

## *Executive Summary*

*Brookhaven National Laboratory (BNL) prepares an annual Site Environmental Report (SER) in accordance with DOE Order 231.1B, 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 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 personnel, regulators, and other technically oriented stakeholders. A brief summary of the information contained in Volume II is included in Chapter 7, Groundwater Protection, of this volume.*

*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.*

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### **INTEGRATED SAFETY MANAGEMENT SYSTEM, ISO 14001, AND OHSAS 18001**

The Laboratory's Integrated Safety Management System (ISMS) incorporates 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 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.

An Environmental Management System (EMS) was established at BNL in 2001 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 and health of 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 also is 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. BNL was also the first DOE Office of Science Laboratory to achieve registration under the OHSAS 18001 (Occupational Health & Safety) Standard. Each certification requires the Laboratory to undergo annual audits by an accredited registrar to assure that the systems are maintained and to identify evidence of continual improvement. In 2011, an EMS and OHSAS surveillance audit determined that BNL remains in conformance with both standards (OHSAS 18001 results are not discussed in this report). In recommended continued EMS certification, auditors from NSF-International Strategic Registrations, Ltd., highlighted 8 Positive Practices, one

Opportunity for Improvement, and one Minor Nonconformance. The Minor Nonconformance resulted from misidentified or omitted aspects for the NASA Space Radiation Laboratory, and the Opportunity for Improvement was the need to clarify that the "core" environmental aspect category of "waste generation" should include solid wastes such as cardboard, recyclables, food waste, trash, etc. Corrective actions are being addressed and tracked to closure.

Executive Order 13514, signed in 2009, sets sustainability goals for federal agencies and focuses on making improvements in environmental, energy, and economic performance. It requires federal agencies to set a greenhouse gas emissions reduction target, increase energy efficiency, reduce fleet petroleum consumption, conserve water, reduce waste, support sustainable communities, and leverage federal purchasing power to promote environmentally responsible products and technologies. The Laboratory's EMS objectives and targets have been established to mirror these requirements.

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. Three of 13 P2 proposals, submitted by employees to BNL's P2 Council, were funded in 2011, for a combined investment of approximately \$21,000. The anticipated annual savings from these projects is estimated at \$20,300, for an average payback period of approximately 1 year. Initiatives to reduce, recycle, and reuse 15.7 million pounds of industrial, sanitary, hazardous, and radiological waste through the P2 program resulted in more than \$2.1 million in

cost avoidance or savings in 2011.

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 2011 follow.

#### ***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, 15 equivalency permits for the operation of 13 groundwater remediation systems, and several other binding agreements. In 2011, the Laboratory complied fully with most requirements; all instances of noncompliance were reported to regulatory agencies and corrected expeditiously.

In 2011, emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the Central Steam Facility (CSF) were all within permit limits. Opacity excursions occurred only during boiler testing periods. Halon portable fire extinguishers continue to be removed and replaced by dry-chemical or clean agent units as they are encountered. The existing supply of Halon in storage will be transferred to the Department of Defense Ozone Depleting Substances Reserve in 2012.

Monitoring of BNL's potable water supply showed that all drinking water quality requirements were met in 2011. Most of the liquid effluents discharged to surface water and groundwater met applicable State Pollutant Discharge Elimination System (SPDES) permit requirements; however, six minor excursions

above permit limits were reported during the year. Three occurred at the Sewage Treatment Plant (STP) — two for iron and one for total nitrogen load. Three minor pH excursions were recorded for discharges to recharge basins — one at Outfall 005 and two at Outfall 008. The permit excursions were reported to the New York State Department of Environmental Conservation (NYSDEC) and the Suffolk County Department of Health Services (SCDHS), as required. Groundwater monitoring at the Major Petroleum Facility (MPF) continues to demonstrate that current oil storage and transfer operations are not affecting groundwater quality.

Routine inspections conducted during the year found no significant instances of noncompliance involving waste disposal; however, the State of Utah issued BNL two Notices of Violation (NOV) with fines totaling \$10,000, for shipments of waste received at EnergySolutions, that did not comply with the site's Waste Acceptance Criteria. In July, a small piece of lead that had been used as shielding at BNL was found in a high integrity container that was previously used for transporting radioactive materials. Lead was not listed or approved under the waste profile for this shipment. In August, the concentration of radionuclides contained in a bin of dust removed from the BNL Brookhaven Graphite Research Reactor (BGRR) during demolition exceeded Class A waste limits and was therefore a violation of the EnergySolutions license.

Ten external environmental inspections were conducted in 2011 by federal, state, and local agencies that oversee BNL activities. These inspections included:

- *Air Compliance.* NYSDEC performed a formal inspection of the Laboratory's air compliance program. NYSDEC was also present during a portion of the annual relative accuracy test audit of the continuous emissions monitoring system at BNL's CSF. There were no issues identified during these inspections.
- *Potable Water.* In August, SCDHS collected samples and conducted its annual inspection of the Laboratory's potable water system. Identified deficiencies are being addressed

by BNL's Energy and Utilities Division.

- *Sewage Treatment Plant*. SCDHS conducts quarterly inspections of the Laboratory's Sewage Treatment Plant (STP) to evaluate operations and sample the effluent. In 2011, no performance or operational issues were identified. NYSDEC performed an annual surveillance inspection in February and also found no issues identified.
- *Recharge Basins*. SCDHS inspected several of BNL's SPDES-regulated outfalls and collected samples. There were no issues identified during the inspection.
- *Major Petroleum Facility (MPF)*. The annual NYSDEC inspection of the Laboratory's MPF was not conducted in 2011 and is scheduled for early 2012.
- *Chemical Bulk Storage Facilities (CBS)*. BNL's CBS facilities are inspected periodically by NYSDEC. The annual inspection was not performed in 2011 and is scheduled for early 2012.
- *Resource Conservation and Recovery Act (RCRA)*. EPA conducted an annual RCRA inspection in September 2011 and found BNL operations to be in compliance with requirements.

Each year, the DOE Brookhaven Site Office (BHSO) conducts several environmentally-related assessments, some of which are supported by the DOE Chicago Office. In April 2011, BHSO performed a collaborative assessment of the Laboratory's waste characterization processes, including both radioactive and hazardous waste, in response to the 2010 State of Utah NOV regarding insufficient characterization of wastes generated by the BGRR cleanup program. The review showed several weaknesses in waste characterization, including inadequate support documentation and ineffective implementation of a corrective action following the 2010 waste characterization NOV. Additional Corrective Actions have been developed to address these findings.

In August 2011, BHSO conducted a second surveillance assessment of the BNL waste characterization processes. The review was restricted to radiological waste streams and looked at radioactive wastes generated by the

Environmental Remediation Program (ERP) and the Brookhaven Linac Isotope Producer (BLIP) program. Overall, the assessment found that future ERP waste streams should be compliant with disposal site waste acceptance criteria and that BLIP waste streams were appropriately characterized. Several recommendations were made to enhance and strengthen the waste characterization processes at BNL, and are currently being implemented.

In August 2011, BHSO performed a collaborative assessment with BSA on the National Environmental Policy Act (NEPA) process at BNL and within the BHSO. The assessment looked at NEPA implementation across all departments and divisions. Additionally, a review of cultural resource institutional awareness was included in the assessment scope. Knowledge of cultural resources was found to be deficient in the Integrated Facility Management System, and NEPA implementation was found to be strong in the scientific departments and at the institutional level. Some smaller projects were found to be deficient in NEPA compliance, and training of newly hired engineers was identified as an opportunity for improvement. Administrative weaknesses were also identified, including out-of-date categorical exclusion updates.

Also in 2011, BNL conducted a programmatic self-assessment on several aspects of the Laboratory's environmental management program. Topics for this assessment were determined based on institutional risk, DOE and regulatory agency expectations, and to ensure that key environmental requirements are being implemented as designed. The self-assessment focused on requirements related to natural and cultural resources and endangered species management. The Natural Resource and Endangered Species assessment included a review of the BNL Natural Resource Management Plan and the need to make some updates. Additional actions aimed at preserving wildlife and enhancing endangered species habitats were identified and added to the plan for future implementation. The Cultural Resource review was performed as part of the NEPA review conducted in cooperation with BHSO.

The Laboratory continues to be a certified

Nevada National Security Site (NNSS) waste generator. As part of the NNSS waste certification process, random unannounced inspections are conducted. NNSS performed an unannounced inspection at BNL in November 2011. There were no findings and one observation noted: the need to develop an approved vendor's list for products and services used to manage waste being disposed of at the NNSS.

Efforts to reduce the number and minimize the severity of spills on site continued in 2011. There were 18 reportable spills of petroleum products, antifreeze, or chemicals. While the total number of spills increased by three from 2010, the severity of releases was minor and spills were promptly 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. 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. During 2011, Laboratory facilities released a total of 5,793 curies of short-lived radioactive gases. The BLIP is the only BNL facility subject to EPA's continuous monitoring requirements. 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 2011. The combined emissions were approximately 4 percent lower than 2010 levels.

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 2011 continued to be very small (0.0861  $\mu$ Ci). Low levels of tritium from the HFBR (0.41 Ci) were primarily due to the presence of residual tritium in ambient air exhausted from the facility prior to and during the structural

integrity inspections.

The Laboratory conducts ambient radiological air monitoring to verify local air quality and assess possible environmental and health impacts from BNL operations. Samples collected from air monitoring stations around the perimeter of the site were analyzed for tritium and gross alpha and beta airborne activity. Results for 2011 continued to demonstrate that on-site radiological air quality was consistent with air quality measured at 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 nitrogen oxide (NO<sub>x</sub>) emissions and opacity. NO<sub>x</sub> emissions cannot exceed 0.30 lbs/MMBtu when No. 6 fuel oil is burned or 0.20 lbs/MMBtu when natural gas or No. 2 fuel oil is combusted. Opacity levels cannot exceed 20 percent, except for one 6-minute period per hour of not more than 27 percent opacity.

In 2011, there were no exceedances of the NO<sub>x</sub> emission standards for either boiler, and there were no excess opacity measurements recorded for either boiler during routine operations. The only recorded opacity excursions were observed during performance testing of the opacity monitors.

Because natural gas prices were lower than residual fuel oil prices throughout 2011, the CSF used natural gas to supply more than 99 percent of the heating and cooling needs of the Laboratory's major facilities during the year. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide were at their lowest in the last decade.

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

### ***Water Quality Surveillance Program***

The Laboratory discharges treated wastewater into the headwaters of the Peconic River via



BNL's 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.

In 2011, the average gross alpha and beta activity levels in the STP discharge were within the typical range of historical levels and well below New York State Drinking Water Standards (NYS DWS). Tritium was detected once in the STP effluent at a concentration just above the minimum detectable activity (320 pCi/L  $\pm$  130 pCi/L), which is less than 2 percent of the NYS DWS. Analysis of the STP effluent and the Peconic River continued to show no detection of cesium-137 (Cs-137), strontium-90 (Sr-90), or other gamma-emitting nuclides attributable to BNL operations.

The STP is also monitored for nonradiological contaminants. In 2011, monitoring of the STP effluent showed that, except for isolated incidents of noncompliance for metals, organic and inorganic parameters were within SPDES effluent limitations or other applicable standards, and no volatile organic compounds (VOCs) were detected above contract laboratory method detection limits.

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 2011, there were no reported gamma-emitting nuclides attributable to BNL operations in any discharges to recharge basins, and tritium was detected only once at a low level in a single sample just above method detection limits. Inorganics (i.e., metals) were detected; however, their presence is due primarily to sediment run-off in stormwater discharges.

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 west of BNL, is monitored as a geographical control location for comparative purposes, as it is not affected by Laboratory operations. Radiological data from Peconic River surface water sampling in 2011 shows that the average concentrations of gross alpha and gross beta activity from off-site locations and control locations were indistinguishable from BNL on-site levels, and all detected levels were below the applicable NYS DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the STP. One tritium sample was detected above method detection limits, but is considered questionable due to the fact that tritium was not detected in the STP discharge during this same period. Inorganic data from Peconic River samples collected upstream, downstream, and at control locations demonstrated that elevated amounts of aluminum and iron detected in the river are associated with natural sources.

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 on site, 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. Activities to eliminate or minimize 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 or within 1 mile 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 2011 in on-site deer meat was 3.08 pCi/g, wet weight. The wet weight concentration is before a sample is dried for analysis, and is the form most likely to be consumed. 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 nor 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 continues to test for Sr-90 in bone to develop baseline information on this radionuclide and its presence in local white-tailed deer.

In collaboration with the NYSDEC Fisheries Division, BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. In 2011, Cs-137 was detected at low levels in all but 13 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 have already removed approximately 88 percent of Cs-137 in the sediment that was co-located with mercury. Natural decay is expected to result in further decreases.

Nonradiological analysis of fish in 2011 showed that 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. Polychlorinated biphenyl (PCB) analysis in fish was discontinued off site, but continued to be performed for fish on site. One fish sample tested positive for PCBs. Historically, PCBs have been found in both fish and sediment at BNL and periodically at other locations in the Peconic River. The cleanup of the Peconic River has removed most PCBs within the sediments on site.

Annual sampling of sediment and vegetation in the Peconic River and a control location on the Carmans River was also conducted in 2011. Cesium-137 was not detected in any on-site aquatic vegetation samples and was detected at levels near the detection level at off-site locations. In addition, low levels of Cs-137 were detected in sediments at off-site locations. Metals analysis conducted indicated metals at background levels, many of which are common in the environment.

Under the Peconic River remediation project, sediment from the Peconic River was excavated to remove mercury and associated contaminants from the river. Sampling results had identified three small areas with mercury concentrations greater than the cleanup goal of 2.0 mg/kg. Cleanup of these areas began in 2010 and was completed in early 2011. Thirty-one of the 33 sediment samples collected by BNL in 2011 met the cleanup goal for mercury concentration. Based on these findings, a recommendation was made to and approved by the regulators to reduce sampling in 2012 to only the three areas remediated in 2010/2011.

Water column sampling for mercury and methyl mercury was performed at Peconic River sampling locations, the STP, and one reference location on the Connetquot River in 2011. The general trend of total mercury in Peconic River water samples decreased with increasing distance downstream from the STP. Methyl mercury concentrations increased slightly from the STP to the BNL site border; then decreased gradually with increasing distance downstream of the site border until reaching the historic range of concentrations for the Connetquot River reference station.

On-site garden sampling in 2011 did not detect any Cs-137 in vegetables, but it was

detected in soils at a very low level that is considered consistent with background levels. Grassy vegetation samples also contained very low levels of Cs-137 and is also considered consistent with historical background levels.

The Laboratory 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 2011, BNL's Environmental Protection Division hosted 26 interns and 3 faculty members who worked on a variety of projects, some of which included flying squirrels, soil microbial studies of Pine Barrens soils, banded sunfish, eastern box turtles, vegetation surveys, acoustic bat surveys, and deer exclosures.

The goal of BNL's Cultural Resource Management Program 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 2011 included sending documents associated with the BGRR and HFBR to be archived, as the cleanup of both facilities was coming to a close. In addition, a loan request was received from the Long Island Museum located in Stony Brook, New York, for materials for display focused on Long Island in the 1950s.

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 2011, the Laboratory collected groundwater samples from 796 permanent monitoring wells during 2,041 individual sampling events.

Under the environmental surveillance program, twelve active research and support facilities are monitored. During 2011, groundwater samples were collected from 134 wells during 230 sampling events. Fifty temporary wells were also installed as part of this program. Although BNL has made significant investments in environmental protection programs over the past 15 years and is making progress in achieving its goal of preventing new groundwater impacts and remediating previously contaminated groundwater, in 2011, a plume of trichlorofluoromethane (also known by the trade name Freon-11) was discovered in the area of the Laboratory's Site Maintenance Facility, Building 452. In response, the BNL Groundwater Protection Contingency Plan was followed to assure that the appropriate characterization, stakeholder notifications, and corrective actions were implemented. The maximum Freon-11 concentration was 38,000 µg/L. Based on the high levels of Freon-11 in the groundwater, BNL began to install a new treatment system in late 2011 to remediate the plume. The treatment system is expected to begin operation by March 2012.

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 2011, BNL continued to make significant progress in restoring groundwater quality with the removal of approximately 156 pounds of VOCs and approximately 2.9 mCi of Sr-90. With the treatment of approximately 1.5 billion gallons of groundwater to date, 6,709 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, and Building 96 areas. Also to date, two of the treatment systems have removed approximately 26 mCi of Sr-90.

Chapter 7 of this report provides an overview of this program, and the SER Volume II, Groundwater Status Report, provides detailed descriptions, data, and maps relating to all groundwater monitoring performed in 2011.

### ***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 2011 was comparable to natural background radiation levels.

To measure direct radiation from Laboratory operations, 58 environmental thermoluminescent dosimeters (TLDs) were placed on site and 14 TLDs were placed in surrounding communities in 2011. An additional 30 TLDs were placed in a lead-shielded container for use as reference and control TLDs for comparison purposes. The average dose from all TLDs showed there was no additional contribution to on- and off-site locations from BNL operations.

In 2011, the annual on-site external dose from all potential sources, including cosmic and terrestrial radiation, was estimated as  $68 \pm 13$  mrem ( $680 \pm 130$   $\mu$ Sv), and the annual off-site external dose was estimated as  $61 \pm 10$  mrem ( $610 \pm 100$   $\mu$ Sv). The effective dose to the MEI

from air emissions was estimated as  $3.02E-01$  mrem (3.0  $\mu$ Sv). The ingestion pathway dose was estimated as 5.9 mrem (59  $\mu$ Sv) from the consumption of deer meat and 0.18 mrem ( $1.8E-01$   $\mu$ Sv) from consumption of fish caught in the vicinity of the Laboratory. The total dose to the MEI from all pathways was estimated as 6.38 mrem (64  $\mu$ 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  $\mu$ Sv), and the total dose was less than 8 percent of DOE’s annual dose limit of 100 mrem (1,000  $\mu$ Sv) from all pathways. Doses to aquatic and terrestrial biota were also evaluated and found to be well below the regulatory limits.

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 2011, the Laboratory used seven off-site contract analytical laboratories to analyze environmental samples: General Engineering Lab, Ecotest Lab, H2M Lab, Test America, Chemtex Lab, Caltest Analytical, and American Radiation. 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.

Based on the data reviews, data validations, and results of the independent PE assessments, the chemical and radiological results reported in this 2011 SER are of acceptable quality.

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