

## *Executive Summary*

The 2003 Site Environmental Report (SER) was prepared to inform regulators, the public, Laboratory employees, and other stakeholders of Brookhaven National Laboratory's (BNL's) environmental performance for the calendar year. The report was prepared in accordance with Department of Energy (DOE) Order 231.1, Environment, Safety and Health Reporting, and summarizes BNL's performance in the areas of environmental management, environmental impacts, compliance with applicable regulations, surveillance monitoring, and restoration. A summary of the report is available as a separate document that provides a general overview of BNL's performance for 2003 and includes a CD version of the full report. The report and the summary are also available on the BNL web page at <http://www.bnl.ser.htm>.

BNL is operated and managed for DOE's Office of Science by Brookhaven Science Associates, a limited-liability company founded by Stony Brook University, and Battelle Memorial Institute, a nonprofit, applied science and technology organization. For more than 50 years, BNL 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. BNL's motto, "Exploring Life's Mysteries...Protecting its Future," reflects BNL's management philosophy to fully integrate environmental stewardship into all facets of its missions and operations.

Brief descriptions of Laboratory facilities, ecological resources, demographics, and history are provided in Chapter 1 of this report.

### **BNL'S ENVIRONMENTAL MANAGEMENT SYSTEM**

One of BNL's highest priorities is ensuring that the Laboratory's environmental performance measures up to its world-class status in science. In 2001, an Environmental Management System (EMS) was established at BNL ensuring that environmental issues are systematically identified, controlled, and moni-

tored. It also provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual environmental improvement.

The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard, with additional emphasis on compliance, pollution prevention, and community involvement. BNL was the first U.S. DOE Office of Science Laboratory to become officially registered to this standard. Annual audits, which are required to maintain the registration, are conducted to validate that BNL's EMS is being maintained and to identify evidence of continual improvement. In 2003, an EMS Surveillance Audit determined that BNL remains in full conformance to the standard.

A strong Pollution Prevention (P2) Program is an essential element of the successful accomplishment of BNL's mission and EMS. The BNL 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 BNL operating philosophy. 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 at the Laboratory.

To date, pollution prevention projects have saved more than \$1.5 million and have resulted in the reduction or reuse of approximately 2.3 million pounds of waste. In 2003, BNL invested approximately \$96,000 in newly funded pollution prevention projects, with an annual anticipated savings of \$88,000, for an average payback period of 1.2 years.

Chapter 2 of this report describes BNL's EMS and related programs in further detail.

### **BNL'S ENVIRONMENTAL MANAGEMENT PROGRAM**

BNL's Environmental Management Program consists of several Laboratory-wide and facility-specific environmental programs. This program

identifies potential pathways for exposure of the public and the environment, and evaluates what impacts BNL activities may be having on the environment. The cornerstone of the Laboratory's Environmental Management Program is the BNL Environmental Stewardship Policy. This policy states the Laboratory's intentions and principles regarding overall environmental management and provides a framework for planning and action. The policy is posted throughout the Laboratory and on the BNL website and is included in all training programs for new employees, guests, and contractors. A brief overview of the Laboratory's environmental programs and a summary of performance for 2003 are presented below.

### ***Compliance Monitoring Program***

BNL has an extensive program in place to ensure compliance with all applicable environmental regulatory requirements and permits. BNL must comply with more than 100 sets of federal, state, and local environmental regulations, numerous site-specific permits, equivalency permits for the operation of nine groundwater remediation systems, and several other binding agreements. In 2003, BNL operated in compliance with the majority of these requirements, and programs are in place to address areas for continued improvement. Routine inspections conducted during the year found no significant instances of noncompliance.

Compliance monitoring in 2003 showed that emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide were all within permit limits; the potable water supply met all drinking water requirements; groundwater monitoring at the Major Petroleum Facility continued to demonstrate that current oil storage and transfer operations are not affecting groundwater quality; and liquid effluents met all applicable New York State Pollutant Discharge Elimination System (SPDES) permit requirements, with the exception of one excursion at the Sewage Treatment Plant (STP) and three at other outfalls. There were 22 reportable spills of petroleum products or antifreeze on site in 2003. All releases were cleaned up or addressed to the satisfaction of the New York State Department of Environmental Conservation (NYSDEC).

BNL underwent nine environmental audits by external regulatory agencies in 2003. These audits included inspections of petroleum storage, air emissions from the Central Steam Facility (CSF), STP operations, other regulated outfalls and recharge basins, and the potable water system. Immediate

corrective actions were taken to address issues raised during these inspections.

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

### ***Air Quality Program***

BNL monitors radioactive emissions at several facilities on site to ensure compliance with the requirements of the Clean Air Act. Facilities that have the potential to deliver an annual radiation dose of greater than 0.1 mrem to a member of the public must be continuously monitored for emissions. Facilities capable of delivering radiation doses below that limit require periodic, confirmatory monitoring. The Brookhaven Linac Isotope Producer (BLIP) is the only BNL facility that requires continuous monitoring. There are three other facilities where periodic monitoring is conducted. During 2003, BNL facilities released a total of 3,725 curies of short-lived radioactive gases. Oxygen-15 (half-life: 122 seconds) and carbon-11 (half-life: 20.48 minutes) emitted from the BLIP constituted more than 99.7 percent of these air emissions.

Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emission monitoring to demonstrate compliance with emission limits. The CSF is the only BNL facility that requires monitoring for nonradiological emissions. Two of the four boilers at the CSF are equipped with continuous emission monitors to measure nitrogen oxides and opacity. In 2003, there were no measured exceedances above the regulatory limits of nitrogen oxides from boiler emissions.

The Laboratory also conducts ambient radiological air monitoring to verify local air quality and assess possible environmental impacts from BNL operations. Air monitoring stations are in place around the perimeter of the BNL site to measure tritium and gross alpha and beta airborne activity. Results measured at BNL in 2003 demonstrated that on-site radiological air quality was consistent with results observed at locations in New York State not located near radiological facilities.

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

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

BNL discharges treated wastewater into the headwaters of the Peconic River via the STP, and 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 helps ensure that wastewater discharges comply with all applicable requirements.

To assess the impact of discharges on the quality of the Peconic River, surface water monitoring is conducted at several locations upstream and downstream of the STP effluent. The Carmans River is monitored as a geographical control location for comparative purposes, as it is not affected by BNL operations. In 2003, the average gross alpha and beta activity levels in the STP discharge were within the typical range of historical levels and were well below drinking water standards. Tritium releases were slightly higher than in 2002 (but still less than 4 percent of the drinking water standard) due to activities at the High Flux Beam Reactor in preparation for its decommissioning. There were no detections of cesium-137 (Cs-137) or strontium-90 (Sr-90) in the STP effluent, a result of remediation activities in 2002 and 2003. Nonradiological monitoring of the effluent showed that, with the exception of isolated incidents of noncompliance, organic and inorganic parameters were within the SPDES effluent limitations or other applicable standards.

Recharge basins are used for the discharge of “clean” wastewater streams, including once-through cooling water, stormwater runoff, and cooling tower blowdown, and are suitable for direct replenishment of the groundwater aquifer. Radiological analysis of data in 2003 showed that low levels of alpha and beta activity were detected in most of the basin discharges and are not attributable to BNL operations, but to natural terrestrial/geological or cosmic sources. The presence of sediment in the stormwater may explain the low level of radionuclides which were detected. Tritium was not detected in the discharge to any basin above the Minimum Detection Level (MDL) during 2003. Nonradiological analyses in 2003 showed that all parameters, except for iron, complied with the respective groundwater discharge or water quality standards.

Chapter 5 of this report describes BNL’s Water Quality Surveillance Program 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 BNL’s scientific mission. The goals of the program include protecting and monitoring the ecosystem, conducting research, and communicating with staff, the public,

and stakeholders regarding environmental issues. Precautions are taken to protect and enhance habitats and natural resources at the Laboratory. Activities to eliminate or minimize negative effects on sensitive or critical species (such as the tiger salamander, eastern hognosed snake, and the banded sunfish) are incorporated into BNL procedures or into specific program 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. BNL also monitors and manages other animal populations, such as the white-tailed deer and the wild turkey, to ensure that they are sustained, and monitors invasive plant species to control their spread.

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. In 2003, deer sampling results were consistent with previous years. Deer sampled on the BNL site contain higher concentrations of Cs-137 than deer sampled from greater than 1 mile off site. This is most likely the result of deer consuming contaminated soil and grazing on vegetation growing in soil where elevated Cs-137 levels are known to exist. Removal of areas of contaminated soil at BNL began in 2000 and will continue. The New York State Department of Health (NYSDOH) has reviewed the potential public health risk associated with elevated Cs-137 levels in on-site deer and determined that neither hunting restrictions nor formal health advisories are warranted.

BNL and the local NYSDEC Fisheries Division maintain an on-going program for analyzing fish from the Peconic River and surrounding freshwater bodies. BNL stopped sampling shellfish in 2003, as historical records indicated there were no impacts attributable from BNL operations. Fish sampling results in 2003 were consistent with previous years. Low levels of Cs-137 were found in all samples taken from the Peconic River system. Concentrations of metals, pesticides, and polychlorinated biphenyls (PCBs) were not considered to have any health impact on fish or humans who may have consumed the fish. Aquatic sampling of sediment, vegetation, and freshwater in the Peconic River and a control location on the Carmans River showed low levels of Cs-137 in sediments at all locations, with levels on site slightly higher than off site. Metal analyses indicated levels both on and off site were above Suffolk County Department of Health Services (SCDHS) cleanup objectives, but below action levels. Pesticides and PCBs analyses of sediment, vegetation, and freshwater from nearly all locations found

the pesticide DDT or its breakdown products, DDD and DDE. These banned pesticides were historically used all across Long Island, including at BNL.

Vegetables grown in the BNL garden plot continue to support historical analyses that there are no Laboratory-generated radionuclides in the produce. Sampling of off-site farm vegetation was discontinued in 2003, since historic data indicated that there were no BNL-related radionuclides in off-site vegetation. Periodic confirmatory sampling will be conducted on a reduced frequency.

A new 5-year testing cycle for recharge basin sediment sampling was established in 2003. Sediment samples taken from a new recharge basin on site associated with one of the outfalls that received discharges permitted under the SPDES permit showed that there were no PCBs or pesticides detected. However, semivolatile organic compound analyses of basin sediments determined that most of the chemicals detected were attributable to a diesel fuel spill.

Precipitation samples were collected quarterly at air monitoring stations and analyzed for radiological content. Samples collected in 2003 showed sporadic detections of gross alpha activity above the MDL. In general, radioactivity in precipitation comes from naturally occurring radionuclides in dust and from activation products that result from solar radiation. Gamma analyses detected beryllium-7, another naturally occurring radionuclide resulting from solar flare activity, in one sample. Lead-212 and thallium-208 were also detected in one of the samples.

In November 2000, the Upton Ecological and Research Reserve (Reserve) was established on site by DOE. This 530-acre Reserve, managed by the U.S. Fish & Wildlife Service (FWS), is used to conduct resource management programs for the conservation, enhancement, and restoration of wildlife and habitat. In 2003, BNL worked with the Reserve's Technical Advisory Group (TAG), regulatory agencies, and other stakeholders to develop a comprehensive, ecosystem-based Natural Resource Management Plan and approved funding for several research projects. The Reserve continues to produce new ecological data each year. Highlights for 2003 include the discovery of the redbellied snake, a species not reported on Long Island in 60 years, and research into the orange striped oakworm, a species capable of decimating the abundant oak forests that make up much of the Long Island ecosystem.

The goal of BNL's Cultural Resource Management Program is to ensure that proper stewardship of BNL and DOE historic resources is established and maintained. Additional goals include

maintaining compliance with various historic preservation and archeological laws and regulations, and ensuring the availability of resources to BNL personnel and the public for research and interpretation. In December 2003, BNL submitted a draft Cultural Resource Management Plan to DOE for approval. This plan will guide the management of all of the Laboratory's cultural resources. Also in 2003, compliance procedures and requirements for archaeological surveys were developed.

Chapter 6 of this report describes BNL's Natural and Cultural Resource Management Programs in further detail.

### ***Groundwater Protection Management Program***

The goal of BNL's Groundwater Protection Management Program is to ensure that plans for groundwater protection, management, monitoring, and restoration are fully defined, integrated, and managed in a cost-effective manner that is consistent with federal, state, and local regulations. BNL is committed to protecting groundwater resources from further impacts from current and past practices, and to remediating existing contaminated groundwater. BNL's extensive groundwater monitoring well network is used to verify that prevention and restoration activities are effective, and to track cleanup progress.

Program elements for groundwater monitoring include the installation of monitoring wells; planning and scheduling; developing and following quality assurance protocols; collecting and analyzing samples; verifying, validating, and interpreting data; and reporting results. Monitoring wells are used to evaluate BNL's 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 entering and leaving the BNL site.

In 2003, BNL collected groundwater samples from 754 monitoring wells during 2,810 individual sampling events. Since the beginning of active groundwater remediation activities in December 1996, BNL has removed 4,156 pounds of volatile organic compounds (VOCs) by treating nearly 6.8 billion gallons of groundwater. During 2003, seven groundwater remediation systems removed 510 pounds of VOCs and returned approximately 1.3 billion gallons of treated water to the Upper Glacial Aquifer. Under the Laboratory's Environmental Restoration Program, a primary goal is to remediate soil and groundwater contamination and prevent additional contamination from migrating off site. Although widespread improvements in groundwater quality at

BNL are expected to require approximately 10 years of aquifer treatment, noticeable improvements are already evident.

BNL is classified as a public water purveyor and maintains water supply wells and associated treatment facilities for the distribution of potable water on site. The quality of the BNL potable water supply is monitored as required by the Safe Drinking Water Act and the analytical results are reported to SCDHS. BNL also prepares an annual Consumer Confidence Report that is distributed to all employees and guests. Monitoring of BNL's potable water system in 2003 showed that the potable water supply met all drinking water requirements.

Chapter 7 of this report describes the BNL Groundwater Monitoring Program in further detail.

### ***Radiological Dose Assessment Program***

BNL routinely assesses its operations to ensure that any potential radiological dose to the public, BNL workers, and the environment is "As Low As Reasonably Achievable." The potential radiological dose is calculated as the maximum dose to a hypothetical Maximally Exposed Individual (MEI) at the BNL site boundary and calculated by considering all direct and indirect pathways. For dose assessment purposes, the pathways included direct radiation exposure, inhalation, ingestion, and skin absorption. Radiological dose assessments at BNL routinely show that the Effective Dose Equivalent (EDE) from BNL operations is well below the Environmental Protection Agency (EPA) and DOE regulatory dose limits for the public and the environment. The dose impact from all BNL activities in 2003 was found to be insignificantly above natural background radiation levels.

To assess the impact of direct radiation from BNL operations, thermoluminescent dosimeters (TLDs) are deployed at the BNL site and in the 16 wind sectors of the surrounding communities. In 2003, the average doses from 56 on-site and 18 off-site TLDs showed that there was no additional contribution from BNL operations to dose above natural background radiation on or off the site. The yearly average ambient external dose was calculated to be  $64 \pm 10$  mrem ( $640 \pm 100$   $\mu$ Sv) on the BNL site and  $61 \pm 9$  mrem ( $610 \pm 90$   $\mu$ Sv) at off-site locations. Both these measurements include contributions from cosmic and natural background sources.

The EDE from the air pathway was calculated as  $5.96E-2$  mrem ( $0.6$   $\mu$ Sv) to the MEI. The ingestion pathway dose was estimated as 2.18 mrem (22  $\mu$ Sv) from venison consumption and 0.19 mrem (1.9  $\mu$ Sv) from consumption of fish caught at Swan

Pond. BNL's total annual dose to the MEI from all pathways was estimated as 2.43 mrem (24  $\mu$ Sv). In comparison, EPA's annual regulatory dose limit is 10 mrem (100  $\mu$ Sv) for the air pathway, and DOE's annual dose limit is 100 mrem (1,000  $\mu$ Sv) from all pathways. In 2003, doses to aquatic animals, terrestrial plants, and terrestrial animals were found to be well below the DOE regulatory limits.

Remediation and waste management projects conducted in 2003 were evaluated for radiological emissions and dose impact. It was concluded that there was no significant dose and radiological risk to the public or the environment from these activities.

Chapter 8 of this report describes the BNL Radiological Dose Assessment Program 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 standard operating procedures that are designed to ensure that samples are representative and that the data are reliable and defensible. Quality control in the analytical laboratories is maintained through daily instrument calibration, efficiency and background checks, and testing for precision and accuracy. Data are verified and validated as required by project-specific quality objectives before they are used to support decision making.

In 2003, BNL used the on-site Analytical Services Laboratory (ASL) and four off-site contractor laboratories to analyze environmental samples. All analytical laboratories were certified by New York State for the tests they performed for BNL, and were subject to oversight that included state and national performance evaluation testing, review of QA programs, and audits.

The laboratories performing radiological analyses (BNL's ASL and two contractor laboratories) each scored 95 percent or better in state and federal laboratory testing programs. BNL's "overall satisfactory" score in radiological testing was 95.9 percent. In nonradiological performance evaluation testing, BNL received an Acceptable rating of 96.1 percent and the off-site contractor laboratories scored Acceptable ratings of between 95 percent and 98 percent. For the 458 radiological and nonradiological performance evaluation tests carried out in 2003, BNL's combined "overall satisfactory" score was 95.9 percent.