

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/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.

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/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 2012, an EMS and OHSAS surveillance 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 better document control to prevent unintended use of obsolete documents. Corrective actions will be 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 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 of eight P2 proposals, submitted by employees to BNL's P2 Council, were funded in 2012, for a combined investment of approximately \$13,500. The anticipated annual savings from these projects is estimated at \$170,000, for an average payback period of approximately 1 month. Initiatives to reduce, recycle, and reuse 13.1 million pounds of industrial, sanitary, hazardous, and radiological waste through the P2 program resulted in more than \$3.0 million in cost avoidance or savings in 2012.

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 2012 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, 13 equivalency permits for the operation of groundwater remediation systems, and several other binding agreements. In 2012, the Laboratory complied fully with most requirements; all instances of noncompliance were reported to regulatory agencies and corrected expeditiously. Routine inspections conducted during the year found no significant instances of non-compliance.

The Laboratory received two Notices of Violation (NOV) from EnergySolutions of Utah and one Notice of Non-Compliance from the Environmental Protection Agency (EPA). The two NOV's from EnergySolutions were received in June and August and resulted in 600 points against BNL's Utah Generator Site Access Permit, but with no monetary fines. In July, EPA issued a Notice of Non-Compliance of Subpart H, 40 CFR 61, National Emissions Standards for Hazardous Pollutants—radionuclides (rad-NESHAP), as a result of some findings from an inspection in July 2012 and review of BNL's 2011 rad-NESHAPs Report. A revised annual report was submitted, which addressed the non-compliance findings.

In 2012, emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from BNL's Central Steam Facility (CSF) were all within permit limits. Nine unexpected opacity excursions occurred in January 2012 due to the sudden

buildup of soot across the transmitter light path for Boiler 6, for which there was no apparent cause. Subsequent shutdown and cleaning of the light path brought opacity readings back to normal. 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 was transferred to the Department of Defense Ozone Depleting Substances Reserve in 2012.

Monitoring of BNL's potable water system indicated that all drinking water requirements were met. During 2012, most of the liquid effluents discharged to surface water and groundwater met applicable New York State Pollutant Discharge Elimination (SPDES) permit requirements. Nine minor excursions above permit limits were reported for the year; three occurred at BNL's Sewage Treatment Plant (STP) (iron, total nitrogen, and total nitrogen load), five pH excursions were recorded for discharges to recharge basins (one at Outfall 007 and four at Outfall 008), and one oil and grease excursion at Recharge Basin 006B. The permit excursions were reported to the New York State Department of Environmental Conservation (NYSDEC) and the Suffolk County Department of Health Services (SCDHS). 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 2012. There were 15 reportable spills of petroleum products, antifreeze, or chemicals, which was slightly less than in 2011. The severity of releases was minor and spills were promptly cleaned up to the satisfaction of NYSDEC.

Nine external environmental inspections or reviews were conducted in 2012 by federal, state, and local agencies that oversee BNL activities. These inspections included:

- *Air Compliance.* NYSDEC did not perform a formal inspection of the Laboratory's air compliance program in 2012; however, NYSDEC was present during a portion of the annual relative accuracy test audit of the continuous emissions monitoring system

at the CSF. There were no issues identified during this inspection.

- *Potable Water.* In July, SCDHS collected samples and conducted its annual inspection of the BNL potable water system. Identified deficiencies 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; no performance or operational issues were identified. NYSDEC performed an annual surveillance inspection in February; there were no issues identified.
- *Recharge Basins.* SCDHS inspected several on-site SPDES-regulated outfalls in 2012; there were no issues identified.
- *Major Petroleum Facility.* The annual NYSDEC inspection of the MPF was performed in February 2012. Three conditions required corrective action were identified. All conditions were corrected in 2012 in accordance with NYSDEC directives.
- *Chemical Bulk Storage (CBS) Facilities.* The CBS facilities are inspected periodically by NYSDEC. An inspection was conducted in February 2012. Two conditions were noted and corrected in 2012 in accordance with NYSDEC directives.

Each year, the DOE Brookhaven Site Office (BHSO) conducts several environmentally-related assessments, some of which are supported by the DOE Chicago Office. In May 2012, BHSO conducted a Readiness Assessment for Transition of BNL's Brookhaven Graphite Research Reactor (BGRR) and High Flux Beam Reactor (HFBR) Long-Term Surveillance and Maintenance (S&M) Program. The purpose of the assessment was to review BSA progress in implementing the BGRR and HFBR Long-Term S&M Transition Plan and to identify any issues or impediments to successfully transferring long-term stewardship responsibilities of the facilities to the Environmental Services Division (ESD), and to complete the Environmental Management Legacy Scope from the Laboratory's Environmental Restoration Projects to other organizations within BNL. The assessment consisted of verification of the completion of the

required actions and development of an open action list, which will be monitored and tracked to completion through BNL's assessment tracking system (ATS).

In July 2012, BHSO performed a surveillance audit of BNL's Response to the Building 705 Stack Drain Tank High-Level Alarm during a severe rainstorm in July 2012. Rainwater that touches the interior surfaces of the stack becomes radioactively contaminated. This water is collected via a stack drain collection system and flows into a double-walled, underground storage tank. During the storm, the tank was overfilled and set off an alarm indicating that water entered the overflow containment sump and ultimately the interstitial space between the primary and secondary containment of the tank. Although there was no release of contaminated water to the environment as a result of this overflowing event, BHSO concluded that the alarm response was inadequate and recommended that BNL evaluate the event and consider potential vulnerabilities across the site where alarm response and notification procedures may be less than adequate. Following the assessment, the Laboratory identified several corrective actions to address the findings and tracked them to completion using BNL's ATS.

In June 2012, BHSO performed a surveillance audit of the Laboratory's SPDES Discharge Monitoring Report Preparation. The intent of the audit was to review BNL's process to track permit requirements, to ensure the correct wastewater samples are collected for analysis, the Laboratory's contract for laboratory analyses, conduct quality assurance reviews of sample results, and to transpose results for reporting to NYSDEC. No findings were identified.

In November 2012, BHSO, with assistance from the Chicago Integrated Support Center, conducted an assessment of BNL's Packaging and Transportation Program, in accordance with DOE Order 460.2A, Departmental Materials Transportation and Packaging Management. DOE concluded that, overall, transportation operations at the Laboratory are performed as required and that BNL has been implementing improvements. However, DOE also concluded that the Laboratory needs to continue to focus

on the implementation of additional corrective actions that were developed during previous self-assessments. BNL agreed to include any additional corrective actions resulting from this assessment into an existing corrective action plan that resulted from a previous assessment of on-site movements of hazardous and radioactive materials. Corrective actions will be tracked to completion through the Laboratory's ATS.

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 2012, Laboratory facilities released a total of 4,901 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: 20.48 minutes) emitted from the BLIP constituted more than 99.9 percent of radiological air emissions on site in 2012. The annual facility emissions of particulate matter and oxides of nitrogen were at their lowest in the last decade.

Monitoring was also conducted at one other active facility, BNL's Target Processing Laboratory (TPL), and one inactive facility, the HFBR. Releases from the TPL in 2012 continued to be very small (0.0944 μ Ci). Low levels of tritium from the HFBR (0.81 Ci) were primarily due to the presence of residual tritium in ambient air exhausted from the facility prior to and during monthly 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 2012 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_x) emissions and opacity. NO_x 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 2012, there were no exceedances of the NO_x emission standards for either boiler, and there were nine excess opacity measurements recorded for Boiler 6, also discussed in Compliance Monitoring Program above. 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 2012, BNL's 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 and nitrogen oxides 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 2012, 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 (630 pCi/L \pm 350 pCi/L), which is 3 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 2012, 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 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 2012, there were no reported gamma-emitting nuclides attributable to BNL operations in any discharges to recharge basins, and tritium was detected 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 2012 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, and all detected levels were below the applicable NYS

DWS. No gamma-emitting radionuclides or tritium attributable to Laboratory operations were detected either upstream or downstream of the STP. 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 2012 in on-site deer meat was 0.27 pCi/g, wet

weight (wet weight is before a sample is dried for analysis and 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 in 2012 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. With 13 years of Sr-90 data providing a sound baseline indicating on- and off-site values having overlapping distributions, BNL will discontinue testing for Sr-90 content in 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. 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 cleanup project. In 2012, fish monitoring results 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 appear to be declining, compared to historic values.

Nonradiological analysis of fish in 2012 detected chromium in a single sample from the Peconic River system. Nickel values in three samples were above the minimum detection level. These reported values are not considered to 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, and all values were less than the method detection limit.

Annual sampling of sediment and vegetation in the Peconic River and a control location on the Carmans River was also conducted in 2012. 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 three locations in 2011. Post cleanup monitoring of the three locations indicated low levels of Cs-137 and one location had a mercury concentration above the 2.0 mg/kg goal set by the Peconic River cleanup project, but it was below SCDHS action levels. Water column sampling for mercury and methyl mercury was performed at 6 of 15 Peconic River sampling locations and 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.

On-site garden sampling in 2012 did not detect any Cs-137 in vegetables, but was detected in soils at a very low level, which is considered consistent with background levels. Ten years of monitoring at the BNL garden area has provided a sufficient baseline showing no impact from any historic or recent operations; therefore, surveillance monitoring will be discontinued in 2013. Grassy vegetation samples also contained very low levels of Cs-137 and are also considered consistent with historical background levels. One soil sample associated with grassy vegetation had a Cs-137 concentration of 43.9 pCi/g. This sample was outside of the former Hazardous Waste Management Facility (HWMF) and just outside of an area that had previously been remediated.

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 2012, research included flying squirrel radiotelemetry surveys and genetics, box turtle home range determination and resource use, acoustic and mist net bat surveys, and impact assessments related to the construction and operation of the Long Island Solar Farm on site.

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 2012 included the loan of BNL artifacts, presentations, and a dedication ceremony at BNL's Chemistry Building as a Historical Chemical Landmark. In addition, the Laboratory completed revisions to BNL's Cultural Resource Management Plan and prepared the plan for submission to the New York State Historic Preservation Office for review.

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 15 years and continues to make progress in achieving its goal of preventing new groundwater impacts and remediating previously contaminated groundwater. 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 2012, BNL collected groundwater samples from 796 permanent monitoring wells and 44 temporary wells during 1,791 individual sampling events.

During 2012, BNL continued to make significant progress in restoring groundwater quality with the removal of approximately 239

pounds of volatile organic compounds (VOCs) and approximately 1.9 mCi of Sr-90 from the groundwater. With the treatment of approximately 1.5 billion gallons of groundwater to date, 6,948 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 27 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 2012.

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 2012 was comparable to natural background radiation levels.

To measure direct radiation from Laboratory operations, 49 environmental thermoluminescent dosimeters (TLDs) were placed on site and 12 TLDs were placed in surrounding communities in 2012. 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.

In 2012, the annual on-site external dose from all potential sources, including cosmic and terrestrial radiation, was estimated as 68 ± 12 mrem (680 ± 120 μ Sv) and the annual off-site external dose was estimated as 62 ± 10 mrem (610 ± 100 μ Sv). The effective dose to the ME-OSI from air emissions was estimated as $2.35E-01$ mrem (2.4 μ Sv). The ingestion pathway dose was estimated as 2.21 mrem (22 μ Sv) from the consumption of deer meat and $1.0E-01$ mrem (1.0 μ Sv) from consumption of fish caught in the vicinity of the Laboratory. The total dose to the maximally exposed individual (MEI) from all pathways was estimated as 2.55 mrem (26 μ Sv). The dose from the air inhalation pathway attributable to BNL operations was less than 3 percent of EPA's annual regulatory dose limit of 10 mrem (100 μ Sv) and the DOE's annual dose limit of 100 mrem ($1,000$ μ Sv) from all pathways. 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 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 2012, 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 reported in this 2012 SER are of acceptable quality.

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