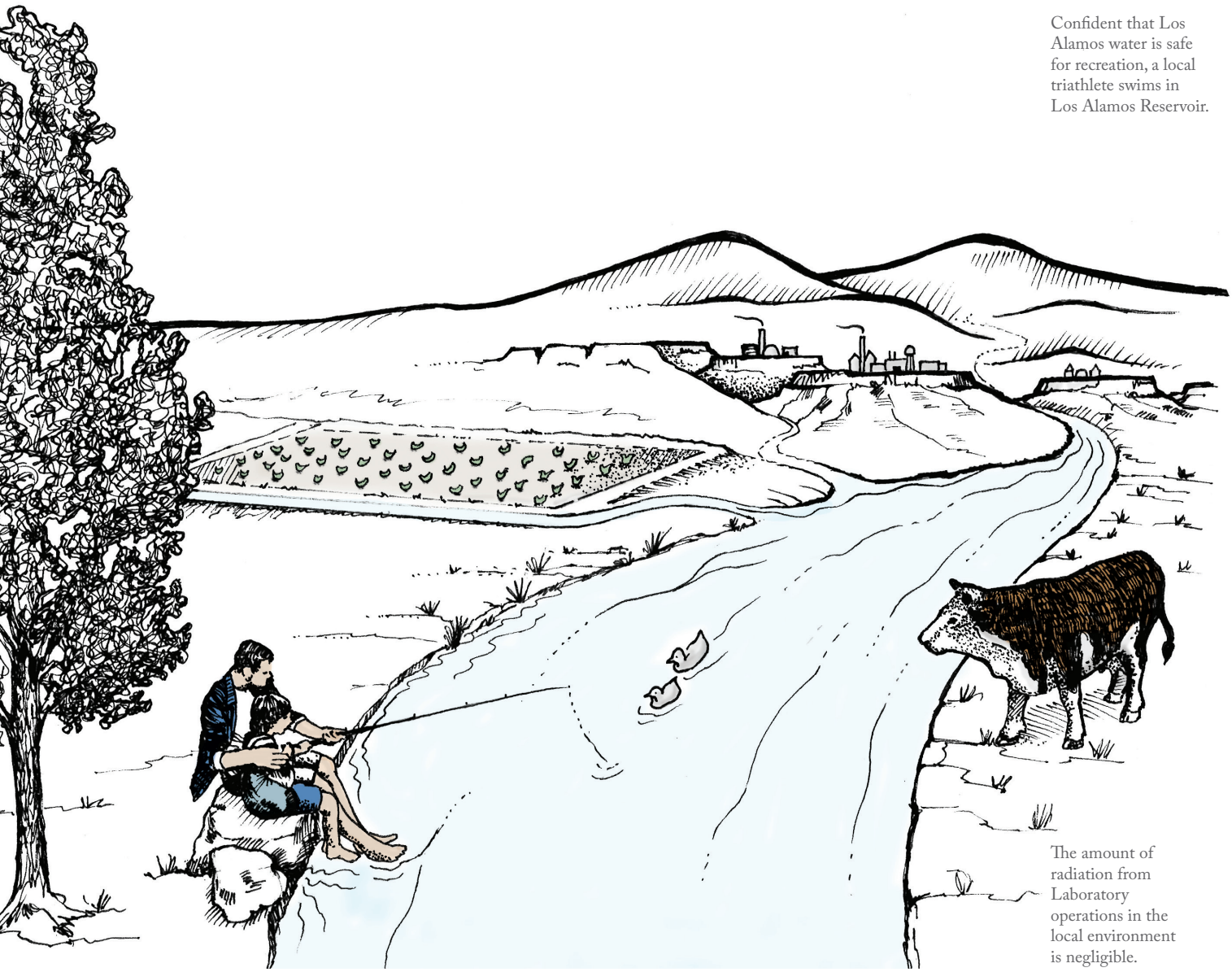
Because ingestion can happen several ways, the Laboratory takes multiple precautions, including checking drinking water, local foodstuffs, and road kill for any signs of radioactivity. The amount of radiation found in each of these sources in 2016 was negligible.

In addition to assessing radiation levels, the Laboratory also examines whether the public is at risk from chemicals being used at the Lab. Like radioactive materials, chemicals can be inhaled and ingested, so the Laboratory monitors air, drinking water and foodstuffs, as well as surface water, sediment and storm water.

"There is no significant risk from radiation and chemicals, even for the most exposed members of the public," says health physicist Michael McNaughton. "For populations of animals, there is no detectable harm." ✦

Photo: Steven Montoya

Confident that Los Alamos water is safe for recreation, a local triathlete swims in Los Alamos Reservoir.



The amount of radiation from Laboratory operations in the local environment is negligible.

ANNUAL SITE ENVIRONMENTAL REPORT SUMMARY

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Bruggeman provides weather data to support a range of projects and programs. He earned a master's degree in meteorology from San Jose State University and bachelor's degrees in meteorology and earth science from Metropolitan State University of Denver and Minnesota State University Mankato, respectively.

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Dombrowski studies environmental economics at Western Washington University and will graduate in spring 2018. She used her knowledge as a Los Alamos native and former Youth Conservation Corps member to assist the Lab's Trail Management Group in trail marking and assessments.

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Echave grew up in Los Alamos and attends the University of New Mexico, where she plans to major in chemistry. At the Laboratory, she measured and analyzed radiation in storm water, among other projects.

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Espinoza is pursuing a master's degree in natural resources stewardship at Colorado State University. She began working at Los Alamos as an undergraduate in 2013; her Laboratory mentors encouraged her to pursue a graduate degree while doing fieldwork.

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Fleming discovered her passion for design after studying abroal in France, Spain, and Mexico. She earned a master's degree in graphic information technology from Arizona State University. This is the second year that Fleming has been the graphic designer for this magazine.

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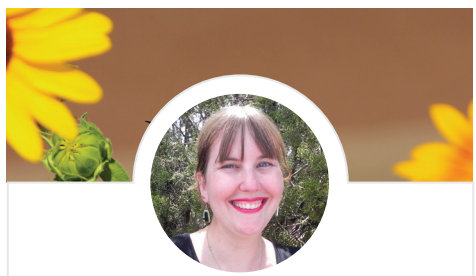
Originally from El Rito, New Mexico, Gallegos is a sophomore at New Mexico State University, where she studies animal and range science with a focus on veterinary medicine. At the Lab, Gallegos does field and data research with the Soils, Foodstuffs, and Biota Team.

Rebecca Lattin

ENVIRONMENTAL PROFESSIONAL FOR ENVIRONMENTAL PROTECTION AND COMPLIANCE

A Los Alamos native, Lattin began working with the Lab's Air Quality Team as an undergraduate at the New Mexico Institute of Mining and Technology. After earning a master's degree from Boston College, she returned to the Lab as an environmental professional in October 2016.



Alison Livesay

DOCTORAL STUDENT FOR ENVIRONMENTAL PROTECTION AND COMPLIANCE

Livesay came to the Lab in 2014 as a doctoral student at the University of Oklahoma-Norman, where she studied anthropology. She works for the Cultural Resources Management Group as an archaeologist and hopes that the Lab's archaeological and historical properties are preserved for future generations.

Victoria Lovato

UNDERGRADUATE STUDENT FOR ENVIRONMENTAL PROTECTION AND COMPLIANCE

Lovato, a native of Ojo Caliente, New Mexico, studies history at New Mexico State University. She expanded her knowledge of local history during her summer at Los Alamos by researching the impact of the Lab on the Hispanic and Native communities of Northern New Mexico.

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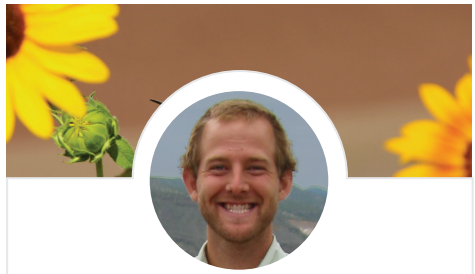
GRADUATE STUDENT FOR PUBLIC (ENVIRONMENTAL) POLICY

A Tennessee native, Mathews has enjoyed two summers at the Lab, where she integrates sustainability into architectural specifications and supports building efficiency projects that reduce greenhouse gas emissions while increasing cost savings. Mathews is pursuing a master's degree in public policy at George Washington University.

Clara Maxam

UNDERGRADUATE STUDENT FOR ENVIRONMENTAL PROTECTION AND COMPLIANCE

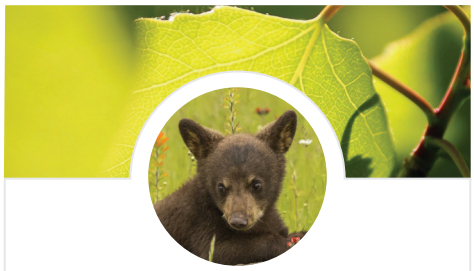
Originally from Corrales, New Mexico, Maxam now attends New Mexico State University in Las Cruces. Maxam plans to graduate in 2020 with a major in animal science. During her summer at the Lab, Maxam worked on fish sampling, data entry, and road kill processing for the Soil, Foodstuffs, and Biota Team.



Ian McNabb

MASTER'S STUDENT FOR ENVIRONMENTAL PROTECTION AND COMPLIANCE

Originally from Colorado, McNabb earned a bachelor's degree from Colorado State University in biological sciences and is working toward a master's degree in health physics with a focus in radioecology. At the Lab, his work included dose pathway modeling and soil sampling and analysis.



Honey Montoya

ONE OF 5,000+ BLACK BEARS IN NEW MEXICO

Originally from the Jemez Mountains, Honey has wandered into Los Alamos because she can't resist the birdseed and fruit trees in residents' yards. Omnivorous and opportunistic, she also enjoys acorns, piñon nuts, and juniper berries, all of which help her put on weight for hibernation.

P. Michael Moss

POST-MASTER'S STUDENT FOR ENVIRONMENTAL PROTECTION AND COMPLIANCE

Santa Fean Michael Moss earned a bachelor's degree in biology from Whitman College and a master's in sustainability management from Columbia University. He volunteered with the Peace Corps as an agroforestry extension agent in rural Paraguay. At the Lab he focuses on cost-analysis for the Pollution Prevention Group.

Karen Musgrave

POST-MASTER'S STUDENT FOR ENVIRONMENTAL PROTECTION AND COMPLIANCE

Musgrave earned a bachelor's degree in psychology from the University of Oregon in 2012 and a master's degree in behavioral ecology from the University of Exeter. At the Lab, she has expanded her knowledge of environmental policy and stewardship.

Beatrice Nisoli

HIGH SCHOOL STUDENT FOR ENVIRONMENTAL MANAGEMENT

Nisoli is a senior at Los Alamos High School and has worked at the Lab since June 2017. After graduating from high school, Nisoli plans to attend college and double major in history and a foreign language; she hopes to one day be a criminal attorney.

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Parkinson is a high school senior, vegetarian, and runner who will graduate from Los Alamos High School in May 2018. Over the summer, he interned for the Sustainability Group, where he did data analysis and other tasks, including working on the *ASER Summary*.

Abby Schmalz

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Schmalz graduated from Los Alamos High School in 2017 and is continuing her education at University of California-Santa Cruz, where she studies environmental science. Schmalz hopes to return to the Lab in the summers as she pursues a career in science.

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A 2017 graduate of Los Alamos High School, Shelton worked with Pollution Prevention and Engineering Services. She attends Rensselaer Polytechnic Institute, where she's pursuing an accredited bachelor's degree in architecture while also exploring her interest in sustainable design.

Aaron Skinner

POST-BACCALAUREATE STUDENT FOR ENVIRONMENTAL PROTECTION AND COMPLIANCE

Originally from Columbia, Missouri, Skinner majored in biology and environmental science as an undergraduate at Trinity University in San Antonio, Texas. He came to the Lab in April 2016 for a stint with the Lab's Biological Resources Team.

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A special thanks to Mark Schraad for donating photographs for use in this magazine. Schraad is a program manager in the Lab's nuclear weapons program; on weekends he is an amateur, but avid, nature and wildlife photographer.

National Nuclear Security Administration

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Photo: Mark Schraad