

Executive Summary

Brookhaven National Laboratory (BNL) prepares an annual Site Environmental Report (SER) in accordance with DOE Order 231.1A, Environment, Safety and Health Reporting of the U.S. Department of Energy. The report is written to inform the public, regulators, employees, and other stakeholders of the Laboratory's environmental performance during the calendar year in review. Volume I of the SER summarizes environmental data; environmental management performance; compliance with applicable DOE, federal, state, and local regulations; and performance in restoration and surveillance monitoring programs. BNL has prepared annual SERs since 1971 and has documented nearly all of its environmental history since the Laboratory's inception in 1947.

Volume II of the SER, the Groundwater Status Report, also is prepared annually to report on the status of and evaluate the performance of groundwater treatment systems at the Laboratory. Volume II includes detailed technical summaries of groundwater data and its interpretation, and is intended for internal BNL users, regulators, and other technically oriented stakeholders. A brief summary of the information contained in Volume II is included in this volume in Chapter 7, Groundwater Protection.

Both reports are available in print and as downloadable files on the BNL web page at <http://www.bnl.gov/ewms/ser/>. An electronic version on compact disc is distributed with each printed report. In addition, a summary of Volume I is prepared each year to provide a general overview of the report, and is distributed with a compact disc containing the full report.

BNL is operated and managed for DOE's Office of Science by Brookhaven Science Associates (BSA), a partnership formed by Stony Brook University and Battelle Memorial Institute. For more than 60 years, the Laboratory has played a lead role in the DOE Science and Technology mission and continues to contribute to the DOE missions in energy resources, environmental quality, and national security. BNL manages its world-class scientific research with particular sensitivity to environmental issues and community concerns. The Laboratory's motto, "Exploring Life's Mysteries...Protecting its Future," and its Environmental, Safety, Security and Health Policy reflect the commitment of BNL's management to fully integrate environmental stewardship into all facets of its mission and operations.

INTEGRATED SAFETY MANAGEMENT SYSTEM, ISO 14001, AND OHSAS 18001

The Laboratory's Integrated Safety Management System (ISMS) integrates management of environment (i.e., environmental protection and pollution prevention), safety, and health issues into all work planning. BNL's ISMS ensures that the Laboratory integrates DOE's five Core Functions and seven Guiding Principles into all work processes. These integrated safety processes contributed to BNL's achievement of registration under both the International Organization for Standardization (ISO) 14001 Standard (for the Laboratory's Environmental Management System) and the Occupational Safety and Health Assessment Series (OHSAS) 18001 Standard (for the Laboratory's Safety and Health Program). Both standards require

an organization to develop a policy, create plans to implement the policy, implement the plans, check progress and take correction actions, and review the system periodically to ensure its continuing suitability, adequacy, and effectiveness.

In 2001, an Environmental Management System (EMS) was established at BNL to ensure that environmental issues are systematically identified, controlled, and monitored. The EMS also provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual environmental improvement. The cornerstone of the Laboratory's EMS is BNL's Environment, Safety, Security, and Health (ESSH) Policy. This policy makes clear the Laboratory's commitments to environmental stewardship, the safety of its employees, and the security of the site. Specific environmental commitments in the policy include compliance, pollution prevention, conservation, community outreach, and continual improvement. The policy is posted throughout the Laboratory and on the BNL website at <http://www.bnl.gov/ESHQ/ESSH.asp>. It is also included in all training programs for new employees, guests, and contractors.

The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized ISO 14001 Environmental Management Standard. BNL was the first laboratory under the DOE Office of Science to become officially registered to this standard in 2001. Annual independent audits, which are required to maintain the registration, are conducted to validate that the Laboratory's EMS is being maintained and to identify evidence of continual improvement. In 2008, an EMS surveillance audit determined that BNL continues to conform to the standard. During the audit, six examples of BNL's continual improvement were highlighted, including an improved Management Review process and excellent spill prevention design practices.

The Laboratory's strong Pollution Prevention (P2) Program is an essential element for the successful implementation of BNL's EMS. The P2 Program reflects the national and DOE pollution prevention goals and policies, and

represents an ongoing effort to make pollution prevention and waste minimization an integral part of the Laboratory's operating philosophy. Pollution prevention and waste reduction goals have been incorporated as performance measures into the DOE contract with BSA and into BNL's ESSH Policy. The overall goal of the P2 Program is to create a systems approach that integrates pollution prevention and waste minimization, resource conservation, recycling, and affirmative procurement into all planning and decision making. In 2008, two DOE Orders were issued which incorporated the goals of the Presidential Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management: DOE Order 430.2B, Departmental Energy, Utilities, and Transportation Management and DOE Order 450.1A, Environmental Protection Program. These orders establish federal requirements for: energy efficiency and conservation, renewable energy, fleet management, water conservation, sustainable buildings, pollution prevention, reduction of toxic chemical use, purchasing environmentally preferred products, electronic stewardship, and implementation of an Environmental Management System. Although most of these requirements have already been incorporated within the Laboratory's P2 Program, the new order will direct its future course.

Five of 15 P2 proposals, submitted by employees to BNL's P2 Council, were funded in 2008, for a combined investment of approximately \$16,000. The anticipated annual savings from these projects is approximately \$14,000, for an average payback period of approximately 1.3 years. Initiatives to reduce, recycle, and reuse 9.7 million pounds of industrial, sanitary, hazardous, and radiological waste through the P2 program resulted in more than \$1.8 million in cost avoidance or savings in 2008.

BNL was accepted into the Environmental Protection Agency's (EPA) Performance Track (PTrack) Program in 2004. This program recognizes top environmental performance among participating U.S. facilities of all types and is considered the "gold standard" for facility-based environmental performance. The program requires that facilities commit to several

improvement goals for a 3-year period and report on the progress of these goals annually. In 2007, the Laboratory renewed its membership to the PTrack Program and established four new goals: reducing non-transportation energy consumption, initiating a biobased fuel program for heavy equipment, achieving 95 percent E-PEAT registered products for all computer acquisitions, and reducing toxic releases through effective biosolids management.

Chapter 2 of this report describes the elements and implementation of BNL's EMS in further detail.

BNL'S ENVIRONMENTAL MANAGEMENT PROGRAM

BNL's Environmental Management Program consists of several Laboratory-wide and facility-specific environmental monitoring and surveillance programs. These programs identify potential pathways of public and environmental exposure and evaluate the impacts BNL activities may have on the environment. An overview of the Laboratory's environmental programs and a summary of performance for 2008 follows:

Compliance Monitoring Program

BNL has an extensive program in place to ensure compliance with all applicable environmental regulatory and permit requirements. The Laboratory must comply with more than 100 sets of federal, state, and local environmental regulations, numerous site-specific permits, 16 equivalency permits for the operation of 13 groundwater remediation systems, and several other binding agreements. In 2008, BNL complied with the majority of these requirements, and instances of noncompliance were reported to regulatory agencies and corrected expeditiously.

Eleven external environmental audits were conducted in 2008 by federal, state, and local agencies that oversee BNL activities:

- The New York State Department of Environmental Conservation (NYSDEC) performed its annual inspection of the BNL Hazardous Waste Program, and three instances of waste labeling were identified that did not fully comply with hazardous waste storage

requirements. NYSDEC issued a Notice of Violation (NOV); however, no fine or penalties were issued because all items were corrected immediately.

- NYSDEC conducted an inspection of BNL's Chemical Bulk Storage (CBS) facilities and one issue was identified that required corrective action: modifying the generic BNL tank identification label to include both the design and working capacities of each tank registered under the CBS program. The issue was corrected in accordance with the NYSDEC directive.
- NYSDEC conducted its annual inspection of the Major Oil Storage Facility and found three conditions that required corrective action: repair of a malfunctioning alarm system associated with a fuel oil pipeline secondary containment leak detection system, inspection and repair of a product pipe stanchion that had settled and was not providing the necessary structural support, and evaluation of the Cathodic Protection System servicing three tanks to ensure that it is adequately protecting the tanks. Three other conditions were identified regarding underground storage tank management: reapplication of the proper color coding for an underground storage tank containing gasoline, addressing deficiencies associated with a satellite fuel tank, and modifying the generic BNL tank identification label to include both the design and working capacities of each tank. Most conditions were corrected in accordance with NYSDEC directives in 2008, and the remaining conditions will be addressed in 2009.
- NYSDEC inspected the Laboratory's Sewage Treatment Plant (STP) and other State Pollutant Discharge Elimination System (SPDES) regulated outfalls; no issues were identified.
- The Suffolk County Department of Health Services (SCDHS) conducted its annual inspection of the BNL potable water system; no issues were identified.
- SCDHS conducted quarterly inspections of the Laboratory's STP to evaluate operations and sample effluent; no performance or operational issues were identified.
- SCDHS also performed an inspection of

BNL recharge basins permitted under the SPDES program; no issues were identified.

- NYSDEC was present during an annual Relative Accuracy Test Audit. Monitoring equipment at the Central Steam Facility (CSF) was evaluated by a contracted testing firm to ensure that all equipment is operating as required and to document compliance with permit-related monitoring requirements. All conditions and equipment were found satisfactory.

In addition to routine regulatory inspections, EPA conducted an unannounced government-initiated oil spill response exercise and field inspection to test notification procedures, equipment deployment, and other actions associated with a response to an oil spill scenario identified within BNL's Facility Response Plan (FRP). BNL's FRP outlines emergency response procedures to be implemented in the event of a worst-case discharge of oil. All objectives were met.

BNL underwent several reviews by DOE in 2008. An assessment of the Laboratory's implementation of its Emergency Management Program was performed by DOE's Office of Emergency Management. Although significant improvement was noted compared to an audit in 2004, several areas for improvement were identified. A corrective action plan has been prepared to continue improvement in this program. The DOE Chicago Support Center and the DOE Brookhaven Site Office (BHSO) conducted a mercury assessment of the site, focusing on efforts to minimize mercury in effluents and emissions and to reduce the on-site inventory of mercury-bearing devices and chemicals. The assessment found mercury management to be satisfactory, with two recommendations for improvement; both recommendations were addressed immediately. BHSO conducted an assessment of the management of radiological inventory at the Waste Management Facility (WMF). Two findings and three noteworthy practices were identified. Corrective actions have been implemented to address accuracy in waste inventory and modification to personnel protective equipment. All corrective actions are complete. BHSO also coordinated with the

Chicago Operations Support Center to perform a review of long-term monitoring and surveillance activities established for the Peconic River. Long-term stewardship was found to be effective and two improvements were recommended: interpret data presented in BNL's annual report and evaluate the need to maintain or remove the sediment trap installed at the site boundary. Both recommendations are being addressed through routine discussions with regulators and through modifications to routine reports.

BNL also performs self-assessments of its programs to ensure continued compliance. In 2008, EPA conducted a programmatic self-assessment on several aspects of BNL's Environmental Management System, including: requirements related to properly maintaining institutional and engineered controls for known or potentially contaminated areas of the site, accurately collecting and analyzing groundwater surveillance samples, and maintaining and retrieving environmental surveillance data. No conformance or noncompliance issues were identified and seven noteworthy practices, six observations, and 15 opportunities for improvement were identified. Corrective actions for the observations are being tracked to closure.

Compliance monitoring in 2008 showed that emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the CSF were all within permit limits. In addition, no opacity excursions were noted for the entire year.

Approximately 1,230 pounds of ozone-depleting refrigerants were recovered from refrigeration equipment for reuse by other DOE facilities or federal agencies. These reductions included the disposition of 10 cylinders of Halon 1301 from fixed fire suppression systems removed from operation. Additionally, approximately 4,500 pounds of ozone depleting substances were transferred to the Department of Defense Ozone Depleting Substances Reserve.

Monitoring of the potable water supply showed that all drinking water quality requirements were met. Most of the liquid effluents discharged to surface water and groundwater met applicable SPDES permit requirements; however, three minor excursions were reported

for the year and reported to NYSDEC and SCDHS. Groundwater monitoring at the Major Petroleum Facility continued to demonstrate that current oil storage and transfer operations are not affecting groundwater quality.

The Laboratory continues to reduce the number and severity of spills on site. In 2008, there were nine reportable spills of petroleum products, antifreeze, or chemicals. All releases were cleaned up to the satisfaction of NYSDEC.

Chapter 3 of this report describes BNL's Compliance Program and status in further detail.

Air Quality Program

BNL monitors radioactive emissions at three facilities on site to ensure compliance with the requirements of the Clean Air Act (CAA). During 2008, Laboratory facilities released a total of 2,650 curies of short-lived radioactive gases. EPA regulations require continuous monitoring of all sources that have the potential to deliver an annual radiation dose greater than 0.1 mrem to a member of the public; all other facilities capable of delivering any radiation dose require periodic confirmatory sampling. Although the dose to the public is less than 0.1 mrem and monitoring is not required by EPA, the Brookhaven Linear Isotope Producer (BLIP) is continuously monitored. Oxygen-15 (half-life: 122 seconds) and carbon-11 (half-life: 20.48 minutes) emitted from the BLIP constituted more than 99.9 percent of radiological air emissions on site in 2008. The combined emissions were approximately 4 percent higher than 2007 levels, primarily due to increased hours of operation.

Monitoring was also conducted at one other active facility, the Target Processing Laboratory (TPL), and one inactive facility, the High Flux Beam Reactor (HFBR). Releases from the TPL in 2008 continued to be very small (0.025 μ Ci). The rise in tritium releases from the HFBR in 2008 were due to periodic venting of the reactor vessel when domestic water was added to the reactor vessel in preparation for the removal of the HFBR control rod blade.

The Laboratory conducts ambient radiological air monitoring to verify local air quality and

assess possible environmental and health impacts from BNL operations. Air monitoring stations around the perimeter of the site measure tritium and gross alpha and beta airborne activity. Results for 2008 continued to demonstrate that on-site radiological air quality was consistent with off-site measurements and with results from locations in New York State that are not located near radiological facilities.

Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emissions monitoring to demonstrate compliance with emission limits. The CSF is the only BNL facility that requires monitoring. Two of the four boilers at the CSF, specifically 6 and 7, are equipped with continuous emission monitors to measure opacity and nitrogen oxide (NO_x) emissions. Opacity levels cannot exceed 20 percent, except for one 6-minute period per hour of not more than 27 percent opacity. In 2008, there were no exceedances of the NO_x emission standards for either boiler. In addition, there were no violations of the 6-minute opacity limits.

Because natural gas prices were lower than residual fuel oil prices from January through October 2008, BNL used natural gas for most heating and cooling needs during these months. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide were considerably lower than in years when residual fuel oil was predominantly used.

Chapter 4 of this report describes BNL's Air Quality Program and monitoring data in further detail.

Water Quality Surveillance Program

BNL discharges treated wastewater into the headwaters of the Peconic River via the STP, and non-contact cooling water and storm water runoff to groundwater via recharge basins. Some wastewater may contain very low levels of radiological, organic, or inorganic contaminants. Monitoring, pollution prevention, and careful operation of treatment facilities ensure that these discharges comply with all applicable requirements and that the public, employees, and the environment are protected.

To assess the potential impact of discharges on the water quality of the Peconic River, surface water monitoring is conducted at several locations upstream and downstream of the STP discharge. The Carmans River, located to the west of BNL, is monitored as a geographical control location for comparative purposes, as it is not affected by Laboratory operations. In 2008, the average gross alpha and beta activity levels in the STP discharge were well below drinking water standards (DWS). Tritium detected at the STP originates from either HFBR sanitary system releases, or from small, infrequent batch releases that meet BNL discharge criteria from other facilities. Although the HFBR is no longer operating, tritium continues to be released from the facility at very low concentrations due to off-gassing. To minimize the quantity of tritium released to the STP, efforts have been made to capture most of the air compressor condensate collected in the equipment areas of the structure.

In 2008, with the exception of a single low-level reported value, tritium was not detected in the STP effluent. Due to the low level of detection and the high uncertainty, the concentration was indistinguishable from the minimum detection limit (MDL). Tritium was also detected in a single sample of STP influent at a similar low-concentration (280 ± 170 pCi/L). This concentration is also indistinguishable from the MDL due to the low level of detection and the uncertainty. Both positive detections were reported as estimates by the contract analytical laboratory. Total tritium released for 2008 was 40 percent less than that recorded for 2007, and the annual average concentration trend has been declining since 1995. There were no gamma-emitting nuclides or strontium-90 (Sr-90) detected in the STP wastewater throughout 2008. The STP effluent continued to show no detection of cesium-137 (Cs-137), Sr-90, or other gamma-emitting nuclides attributable to BNL operations. There were also no radionuclides detected along the Peconic River attributable to BNL operations.

The STP is also monitored for nonradiological contaminants. In 2008, Peconic River samples collected upstream, downstream, and

at control locations demonstrated that elevated amounts of aluminum, iron, and vanadium detected in the river are associated with natural sources. Metals including copper, lead, silver, and zinc are present downstream of the STP at concentrations that are greater than the ambient water quality standard, but less than permitted levels for the STP discharge.

Discharges to recharge basins are sampled throughout the year for analyses of gross alpha and beta activity, gamma-emitting radionuclides, and tritium. Each recharge basin is a permitted point-source discharge under the Laboratory's SPDES permit. In 2008, there were no reported gamma-emitting nuclides attributable to BNL operations in any discharges to recharge basins. Tritium was also not detected. Low concentrations of disinfection byproducts were periodically detected in discharges to several of the basins throughout the year. Sodium hypochlorite and bromine, used to control bacteria in the drinking water and algae in cooling towers, lead to the formation of volatile organic compounds (VOCs), including bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. All concentrations were less than 10 $\mu\text{g/L}$. Acetone was also detected above the MDL for most recharge basins. In most instances, acetone was also found as a contaminant in the contract analytical laboratory, as evidenced by detections in blank samples.

Chapter 5 of this report describes BNL's Water Quality Surveillance Program and monitoring data in further detail.

Natural and Cultural Resource Management Program

The BNL Natural Resource Management Program was designed to promote stewardship of the natural resources found on site and to integrate natural resource management and protection with the Laboratory's scientific mission. The goals of the program include protecting and monitoring the ecosystem, conducting research, and communicating with the public, stakeholders, and staff members regarding environmental issues. Precautions are taken to protect and enhance habitats and natural resources at BNL. Activities to eliminate or mini-

mize negative effects on sensitive or critical species (such as the eastern tiger salamander, eastern hognose snake, and banded sunfish) are incorporated into procedures or into specific programs or project plans. Restoration efforts continue to remove pollutant sources that could contaminate habitats. In some cases, habitats are enhanced to improve survival or increase populations. The Laboratory also monitors and manages other wildlife populations, such as white-tailed deer and Canada geese.

BNL conducts routine monitoring of flora and fauna to assess the impact, if any, of past and present activities on the Laboratory's natural resources. Generally, deer sampled on site contain higher concentrations of Cs-137 than deer sampled from more than 1 mile off site. This is most likely because on-site deer consume small amounts of contaminated soil and graze on vegetation growing in soil where elevated Cs-137 levels are known to exist. The maximum on-site concentration in 2008 was seven times higher than the highest level reported in 2007, but continues to be much lower than the highest level ever reported (1996). The New York State Department of Health (NYSDOH) has formally reviewed the potential public health risk associated with elevated levels of Cs-137 in on-site deer and determined that neither hunting restrictions or formal health advisories are warranted. Testing of deer bones for Sr-90 indicated background levels. Sr-90 is present in the environment at background levels as a result of worldwide fallout from nuclear weapons testing. BNL will continue to test for Sr-90 in bone to develop baseline information.

In an effort to restore fish populations, the Laboratory suspended most on-site fish sampling in 2001. By 2007, fish populations had recovered and annual on site sampling resumed. In 2008, Cs-137 was detected at low levels in all samples from the Peconic River system and appears to be declining compared with historic values. The cleanup of both on-and off-site portions of the Peconic River in 2004 and 2005 removed approximately 88 percent of Cs-137 in the sediment that was co-located with mercury. Natural decay and the removal of this contamination are expected to result in further decreases.

Nonradiological analysis of fish continued in 2008. All concentrations for metals are considered safe and do not pose any health risks to humans or other animals that may consume fish. Due to its known health risk, mercury is the metal of most concern. In general, a trend of decreasing mercury content downstream from BNL's STP is evident. Pesticide analysis in fish was discontinued in 2008, since several years of sampling detected pesticides in only a few fish far off-site. Polychlorinated biphenyl (PCB) analysis in fish was also discontinued off site, but continued to be completed for fish on site. A single sample taken from Area A tested positive for PCBs. The cleanup of the Peconic River, completed in 2005, has removed most PCBs within the sediments on site.

Annual sampling of sediment, vegetation, and freshwater in the Peconic River and a control location on the Carmans River was conducted in 2008. On- and off-site aquatic vegetation and sediments contained low levels of Cs-137 and metals in amounts that were consistent with levels detected in previous years. Pesticides and PCB analyses of aquatic sampling were also discontinued in 2008.

Under the Peconic River remediation project, sediment from the Peconic River was remediated to remove mercury and associated contaminants from the river. This project was completed in the summer of 2005. Sampling results for 2008 indicated that 97 percent of the samples were below the cleanup goal of 2.0 mg/kg.

Water column sampling for mercury and methylmercury was performed at 20 Peconic River sampling locations, the STP, and one reference location on the Connetquot River in 2008. The general trend of total mercury in water samples decreased with increasing distance downstream from the STP. Methylmercury concentrations increased slightly from the STP to the BNL site border; then decreased gradually with increasing distance downstream of the BNL site border until reaching the historic range of concentrations for the Connetquot River reference station.

BNL has completed two years of wetland monitoring and invasive species control. A formal approval from EPA will be requested in

2009 that all Peconic River federal wetland restoration requirements have been met.

On-site sampling of garden vegetables was completed in 2008 and the 5-year periodic confirmatory sampling of local farm vegetables was also conducted. Data shows that vegetables grown in the BNL garden plot and by local farmers continue to support historic analyses that there are no Laboratory-generated radionuclides in produce.

BNL sponsors a variety of educational and outreach activities involving natural resources. These programs are designed to help participants understand the ecosystem and to foster interest in science. Wildlife programs are conducted at BNL in collaboration with DOE, local agencies, colleges, and high schools. Ecological research is also conducted on site to update the current natural resource inventory, gain a better understanding of the ecosystem, and guide management planning. In 2008, the Environmental Protection Division hosted interns and one faculty member who worked on a variety of projects including: surveying dragonflies and damselflies, radio tracking and genetics of red and grey foxes, analyzing the water chemistry of the Carmans and Peconic Rivers, investigating the loss of the southern leopard frog on Long Island, assessing population health of the banded sunfish, analyzing soil microbial communities, performing statistical analysis of migratory bird data, and studying the distribution of aquatic invertebrates within the Carmans River. Teachers also participated in a workshop on environmental monitoring under the Open Space Stewardship Program (OSSP), managed by the BNL Office of Education Programs. In addition, the Foundation for Ecological Research in the Northeast (FERN) began work on video-based instruction for protocols used within OSSP.

The goal of BNL's Cultural Resource Management Program (CRMP) is to ensure the proper stewardship of BNL and DOE historic resources. Additional goals include maintaining compliance with various historic preservation and archeological laws and regulations, and ensuring the availability of resources to Laboratory personnel and the public for research and

interpretation. Cultural resource management activities performed in 2008 included acquiring storage space for cultural resources and participating in the planning and execution of the 77th Division Casing of the Colors Ceremony. During this ceremony, U.S. Army officers of the division retired the 77th U.S. Army Regional Readiness Command.

Chapter 6 of this report describes BNL's natural and cultural resources in further detail.

Groundwater Protection Management Program

BNL's extensive groundwater monitoring well network is used to evaluate progress in restoring groundwater quality, to comply with regulatory permit requirements, to monitor active research and support facilities, and to assess the quality of groundwater that enters and exits the site. The Laboratory monitors research and support facilities where there is a potential for environmental impact, as well as areas where past waste handling practices or accidental spills have already degraded groundwater quality. In 2008, the Laboratory collected groundwater samples from 860 on- and off-site monitoring wells during 2,055 individual sampling events.

Under the environmental surveillance program, 10 active research and support facilities were monitored during 2008. Although no new impacts to groundwater quality have been discovered since 2001, groundwater quality continues to be impacted from past releases at two facilities: the former g-2 experiment within the Alternating Gradient Synchrotron (AGS) facility, and the Upton service station facility. Tritium continues to be detected at concentrations above the 20,000 pCi/L DWS in wells monitoring the g-2 source area. Monitoring data suggest that the continued release of tritium from the source area is due to residual tritium being flushed out of the unsaturated zone close to the water table by natural water table fluctuations. The amount of tritium entering the groundwater is expected to decrease over time, due to this flushing mechanism and by natural radioactive decay. At the Upton service station, VOCs associated with historical petroleum and solvent spills continue to be detected in the

groundwater at concentrations above the applicable DWS. The levels of VOCs are expected to decrease over time by means of natural attenuation.

The primary mission of the Laboratory's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) groundwater program is to operate and maintain groundwater treatment systems and prevent additional groundwater contamination from migrating off site. During 2008, BNL continued to make significant progress in restoring groundwater quality with the removal of approximately 220 pounds of VOCs and approximately 3.4 mCi of Sr-90 with the treatment of more than 1.5 billion gallons of groundwater. To date, 6,117 pounds of VOCs have been removed from the aquifer, and noticeable improvements in groundwater quality are evident in the Operable Unit (OU) I South Boundary, OU III South Boundary, OU III Industrial Park, OU III Industrial Park East, OU III North Street, OU IV, Building 96, and Carbon Tetrachloride areas. Also to date, two of the treatment systems have removed approximately 20 mCi of Sr-90.

Chapter 7 of this report provides an overview of this program, and the SER Volume II, Groundwater Status Report, provides a detailed description, data, and maps relating to all groundwater monitoring performed in 2008.

Radiological Dose Assessment Program

BNL routinely assesses its operations to ensure that any potential radiological dose to members of the public, BNL workers, visitors, and the environment is "As Low As Reasonably Achievable" (ALARA). The potential radiological dose is calculated as the largest possible dose to a hypothetical Maximally Exposed Individual (MEI) at the BNL site boundary. For dose assessment purposes, the pathways include direct radiation exposure, inhalation, ingestion, immersion, and skin absorption. Radiological dose assessments at the Laboratory have consistently shown that the effective dose equivalent from operations is well below the EPA and DOE regulatory dose limits for the public and the environment. The dose impact from all BNL activities in 2008 was compa-

able to natural background radiation levels.

To measure direct radiation from Laboratory operations, 58 thermoluminescent dosimeters (TLDs) were placed on site and 15 TLDs are placed in surrounding communities. An additional 30 TLDs were placed in a lead-shielded container for use as reference and control TLDs for comparison purposes. In 2008, the average doses from all TLDs showed there was no additional contribution to on- and off-site locations from BNL operations.

The annual on-site external dose from all potential sources, including cosmic and terrestrial radiation, was 69 ± 13 mrem (690 ± 130 μ Sv), and the annual off-site external dose was 63 ± 11 mrem (630 ± 110 μ Sv). The effective dose to the MEI from air emissions was $6.12E-2$ mrem (0.61 μ Sv). The ingestion pathway dose was estimated as 12.48 mrem (125 μ Sv) from consumption of deer meat and 0.09 mrem (0.9 μ Sv) from consumption of fish caught in the vicinity of the Laboratory. The total annual dose to the MEI from all pathways was estimated as 12.63 mrem (126 μ Sv). The dose from the air inhalation pathway attributable to BNL operations was less than 1 percent of EPA's annual regulatory dose limit of 10 mrem (100 μ Sv), and the total dose was less than 13 percent of DOE's annual dose limit of 100 mrem (1,000 μ Sv) from all pathways. Doses to aquatic and terrestrial biota were also evaluated and found to be well below the regulatory limits.

As a part of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) review process at BNL, any source that has the potential to emit radioactive materials is evaluated for regulatory compliance. In 2008, a preliminary NESHAP evaluation was performed for the removal of the graphite pile and bioshield at the Brookhaven Graphite Research Reactor (BGRR). The evaluation determined that this project could give a potential dose exceeding 0.1 mrem; therefore, the facility will be continuously monitored for radionuclides during the removal of these materials.

In 2008, the BLIP facility operated over a period of 23 weeks. Due to an anticipated increase in production of medical isotope production in 2009, BNL applied to EPA for NESHAPs

authorization to increase dose from facility emissions to a maximum of 0.2 mrem. The request was approved noting that the Laboratory continue its efforts to maintain the dose “as low as reasonably achievable.”

During 2008, tritium monitoring at the HRBR was increased from monthly to weekly when the reactor vessel, primary cooling water system, and fuel canal were filled with domestic water to prepare for removal of the control rod blades. Because the reactor vessel was periodically opened, tritium levels in the building were much higher than observed in recent years.

Chapter 8 of this report describes the BNL Radiological Dose Assessment Program and monitoring data in further detail.

Quality Assurance Program

The multilayered components of the BNL Quality Assurance (QA) Program ensure that all analytical data reported in this document are reliable and of high quality, and that all environmental monitoring data meet quality assurance and quality control objectives. Samples are collected and analyzed in accordance with EPA methods and standard operating procedures that are designed to ensure samples are representative and the resulting data are reliable and defensible. Quality control in the analytical laboratories is maintained through daily instrument calibrations, efficiency and background checks, and testing for precision and accuracy. Data are verified and validated as required by project-specific quality objectives before being used to support decision making.

In 2008, the Laboratory used five off-site contract analytical laboratories to analyze environmental samples: General Engineering Lab (GEL), H2M Lab, Test American (TA), Chemtex Lab, and Brooks Rand. All analytical laboratories were certified by NYSDOH for the tests they performed for BNL, and were subject to oversight that included state and national performance evaluation (PE) testing, review of QA programs, and audits.

Four of the contract analytical laboratories (GEL, TA, H2M, and Brooks Rand) participated in several national and state PE testing programs in 2008. The fifth contractor, Chemtex Labora-

tory, did not participate in PE testing because there is no testing program for the specific analytes Chemtex analyzed. Each of the participating laboratories took part in at least one testing program, and several laboratories participated in multiple programs. Results of the tests provide information on the quality of a laboratory’s analytical capabilities. The testing was conducted by Environmental Resource Associates (ERA), the National Voluntary Laboratory Accreditation Program (NVLAP), the voluntary Mixed Analyte Performance Evaluation Program (MAPEP), and NYSDOH Environmental Laboratory Accreditation Program (ELAP).

As part of DOE’s Integrated Contract Procurement Team Program, TA and GEL were audited in 2008. During the audits, errors are categorized into Priority I and Priority II findings. Priority I status indicates a problem that can result in unusable data or a finding that the contract analytical laboratory cannot adequately perform services for DOE. Priority II status indicates problems that do not result in unusable data and do not indicate that the contract analytical laboratory cannot adequately perform services for DOE. There were no Priority I findings for GEL and two Priority II findings. The first Priority II finding stated that the GEL Standard Operating Procedure (SOP) for semivolatile analysis did not contain sufficient information on method blanks; the lab updated the SOP. The second Priority II finding indicated a failure to pass the PE sample for selenium in a soil matrix. Since this PE result, GEL has changed analysis techniques for selenium in soil and has obtained acceptable results on PE samples. Both these findings have been closed. TA had one Priority I finding and one Priority II finding. Both findings were from their inorganic division. The Priority I finding originated from a failure to obtain acceptable PE test results for antimony in a soil matrix. TA adjusted their soil preparation methods and received passing scores on the next two PE samples for antimony in a soil matrix. DOE accepted these results and closed this finding. The Priority II finding dealt with inorganic lab practices that did not exactly meet internal SOPs. TA updated their SOPs and this finding was also closed.

Based on the data reviews, data validations, and results of the independent PE assessments, the chemical and radiological results reported in this 2008 SER are of acceptable quality.

Chapter 9 of this report describes the BNL Quality Assurance/Quality Control Program in further detail.