

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 (DOE). 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/esh/env/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 Environmental, Safety, Security and Health Policy reflects the commitment of BNL's management to fully integrate environmental stewardship into all facets of its mission and operations.

ENVIRONMENTAL MANAGEMENT SYSTEM

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 [EMS]) 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 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>. 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 2013, an EMS and OHSAS re-certification audit determined that BNL remains in conformance with both standards. In recommended continued EMS certification, auditors from NSF-International Strategic Registrations, Ltd., found one Minor Nonconformance

regarding the need for more consistent communication of BNL's Environmental Policy to contractors. As a corrective action, contractors are now presented with a copy of BNL's current ESSH Policy.

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 Brookhaven Science Associates 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 P2 proposals were funded in 2013, for a combined investment of approximately \$6,000. The anticipated annual savings from these projects is estimated at \$17,500, for an average payback period of approximately 4 months. Initiatives to reduce, recycle, and reuse 13.4 million pounds of industrial, sanitary, hazardous, and radiological waste through the P2 program resulted in more than \$12.7 million in cost avoidance or savings in 2013.

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 2013 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, 12 equivalency permits for the operation of groundwater remediation systems, and several other binding agreements. In 2013, the Laboratory operated in compliance with most of the requirements, and any instance of noncompliance was reported to regulatory agencies and corrected expeditiously. Routine inspections conducted during the year found no significant instances of non-compliance.

In 2013, emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from BNL's Central Steam Facility (CSF) were all within permit limits. One unexpected opacity excursion occurred in August 2013 as a result of a localized short-term power outage that occurred during scheduled electrical system maintenance in Boiler 6. Halon portable fire extinguishers continue to be removed and replaced by dry-chemical or clean agent units as they are encountered.

Monitoring of BNL's potable water system indicated that all drinking water requirements were met during 2013. Most of the liquid effluents discharged to surface water and groundwater met applicable New York State Pollutant Discharge Elimination (SPDES) permit requirements. Six excursions above permit limits were reported for the year; five occurred at BNL's Sewage Treatment Plant (STP) for total nitrogen, ammonia nitrogen, and total nitrogen load. The permit excursions were reported to the New

York State Department of Environmental Conservation (NYSDEC) and the Suffolk County Department of Health Services (SCDHS) and corrective actions were taken. Groundwater monitoring at the Laboratory's Major Petroleum Facility (MPF) continued to demonstrate that current oil storage and transfer operations are not affecting groundwater quality.

Efforts to reduce the number and minimize the severity of spills on site continued in 2013. There were nine reportable spills of petroleum products, antifreeze, or chemicals, which was less than reported in 2012. The severity of releases was minor and spills were promptly cleaned up to the satisfaction of NYSDEC.

External environmental inspections or reviews conducted in 2013 by federal, state, and local agencies that oversee BNL activities included:

- *Air Compliance.* BNL representatives accompanied NYSDEC on a site inspection in September 2013; there were no issues identified.
- *Potable Water.* In August 2013, SCDHS collected samples and conducted its annual inspection of the BNL potable water system. Corrective actions for all identified deficiencies were established and communicated with SCDHS and are being addressed by the Laboratory's Energy and Utilities Division.
- *Sewage Treatment Plant.* SCDHS conducts quarterly inspections of the Laboratory's STP to evaluate operations and sample the effluent. In 2013, no performance or operational issues were identified. NYSDEC performed an annual surveillance inspection in March; there were no issues identified.
- *Recharge Basins.* SCDHS inspected several on-site SPDES-regulated outfalls in 2013; there were no issues identified.
- *Major Petroleum Facility.* The annual NYSDEC inspection of the MPF was performed in March 2013. Five conditions that required corrective action were identified: one for faded/illegible color coding and tank identification labels and four instances where for electronic leak detectors or high-level alarm systems that were not fully functional. All conditions were corrected in accordance with NYSDEC directives.

- *Chemical Bulk Storage (CBS) Facilities.* The CBS facilities are inspected periodically by NYSDEC. An inspection was conducted in March 2013; there were no issues identified.
- *Resource Conservation and Recover Act Inspections.* NYSDEC and EPA performed RCRA inspections in 2013; there were no issues identified.

Each year, the DOE Brookhaven Site Office (BHSO) conducts several environmentally-related assessments, some of which are supported by the DOE Chicago Office. In 2013, BHSO conducted a follow-up surveillance on BSA's response to the Building 705 Stack Drain Tank High-Level Alarm, which occurred in July 2012, to verify the effectiveness of the corrective actions and participated in a peer assessment of BSA's NESHAP's Program along with a team of environmental professionals from Oak Ridge National Laboratory. The Stack Drain Tank follow-up surveillance verified that BSA has successfully implemented numerous corrective actions to prevent recurrence of the overflow of the HFBR stack drain tank and lack of timely alarm response. The National Emission Standards for Hazardous Air Pollutant (NESHAP) assessment yielded no non-conformances, five programmatic strengths, and 19 opportunities for improvement (OFIs). In May 2013, a team of BNL Subject Matter Experts were assembled to analyze the OFIs and identify actions needed to improve Rad-NESHAP program implementation. A final report was completed in June, and most of the corrections were completed by September 30, 2013.

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 2013, Laboratory facilities released a total of 4,919 curies of short-lived radioactive gases. BNL's Brookhaven Linac Isotope Producer (BLIP) is the only facility subject to EPA's continuous monitoring requirements. Oxygen-15 (half-life: 122 seconds) and carbon-11 (half-life: 20.4 minutes) emitted from the BLIP constituted more than 99.9 percent of radiological air emissions on site in 2013.

The Laboratory conducts ambient radiological air monitoring to verify local air quality and to 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 2013 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 (boilers 6 and 7) are equipped with continuous emission monitors to measure nitrogen oxide (NOx) emissions and opacity. NOx 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 2013, there were no exceedances of the NOx emission standards for either boiler, and there was one excess opacity measurement recorded for Boiler 6 during routine operations, which was due to a localized short-term power outage caused by electrical maintenance work, as discussed in Compliance Monitoring Program above. Multiple opacity excursions were recorded during performance testing of the opacity monitors and were documented in quarterly Monitoring System Performance Reports submitted to NYSDEC.

Because natural gas prices were lower than residual fuel oil prices throughout 2013, BNL's CSF used natural gas to supply more than 97.4

percent of the heating and cooling needs of the Laboratory's major facilities. As a result, annual facility emissions of particulate matter and nitrogen oxides were slightly higher than 2012 levels, when natural gas use accounted for 99 percent of Laboratory major facilities heating and cooling needs.

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 2013, 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 not detected above method detection limits throughout the year. There was also 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 2013, 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.

Discharges to recharge basins are sampled throughout the year and analyzed for 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 2013, there were no reported gamma-emitting nuclides attributable to BNL operations in any discharges to recharge basins. 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 2013 show 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. In addition, and all detected levels were below the applicable NYS DWS. Tritium was detected in one water sample collected upstream of the STP discharge. Due to the low level of detection and high uncertainty with the measurement, the data may be a false positive. 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 (e.g., the eastern tiger salamander, banded sunfish, and northern long-eared bat) are incorporated into procedures or into specific programs or project plans. While most restoration efforts have been completed, minor actions continue to remove pollutant sources that could contaminate

habitats. When possible, 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 of the Laboratory 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 2013 in deer meat was 0.85 pCi/g, wet weight (wet weight is before a sample is dried for analysis and the form most likely to be consumed). The highest concentration of Cs-137 in deer meat was 1.39 pCi/g, wet weight, from a deer taken more than 5 miles south of BNL. 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.

BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. Sampling is now alternated each year either as part of BNL's routine surveillance monitoring program or sampling performed as part of the post-cleanup monitoring for the Peconic River remediation project. In 2013, results from surveillance monitoring of fish showed low levels of Cs-137 from the Peconic River System and all samples from the Carmans River were non-detectable. Levels of Cs-137 in all fish species are within the range of results historically seen from the Peconic River.

Metals analysis of fish in 2013 focused on mercury due to its known health risk. In general, a trend of decreasing mercury content downstream from BNL's STP is evident with the highest concentration of 4.08 mg/kg measured in a chain pickerel from Area D on site. Polychlorinated biphenyl (PCB) analysis in fish

was discontinued off site, but continued to be performed for fish on site. Very low levels of Aroclor 1254 and 1260 were detected in several samples.

Annual sampling of vegetation in the on-site portion of the Peconic River was conducted in 2013. Cs-137 was detected in a single on-site aquatic vegetation sample. Under the Peconic River remediation project, sediment from the Peconic River was excavated to remove mercury and associated contaminants from three locations in 2011. Post cleanup monitoring of the three locations indicated low levels of Cs-137 and no location had a mercury concentration above the 2.0 mg/kg goal set by the Peconic River remediation project. Water column sampling for mercury and methyl mercury was performed at 9 of 15 Peconic River sampling locations in June and 6 of 15 locations in July, including BNL's STP outfall. The general trend of total mercury in Peconic River water samples decreased with increasing distance downstream from the STP. Methyl mercury concentrations fluctuated between sampling periods and between both on- and off-site locations.

Cs-137 analysis in farm vegetable samples did not detect any Cs-137 in 2013, but was detected in soils at a very low level; this is consistent with levels seen from worldwide fallout from weapons testing. Farm vegetable monitoring will be discontinued after 2013, as historic monitoring of farm vegetables showed no impacts from BNL operations. Some grassy vegetation samples and associated soil samples contained very low levels of Cs-137, and are considered consistent within the range of historical 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 2013, research included radiotelemetry surveys to determine home range and resource use by box turtles,

acoustic and mist net bat surveys, impact assessments related to the construction and operation of the Long Island Solar Farm on site, and statistical analysis of long-term ecological and environmental monitoring data.

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 2013 included the submission of BNL's Cultural Resource Management Plan to the New York State Historic Preservation Office for review and the preparation of loan papers for the loan of Camp Upton artifacts to the Long Island History Museum for a display on "Long Island at War."

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

Groundwater Protection Management Program

BNL has made significant investments in environmental protection programs over the past 20 years and continues to make progress in achieving its goal of preventing new groundwater impacts and remediating previously contaminated groundwater. No new impacts to groundwater quality were discovered during 2013. The Laboratory's extensive groundwater monitoring well network is used to evaluate progress in restoring groundwater quality, to comply with regulatory permit requirements, and to monitor active research and support facilities where there is a potential for environmental impact. In 2013, BNL collected groundwater samples from 780 permanent monitoring wells and 65 temporary wells during 2,815 individual sampling events.

BNL continues to make significant progress in restoring groundwater quality. During 2013, approximately 183 pounds of volatile organic compounds (VOCs) and approximately 1.3 mCi of Sr-90 were removed while treating almost 1.4 billion gallons of groundwater. With the

treatment of approximately 22 billion gallons of groundwater since the start of active remediation, 7,133 pounds of VOCs and 29 mCi of Sr-90 have been removed from the aquifer, and noticeable improvements in groundwater quality are evident in a number of on- and off-site areas.

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 2013.

Radiological Dose Assessment Program

The Laboratory routinely reviews 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 to the Maximally Exposed Off-Site Individual (MEOSI), which is defined as the possible largest dose to a person at a residence, office, or school beyond 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 2013 was comparable to natural background radiation levels.

To measure direct radiation from Laboratory operations, 58 environmental thermoluminescent dosimeters (TLDs) were deployed, of which 9 were placed in known radiation areas and 11 off-site areas in 2013. An additional 30 TLDs were placed in a lead-shielded container for use as reference and control TLDs for comparison purposes. The average dose of all TLDs showed there was no additional contribution above the natural background radiation 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 estimated as 66 ± 8 mrem (660 ± 80 μ Sv) and the annual off-site external dose was estimated as 61 ± 7 mrem (610 ± 70 μ Sv).

The ingestion pathway dose was estimated as 2.02 mrem (20 μ Sv) from the consumption of deer meat and 1.64E-01 mrem (1.6 μ Sv) from consumption of fish caught in the vicinity of the Laboratory. The dose from the air inhalation pathway attributable to BNL operations was 3.65 E-01 (36 μ Sv), which is less than 4 percent of EPA's annual regulatory dose limit of 10 mrem (100 μ Sv). The total dose to the MEI from all pathways was estimated as 2.55 mrem (26 μ Sv), which is less than 3 percent of DOE's 100-mrem limit. Doses to aquatic and terrestrial biota and also from short-term projects, such as remediation work and waste management disposal activities, 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 report 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 2013, the Laboratory used six off-site contract analytical laboratories to analyze environmental samples: General Engineering Lab, H2M Lab, Test America, Chemtex Lab, Caltest Analytical, and American Radiation Services. 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 documented in this report are of acceptable quality.

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