EX

Executive Summary

Purpose of this Report

The Lawrence Livermore National Laboratory (LLNL) annual *Environmental Report,* prepared for the Department of Energy (DOE) and made available to the public, presents summary environmental data that characterizes site environmental management performance, summarizes environmental occurrences and responses reported during the calendar year, confirms compliance with environmental standards and requirements, and highlights significant programs and efforts. By explaining the results of effluent and environmental monitoring, mentioning environmental performance indicators and performance measure programs, and assessing the impact of Laboratory operations on the environment and the public, the report also demonstrates LLNL's continuing commitment to minimize any potentially adverse impact of its operations.

Major LLNL Programs

LLNL is managed by the University of California for the National Nuclear Security Administration (NNSA) within the Department of Energy. LLNL was established in 1952 in Livermore to ensure national security through the design, development, and stewardship of nuclear weapons; its research programs address national security and national needs; in 1955, operations began at Site 300, LLNL's experimental test site.

LLNL plays a prominent role in NNSA's Stockpile Stewardship Program, in which laboratory scientists and engineers ensure the safety and reliability of the nation's nuclear weapons and certify weapon performance without nuclear testing. Nuclear weapons expertise and extensive capabilities in physical and life sciences are applied to Nonproliferation and Homeland Security, meeting the challenge of protecting the nation from terrorism. LLNL also provides the Department of Defense, the intelligence community, and other agencies with analytical support and advanced technologies to meet national security needs.

LLNL also pursues research and development in other areas of importance to the nation. LLNL carries out long-term research to help provide the United States with abundant, secure, reliable, and sustainable energy coupled with a clean environment. Bioscience research at LLNL is directed at understanding the causes and mechanisms of ill health, developing biodefense capabilities, improving disease prevention and lowering healthcare costs. In addition, often in collaboration with universities, industry, and/or other laboratories, scientists and engineers pursue projects in fundamental science and applied technology that build on the Laboratory's strengths and take advantage of LLNL's unique research capabilities and facilities.

Laboratory Policy

Safe, secure, and efficient operations that provide a safe, clean environment for employees and neighboring communities are an essential part of the Laboratory's research and development programs and underpin their success. Experts in environment, safety and health (ES&H) within the Safety and Environmental Protection Directorate support all Laboratory activities. Using the Integrated Safety Management System, work is performed in a manner that protects the health and safety of employees and the public, preserves the quality of the environment, and prevents property damage. LLNL complies with applicable ES&H laws, regulations, and requirements identified in approved Work Smart Standards. A high-quality radiological control program at LLNL assures that radiological exposures and releases are reduced to as low as reasonably achievable to protect the health and safety of all its employees, contractors, the general public, and the environment.

Over the last two decades, LLNL has made great strides in improving its environmental stewardship and has actively taken steps to reduce any potential impacts the Laboratory's operations might have on the environment and the community. For example, the new Decontamination and Waste Treatment Facility has increased LLNL's ability to provide safer, cost-effective waste operations and to reduce legacy wastes. To further these efforts, LLNL is committed to the implementation of a strong Environmental Management System through its Integrated Safety Management System. The Laboratory encourages participation by the public on matters related to its environmental impact on the community and provides access to information on its ES&H activities.

All monitoring and analysis of samples and data, including the preparation of this report, are conducted under the Environmental Protection Department's Quality Assurance Management Plan. This plan is included under LLNL's Quality Assurance Policy, with its commitment to effectiveness, excellence, innovation, and continuous quality improvement.

Monitoring

Air Monitoring

In 2004, radioactivity released to the atmosphere was monitored at 67 sampling locations at six facilities on the Livermore site and one at Site 300. Because filtering systems in exhaust stacks trap essentially all particulates, the only radioactive contaminant released to the environment through monitored stacks was tritium. Stack releases of tritium from the Tritium Facility and the Decontamination and Waste Treatment Facility contributed 90% of the estimated of 1.5 TBq (40.4 Ci) released from the Livermore site in 2004. This 1.5 TBq release is a third of the tritium released in 2003 but is about 60% higher than releases in 2001 and 2002.

The magnitude of nonradiological releases (e.g., criteria pollutants such as organics/volatile organics, nitrogen oxides, carbon monoxide, particulates, sulfur oxides) is estimated based on specifications of equipment and hours of operation. All criteria pollutant emissions were far below limits prescribed by the air districts.

In addition to effluent monitoring, numerous ambient air monitors sample for tritium, radioactive particles, and beryllium. Some samplers are situated specifically to monitor areas of known contamination, some monitor potential exposure to the public, and others, distant from the sites, monitor natural background. In 2004, ambient air monitoring confirmed estimated releases from monitored stacks and helped to determine source terms for resuspended plutonium (Livermore site) and uranium (Site 300); no unexplained radioactivity was detected.

Water (Except Groundwater) and Wastewater Monitoring

At the Livermore site, waters monitored for potential radiological and nonradiological contaminants related to LLNL operations include sewer water, storm water runoff, rainwater, drinking water, and surface waters; at Site 300, sewage ponds, surface impoundments, rainwater, and storm water runoff are monitored for radiological and nonradiological contaminants. Water monitoring is carried out to determine if any contaminants have the potential to reach drinking water wells or surface waters to which the public is exposed; water monitoring also helps determine the impact of Laboratory operations on groundwater. LLNL monitors wastewater to demonstrate compliance with permit requirements.

In 2004, no wastewater discharges from LLNL to the Livermore Water Reclamation Plant (LWRP) exceeded any discharge limits for release of radioactive materials to the sanitary sewer; data were comparable to the lowest historical values. LLNL's continuous sanitary sewer monitoring system detected only one release of nonradiological constituents outside permissible limits: in March, there was a minor discharge (250–300 gallons) of pH 4.6 effluent, slightly below the 5.0 pH limit. Overall sanitary sewer monitoring data for 2004 demonstrated that LLNL's wastewater discharge control program effectively ensured that sanitary sewer effluent posed no threat to the LWRP or the environment.

Storm water is sampled both upstream and downstream from both sites to determine the impact of each site. It is sampled for oxygen content and contaminants such as radioactivity, metals, dioxins, polychlorinated biphenyls (PCBs), and nitrate. At the Livermore site, tritium was higher in downstream than in upstream samples; for 2004, the maximum concentration measured was 0.55% of the drinking water standard. Exposure of fathead minnows to runoff collected from the first major storm of the season showed neither acute nor chronic toxicity.

Concentrations of tritium in rain samples may be highly variable depending upon operations taking place during the rain. In 2004, the maximum concentration of tritium in rain collected on the Livermore site was 2.6% of the drinking water standard; at Site 300, all rain collected was below the lower limit of detection.

All off-site surface waters and all drinking waters had no gross alpha or tritium measurements above the detection limit; median gross beta measurements were below detection limits. The on-site surface water in the Drainage Retention Basin (DRB) exhibited very low levels of gross alpha, gross beta, and tritium; toxicity tests on fathead minnows showed no ill effects. At Site 300, maintenance on the drinking and cooling water systems resulted in discharges to ground without adverse effect on surrounding waters.

Terrestrial Monitoring

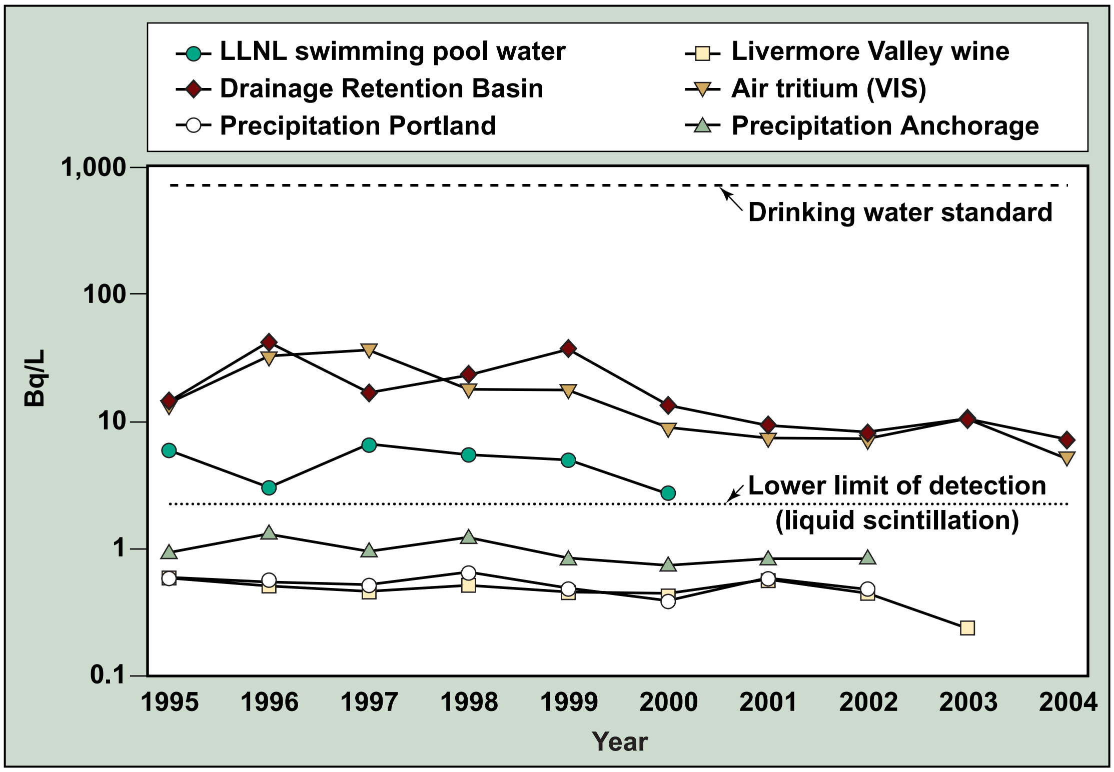
Except for plutonium concentrations at the Livermore site that continue to be slightly elevated due to historic operations, concentrations of radionuclides in soils and sediments were within global background levels in 2004. Plutonium concentrations at the LWRP continue to be about a factor of 30 higher than concentrations at any other sampled location, but even this concentration is only 2% of the screening level for cleanup recommended by the National Council on Radiation Protection. Uranium-238 was found in the soils at Site 300, but it was below screening levels except near Building 812, which is currently undergoing remedial investigation under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA).

Vegetation and wine are sampled for tritium. The median concentrations of all off-site vegetation samples except one were below the lower limit of detection of the analytical method. Concentrations in Livermore Valley wines, although about 2.5 times higher than other California wines, were a factor of four times lower than concentrations in wines from the Rhone Valley in France.

LLNL uses thermoluminescent dosimeters (TLDs) to monitor potential releases of gamma radioactivity from Laboratory operations. TLDs also measure naturally-occurring cosmic and terrestrial radioactivity. As in other years, any effect of LLNL operations was indistinguishable from normal background.

Multimedia Comparison

In **Figure EX-1**, annual median concentrations of tritium in various environmental media sampled by LLNL over the last ten years are compared with background levels of tritium in rain (measured at Portland, Oregon and Anchorage, Alaska), the Environmental Protection Agency's (EPA's) drinking water standard, and the lower limit of detection for liquid scintillation counting. A reasonable correlation may be seen between the media measured by LLNL—air moisture, water from the DRB, water from the LLNL swimming pool, and Livermore Valley wine. Differences are due to distance from the tritium sources to the location of the sampled medium, the fraction of time the wind blows towards the location, and how well the sample medium reflects tritium concentrations throughout the year.



Source: Concentrations in precipitation in Portland and Anchorage: Data from IAEA/WMO (2004). Global Network of Isotopes in Precipitation. The GNIP Database. Accessible at: http://isohis.iaea.org.

Figure EX-1. Annual median concentrations of tritium in various LLNL media compared with background levels in precipitation and the drinking water standard

Background tritium levels seen in rain samples from Portland and Anchorage include cosmogenic tritium and residual tritium from bomb tests. Background tritium levels show large variability because of latitude-effects and distance from large bodies of water. Livermore Valley wines and rain in Portland exhibit similar tritium concentrations. In 2004, the highest tritium concentrations measured at LLNL were 120 times lower than the drinking water standard.

Radiological Dose

Dose calculated to the site-wide maximally exposed individual (SW-MEI) for 2004 was 0.079 µSv (0.0079 mrem) for the Livermore site and 0.26 µSv (0.026 mrem) at Site 300. Three sources of tritium at LLNL contributed 94% of the dose received by the SW-MEI. At Site 300, the Building 851 firing table contributed 95% of the dose to the SW-MEI. There were no unplanned releases to the environment. The dose for 2004 is less than 20% the 2003 dose for the Livermore site and less than half of the previous lowest dose (in 2001) since dose reporting began. The dose to the SW-MEI at Site 300 was 50% higher in 2004 than in 2003 but was comparable to releases over the last 10 years.

In **Figure EX-2**, calculated radiological doses to the maximally exposed member of the public from operations at each site in 2004 are compared with regulatory limits and doses potentially received from the environment or from common activities (e.g., medical x-rays). The contribution of LLNL operations to unavoidable dose was inconsequential.

The 2004 dose calculated for biota at the Livermore site or at Site 300 was far below screening limits set by DOE, even when extremely unlikely assumptions were made that maximized the effect of LLNL releases on biota.

Groundwater Remediation and Monitoring

Groundwater at both the Livermore site and Site 300 is contaminated from historical operations; both are undergoing CERCLA (or Superfund) cleanup. At the Livermore site, contaminants include volatile organic compounds (VOCs), fuel hydrocarbons, metals, and tritium, but only the VOCs in groundwater, and saturated and unsaturated soils need remediation. Cleanup began in 1989. In 2004, concentrations continued to decrease in most Livermore site VOC plumes due to active remediation. VOC concentrations on the western edge of the site either declined or remained the same.

Site 300 cleanup began in 1981. VOCs are the main contaminant found at the eight Site 300 operable units (OUs). As well, nitrate, perchlorate, tritium, high explosives, depleted uranium, organosilicate oil, and metals are found at one or more of the OUs. In addition to VOCs, in 2004, perchlorate, nitrate, the high explosive RDX, and organosilicate oil were removed from groundwater. No off-site wells contain any VOCs in excess of cleanup levels, and considerable reduction in on-site concentrations has been

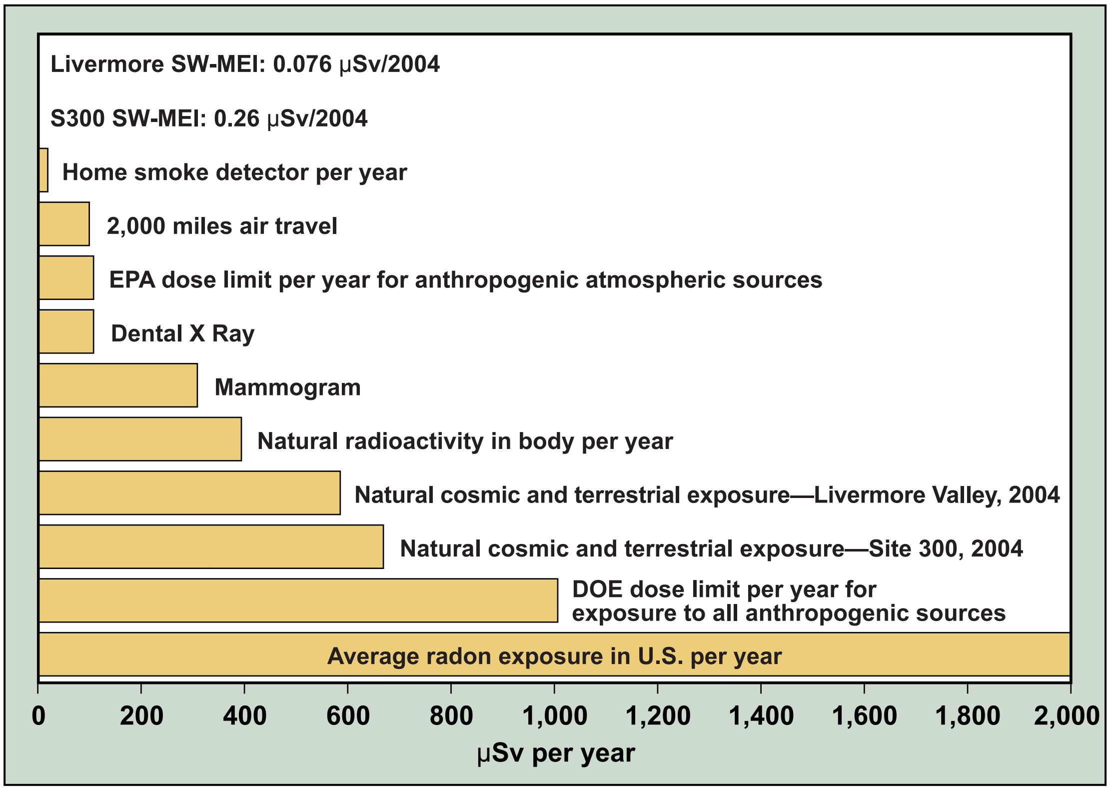


Figure EX-2. Comparison of doses to the SW-MEI at the Livermore site and Site 300 with doses received from natural background and other everyday exposures

made (most contamination is well contained within the site). Tritium above drinking water standards will have decayed to below the standard by the time the groundwater leaves the site, and depleted uranium is already below the drinking water standard. In addition to the eight operable units under remediation, four areas are under investigation to determine remediation options.

In the last ten years, the Livermore site has processed about nine times the volume of groundwater than has Site 300, but Site 300 has processed 2.5 times more soil vapor than the Livermore site. Long-term VOC concentrations in groundwater and soil vapor for Site 300 are lower by factors of two and seven, respectively, than concentrations at the Livermore site. Cumulative kilograms of VOCs removed over the last ten years from each site are shown in **Figure EX-3**.

As well as groundwater remediation activities, extensive monitoring of groundwater occurs at and near the Livermore site and Site 300 to determine potential impact on the environment and the public. Groundwater from wells down gradient from the Livermore site is analyzed for pesticides, herbicides, radioactivity, nitrate, and hexavalent chromium; the maximum off-site concentration of tritium measured was 0.73% of the drinking water standard. At Site 300, groundwater is analyzed for radioactivity, a wide

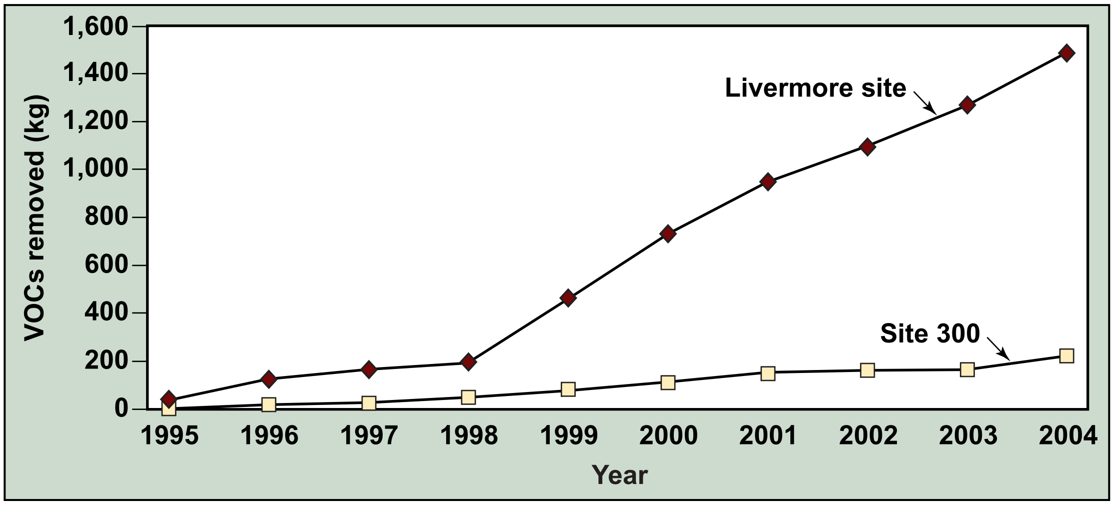


Figure EX-3. Cumulative kilograms of VOCs removed from groundwater and soil vapor at the Livermore site and Site 300 over the last ten years

range of organic compounds, metals, explosive compounds, and VOCs. No new release of constituents of concern (COC) to groundwater from any of the Site 300 sampling areas was found in 2004, and no COC that could be related to LLNL operations was found in off-site Site 300 wells.

REGULATORY PERMITTING AND COMPLIANCE

LLNL undertakes substantial activities to comply with the many federal, state, and local environmental laws. The major permitting and regulatory activities that LLNL conducts are required by the Clear Air Act; the Clean Water Act and related state programs; the Resource Conservation and Recovery Act and state and local hazardous waste regulations; the National Environmental Policy Act and the California Environmental Quality Act; the Endangered Species Act; the National Historic Preservation Act; the Antiquities Act; and CERCLA.

In 2004 and early 2005, the Agency for Toxic Substances and Disease Registry (ATSDR) completed public health assessments (PHAs) for the Livermore site and Site 300 that were several years in preparation. ATSDR is required by law to conduct a PHA at each site on the EPA National Priorities List to determine if people are being exposed to hazardous substances and if the exposure is harmful and should be reduced. At the Livermore site, ATSDR determined that the only COCs were off-site boron (found naturally in groundwater and storm water runoff), nitrate (in groundwater, but unrelated to LLNL releases), tritium (in air), plutonium-239 (in resuspended soil and sewage sludge), and tetrachlorethyelene (in groundwater); at Site 300 the COCs were VOCs in the groundwater in the General Services Area. The Livermore site PHA concluded "no apparent public health hazard" from past and present releases, while the Site 300 PHA concluded "no public health hazard", because there have been no exposures in the past and exposures in the future are unlikely.

LLNL continued to perform all activities necessary to comply with clean air and clean water requirements. In 2004, LLNL held 178 permits from the Bay Area Air Quality Management District and 40 from the San Joaquin Valley Air Pollution Control District. In addition, for the Livermore site, LLNL had permits for operation of hazardous waste facilities, generation and treatment of medical waste, discharges of treated groundwater to the recharge basin, discharges of storm water associated with industrial activities and construction, discharges of waste water and CERCLA restoration activities to the sanitary sewer, and use of aboveground and belowground storage tanks. Site 300 held many similar permits; in addition, it held permits for operation of a domestic sewage lagoon and percolation pits and large discharges from the drinking water system. Both sites have a Federal Facility Agreement for groundwater investigation/remediation. The Laboratory complies with all requirements for self-monitoring and inspections associated with these permits.

Special Status Wildlife and Plants

In 2004, a bridge over the Arroyo Mocho was permitted and constructed. It replaced an eroded, low flow crossing that obstructed the movement of threatened steelhead trout to historic spawning grounds and was impassible to vehicles throughout much of the winter. Wildlife biologists worked closely with the design and construction teams to ensure minimal disturbance of flora and fauna. When disturbance was anticipated, amphibians, reptiles, and fish were moved temporarily out of harm's way; at construction's end, plants raised elsewhere were transplanted to the bridge site.

LLNL studies, guards, and tries to improve the habitat of five species at Site 300 that are covered by the federal or California endangered species act (California tiger salamander, California red-legged frog, Alameda whipsnake, valley elderberry longhorn beetle, and large-flowered fiddleneck) as well as rare species or those otherwise of special interest. At Site 300, LLNL also counts nests, birds, and rare species of plants. The red-legged frog is found also on the Livermore site, where egg masses are counted annually and bullfrogs (a predator) are eradicated. In 2004, masses of bullfrog eggs were removed weekly throughout the spring and summer. Adult bullfrogs were also removed.

Pollution Prevention

LLNL has an active program of pollution prevention, energy efficiency, waste minimization, sustainable design, and other activities to protect the environment. In June 2004, LLNL submitted its estimate to NNSA that, due to the use of nonlead frangible ammunition at the Site 300 firing range, lead releases to the environment had been reduced by 72% since 2002. In 2005, this program received an NNSA Environmental Stewardship Award.

In early 2005, LLNL received a DOE Best-in-Class award for its tilt-pour furnace process. Traditional processing uses ceramic crucibles that are disposed of as radioactive waste after a single use. In the tilt-pour furnace process, crucibles can be used for hundreds of runs before replacement is needed.

Use of a flow-through radionuclide detector that detects multiple radionuclides in a waste stream has resulted in recharacterization of 44% of the surveyed waste from mixed to low-level. In 2005, this program received a DOE Best-in-Class Award and a DOE P2 Star Award.

Other promising projects in 2004 included a pilot program to use biodiesel in ten of LLNL's medium duty fleet of vehicles and an accelerated solvent extraction system that will remove soluble VOCs and PCBs from solid samples, which will result in reductions of 230 kg mixed low-level waste and 1 kg transuranic waste each year.

CONCLUSION

The combination of environmental and effluent monitoring, source characterization, and dose assessment showed that radiological doses to the public caused by LLNL operations in 2004 were less than 0.26% of regulatory standards and more than 11,000 times smaller than dose from natural background. Analytical results and evaluations generally showed continuing low levels of most contaminants; remediation efforts further reduced the concentrations of contaminants of concern in groundwater and soil vapor. In addition, LLNL's extensive environmental compliance activities related to water, air, endangered species, waste, wastewater, and waste reduction controlled or reduced LLNL's effects on the environment. LLNL's environmental program clearly demonstrates a commitment to protecting the environment from operational impacts.